

Review Article

Physical Activity and Exercise as a Tool to Cure Anxiety and Posttraumatic Stress Disorder

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Anxiety and posttraumatic stress disorder (PTSD) are the most prevalent psychiatric conditions and significant public health problems. However, research has tended to support claims that engaging in physical activity (PA) has beneficial psychological effects. The objective of this review is to examine exercise and PA therapies as a kind of PTSD and anxiety treatment. Exercise has been shown in interventional trials to be both anxiolytic and antidepressive in healthy individuals. Exercise and PA therapies have a variety of benefits and varying degrees of efficacy in treating PTSD and anxiety symptoms. PA has been shown to promote physical health; psychological health and a growing body of studies indicate that PA and general health are associated with PTSD and anxiety. These findings led to recommendations for exercise interventions as a safe, efficient, and effective therapeutic option for treating anxiety and PTSD symptoms. Studies have not, however, demonstrated that they can lower anxiety to the same degree as psychotropic drugs. Additionally, the majority of published studies have significant methodological flaws, necessitating the need for additional research to determine the ideal exercise modalities, frequency, duration, and intensity for enhancing the beneficial benefits of exercise on anxiety and PTSD.

1. Introduction

Lack of activity destroys the good condition of every human being, while improvement and methodical PA save it and preserve it. Plato, fourth century BC. Physical activity (PA) is any skeletal muscle movement that causes energy expenditure [1]. This definition covers a wide range of subgroups, such as occupational, athletic, conditioning, domestic, or other activities [2]. Exercise is a part of PA characterized as repetitive PA that is planned, structured, and performed over time to improve PA to increase or maintain fitness [3], and mindful training is a connection between mind and body done with a strong inward contemplative focus [4]. In this review article, PA/Exercise is used as an umbrella term.

The benefits of regular PA for general health and physical fitness are both evident [5]. Increased PA and decreased inactive time are associated with high positive affectivity and feelings of energy [6]. The health benefits of consistent PA are intriguing, as exercise is believed to be the first lifestyle change to treat and prevent chronic disease. According to

a US Department of Health and Human Services survey [7], regular exercise and PA, which have health benefits across all age groups and categories, can reduce causes of death by up to 30% in both men and women. Along with a number of risk factors that increase the likelihood of heart disease, such as obesity, high blood pressure, and a rapid heart rate, PA lowers the incidence of infections such as type 2 diabetes, angina, heart attacks, and strokes [8, 9].

Physical inactivity is a global problem, with 80% of young people lacking access to a supportive environment for physical, social, cognitive, and mental health (MH) [10, 11]. Mental illnesses may be linked to a lack of PA. Exercise and PA therapies, especially for anxiety, stress, and depression, may be crucial in the management of mild-to-moderate MH conditions [12, 13]. Exercise has been shown to positively affect the signs and symptoms of generalized anxiety disorder (GAD), posttraumatic stress disorder (PTSD), trait anxiety, depressive symptoms, tension, weariness, and energy levels. It also helps with stress management and social withdrawal symptoms [14–18]. PA has declined

in importance as sedentary lifestyles become increasingly prevalent in modern society. People who exercise regularly report experiencing less age-related memory loss and cognitive decline [19, 20].

The results underscored the importance of PA for physical and mental well-being. Exercise has been demonstrated to safeguard and improve both mental and physical health when done as part of PA. Exercise has a significant impact on people's social, mental, and physical health. More relaxation and better sleep were also associated, as sleep difficulties are common in war and torture survivors, and poor sleep quality is associated with decreased PA in people with PTSD [21]. The limited evidence suggests that PA can improve overall sleep quality, as well as PTSD, anxiety, and depression symptoms [22]. For individuals with PTSD, three weeks of high-intensity resistance training can improve sleep quality and reduce anxiety [23]. In GAD patients, short-term physical training improves self-reported sleep outcomes. According to the results, better sleep may be associated with lower clinical severity in GAD patients [24]. The search strategy for this review paper is available in the supplementary information (available here).

2. PA/Exercise Linked to MH

More than 150 million people currently suffer from a mental illness. Many mental illnesses are related to population growth, changing lifestyles, and broken families. Exercise is thought to be crucial for the prevention and treatment of MH issues [25, 26]. A significant association between PA and exercise and physical health, life satisfaction, cognitive functioning, and psychological well-being has been demonstrated in numerous studies that have highlighted the benefits of PA and exercise for MH. Studies on the benefits of PA and exercise for MH and well-being have also advanced the theory that these activities increase the likelihood of positive emotions such as strength, joy, and energy while decreasing the likelihood of negative emotions such as worry, sadness, tension, exhaustion, and anger [14, 18, 27, 28].

Many studies have demonstrated a connection between exercise and PTSD and its cooccurring disorders, as well as a positive effect on PTSD treatment [29, 30]. By relieving PTSD symptoms and improving quality of life (QOL), sport and PA contribute to the health and rehabilitation of injured war veterans [31]. Exercise is the finest approach to improving MH and is also extremely important in the management of many medical conditions [32, 33]. Regular exercise has been shown to have a positive impact on symptoms of anxiety and depression [34–38].

PA can improve awareness, concentration, mood, and QOL through social connection, meaningful use of time, and focused activities, according to a study of reviewed papers that included PA as a treatment for people with severe mental illness [39]. Studies have shown that aerobic and anaerobic exercise, as well as PA, can aid people who are experiencing MH problems [40, 41]. Previous study has indicated that the intensity of exercise is crucial in managing and treating MH disorders. Broman and colleagues found that both high- and low-intensity exercise lowered anxiety

sensitivity. High-intensity exercise, on the other hand, resulted in a faster drop in a global measure of anxiety sensitivity (GMAS) and a larger response to treatment than low-intensity exercise [42]. Structured group programs, according to Sharma, et al. [43], can be beneficial for those with severe mental illness, but for most patients, lifestyle changes that focus on accumulating and increasing moderate-intensity movement throughout the day may be more appropriate. Additionally, these MH advantages can be achieved with just 30 minutes of moderately intense exercise, such as brisk walking, three days a week. According to a study of more than 4,323 men and women, those who engaged in moderate-to-vigorous PA had a significantly lower risk of developing depressive symptoms than those who engaged in lighter activity or sedentary behaviors [44]. There is growing evidence that exercise can be an important part of a comprehensive PTSD treatment program [45]. Low- to moderate-intensity exercise can reduce anxiety, improve mood, and act as a stress buffer [45]. Exercise has been shown to reduce the signs and symptoms of depression and PTSD, particularly mind-body exercise and low-intensity aerobic exercise [17]. In general, PA can be a helpful tactic for increasing self-esteem, evoking positive feelings, promoting psychological well-being in adolescents by improving physical cognition and body satisfaction, and reducing stress [46, 47].

2.1. Detrimental Effects of PA/Exercise on Physical and MH. Excessive or inappropriate exercise can also sometimes be detrimental to physical condition and MH. Some people may overuse PA and overwhelm themselves [48]. A person can become just as addicted to exercise as any other substance if they overemphasize it [49]. PA addiction can lead to mental disorders and deterioration in physical health [50]. Excessive exercise without adequate rest can lead to overtraining, which increases susceptibility to disease and hormonal imbalances [51, 52]. Any fitness program should include time for rest and recovery as this allows the body to heal and regenerate. Inadequate recovery time between workouts can lead to physical fatigue, reduced muscle strength, and a weakened immune system [53]. Excessive exercise can increase the risk of developing atrial fibrillation, coronary artery disease, and malignant ventricular arrhythmias. These bursts of intense activity can cause cardiac dilation, cardiac dysfunction, and the release of troponin and natriuretic peptide in the brain [54]. Exercising can result in body sensations such as increased heart rate, muscle tightness or pain, sweating, or shortness of breath that have previously been associated with traumatic events or stress. [21]. Somatic symptoms are more common in people with panic disorders after PA [55, 56].

People who exercised for 3 hours or more had higher psychological distress than those who did not exercise at all [57]. Depression is associated with mental fatigue, which can be exacerbated by strenuous exercise [58]. Additionally, individuals at risk for exercise addiction show more signs of anxiety, depression, attention deficit hyperactivity disorder, and childhood trauma than frequent athletes who are not at risk [59, 60]. The strenuous training in endurance sports often leads to increased mood swings in athletes. Overtraining in extreme

situations can lead to staleness syndrome, a disorder characterized by a drop in performance and behavioral problems, including severe depression. Exercise can produce either positive or negative changes in MH, and the outcome appears to depend primarily on the dose used [50]. There is a significant negative association between the severity of PTSD symptoms and PA. In regression models, PTSD hyperarousal was the only significant predictor of PA. The results of the observational studies are divided, with half reporting a significant negative correlation between PTSD and PA and the other half reporting no significant associations between PTSD and PA. In studies looking at specific PTSD symptoms, only PTSD hyperarousal was associated with a significant correlation. However, results from two pilot intervention studies suggest that PA interventions have a beneficial effect on PTSD symptoms [61]. They found no evidence that acute training seizures trigger panic attacks (although they rarely and coincidentally occur together). On the contrary, there is evidence that patients with panic disorder benefit from PA [62]. It is worth noting that the detrimental effects of exercise on MH are typically related to heavy or unhealthy exercise routines rather than moderate and balanced PA. Regular exercise, when done safely and sustainably, is often helpful for MH. Figure 1 provides an overview about the outcomes of PA and exercise for MH.

2.2. Anxiety and Exercise. One of the main groups of psychiatric illnesses, as well as in other medications, is anxiety disorder. It is a mental illness that can be grouped into the categories of worry, fear, and anticipation about a specific person or situation. This psychological symptom affects the majority of people. According to the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5), there are several different types of anxiety disorders, including GAD, social anxiety disorder, panic disorder, separation anxiety disorder, agoraphobia, and specific phobias [63]. The effects of exercise on anxiety disorders and the effects of both short- and long-term PA on anxiety symptoms in healthy participants or those with medical conditions have only been studied in a few researches [64, 65].

Regular PA can prevent a variety of diseases, including coronary heart disease, hypertension, noninsulin-dependent diabetes, osteoporosis, and MH conditions, such as depression and anxiety [66, 67]. Exercises help to relieve anxiety, tension, and stress symptoms in various situations. Exercising at 70 to 90% of maximum heart rate for 20 minutes three times a week has been shown to reduce anxiety sensitivity [68]. It can also be used as a stress-reduction technique that improves mood and self-esteem while minimizing emotional and physical stress responses [69].

2.2.1. Somatic Symptoms, Self-Efficacy, and Distractions. Somatic symptoms are the manifestations of feelings or emotions that patients perceive and communicate through physical discomfort and distress [70]. This phenomenon could be caused by a range of cultural, familial, and personal factors, such as prejudices against the depiction of psychological pain [71–73]. About 30% of anxiety patients have somatic symptoms at the same time [74]. Interoceptive

training resulted in significant improvements in interoceptive accuracy ratings, as well as significant decreases in somatic symptoms and anxiety [75]. Across a wide range of adult populations, PAs are very helpful in reducing the signs and symptoms of anxiety, depression, and psychological distress [76]. According to Henriksson et al. [77], a 12-week group exercise program for individuals with anxiety symptoms in a primary care setting was helpful. Similarly, Broman-Fulks, & Storey [78], examine the effectiveness of a brief aerobic intervention for people with high anxiety sensitivity. Participants with high levels of anxiety sensitivity (Anxiety Sensitivity Index-Revised Scores >28) were randomly assigned to either six 20-minute aerobic exercise sessions or a no-exercise control condition. Individuals assigned to the aerobic exercise condition reported significantly lower anxiety sensitivity postexercise, whereas anxiety sensitivity ratings did not change significantly among non-exercise participants.

Self-efficacy is the domain in which the effects of exercise on anxiety fall. The belief in one's own capacity to finish activities and accomplish goals is known as self-efficacy [79]. Self-efficacy belief belongs to an important class of proximal factors that influence human motivation, affect, and behavior. It relates with how in control someone feels about potential hazards, which may be closely tied to the arousal of anxiety. In some situations, people with high self-efficacy can control their own intentions and behavior [80]. Another self-efficacy-based intervention with 122 volunteer participants that was exposed to greater self-efficacy and behavioral barriers found that a coaching approach on self-set goals significantly improved group exercise behavior. When fitness levels increase, one gains more power, less discomfort, more endurance, and other advantages [81].

Distraction is the act of diverting or changing one's focus from one activity to another. Distraction is another factor that makes exercise beneficial at lowering anxiety. A single exercise session has been found to be less effective at reducing anxiety than distraction tactics like meditation and rest periods [82]. In a study examining the effects of rumination and distraction on depressive and anxious emotions, rumination was found to be a more important cognitive susceptibility factor to depression and anxiety than distraction [83]. In a similar vein, the efficacy of cognitively based distraction techniques and exercise in reducing state anxiety were compared; however, exercise was more successful in lowering trait anxiety [79].

Stubbs et al. [84] conducted a cross-sectional study to examine the general association between anxiety and PA. When the study looked at the global prevalence of PA and anxiety, a connection between the two was discovered. The Global Health Survey found that 237,964 individuals from 47 different countries had an estimated prevalence rate of anxiety. 11.4% (95% CI 11.1%-11.8%) was the global baseline prevalence rate of anxiety across 47 countries. According to the International PA Questionnaire (IPAQ), PA ranges were divided into low, moderate, and high categories (short form). Poor PA was more common in those with anxiety than in those without, at 22.9% vs. 16.6%. ($p < 0.001$). Low PA levels are associated with a higher prevalence of anxiety;

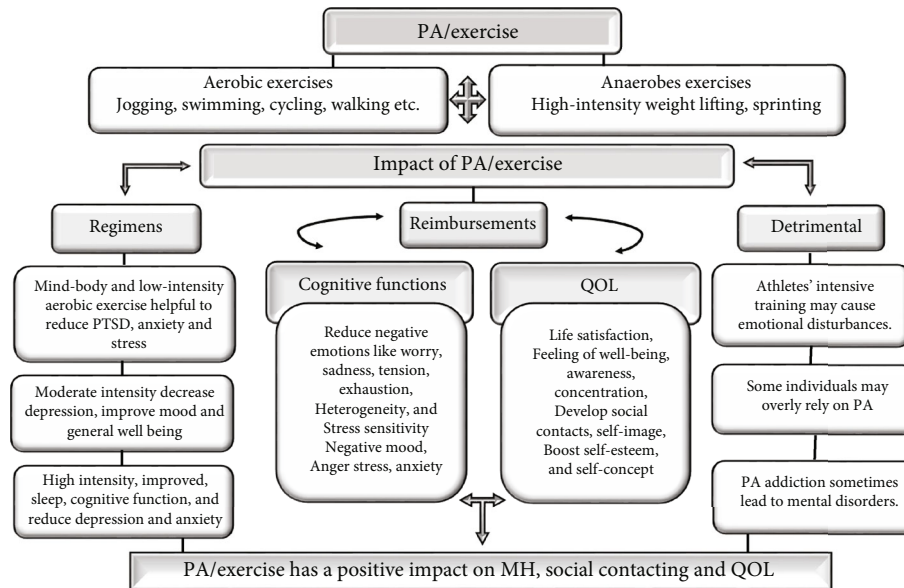


FIGURE 1: Effects of PA/exercise on MH.

17 out of 38 countries report that there is a strong positive correlation between the two.

A cross-sectional study showed a link between a flexible lifestyle and MH in 278 community-based women aged 70 and older. Participants were regarded to be physically active if they reported engaging in three or more hours of PA each week (ranging from light exercise to vigorous exercise). The findings revealed that the likelihood of experiencing anxiety and depression symptoms among physically active women was half that of inactive women [85]. An investigation examining the relationship between changes in PA, subsequently self-reported mood, and daily functioning was conducted in a cohort study in 1985, 1995, and 2001. Between 1920 and 2001, Finland fielded 2,448 male athletes in international or domestic contests. Between the PA level in 1985 and mood, anxiety symptoms, and day-to-day functioning, connections were found in 1995 and 2001. A rise in PA between 1985 and 1995 also helped to fend off the onset of anxiety between 1995 and 2001. [86]. Physical therapy was beneficial as an extra therapy, according to Jayakody, Gunadasa, and Hosker [87], who conducted a thorough analysis to evaluate the effectiveness of PA on anxiety disorders (associated with pharmacotherapy and cognitive-behavioral therapy). There was no clear distinction found between aerobic and nonaerobic activities.

For the purpose of comparing several PA methods for treating anxiety symptoms in older people, one randomized controlled experiment was created. 150 senior citizens aged 60 to 70 were split into five groups for the study: swimming, running, square dancing, tai chi, and a control group. For 18 months, a moderate-intensity fitness regimen was given to each participant group. When compared to the control group, the findings of the 12-month intervention indicated a significant decrease in depressive symptoms. However, there were no discernible variations in anxiety symptoms between the various PA methods [73]. The study's findings,

which were reviewed, showed that exercise and PA can reduce anxiety symptoms in a variety of ways.

- (i) Low PA levels are linked to a higher prevalence of anxiety, whereas activity of a moderate to intense intensity significantly lessens anxiety symptoms and improves wellbeing
- (ii) According to the study, numerous diseases that impair physical and mental well-being can be avoided by regular PA
- (iii) Exercise and PA are typically connected with those who have higher levels of anxiety, but they can also assist people with lower levels of anxiety by easing their symptoms
- (iv) In terms of producing more meaningful and beneficial changes in the way anxiety symptoms are treated, long-term therapies outperform short-term interventions

2.3. PTSD and Exercise. PTSD is the only mental illness whose cause is known. It is a horrific or traumatic incident that resulted in significant physical harm and its repercussions, which include domestic aggression, physical violence, war, catastrophic events, and other risks to a person's life [88]. PTSD affects 5 to 10% of the population and is twice as common in women as it is in men. PTSD has an effect on a wide range of biological functions, including neural circuits, neuropathology, cytotoxic, immunological, endocrinological, and physiological functions. It is possible to have unpleasant thoughts, feelings, or dreams about the events, as well as to suffer mentally or physically in response to trauma-related cues, be unable to concentrate, have trouble falling asleep, and withdraw emotionally [89].

To find anomalies in important brain regions in PTSD patients, numerous neuroanatomical studies have been conducted. The ventromedial prefrontal cortex, the amygdala, and the hippocampus are three of the well-studied networks in behavioral neuroscience [90]. The hippocampus governs the hypothalamic-pituitary-adrenal axis, which regulates stress hormones and responses. The hippocampus has been related to contextual modulation of behaviour due to its function in fear learning and suppression of fear in safe contexts, i.e., fear conditioning, extinction, and fear renewal [91]. In people with multiple sclerosis, exercise improves hippocampal volume and connectivity. Exercise improved hippocampal volume by 2% [92, 93]. The central core that generates the main outputs of the amygdala controls anxiety-related behaviour. In healthy adults, amygdala involvement is firmly established throughout fear conditioning. Therefore, activation of the amygdala in PTSD may reflect an overreaction of fear circuits and explain PTSD symptoms such as hypervigilance and hyperarousal [94]. Furthermore, the amygdala is adjacent to the hippocampus, and there is considerable evidence of a mutual modulating influence between these two highly interconnected regions, particularly on emotional memory [91]. PTSD has been associated with changes in the ventromedial prefrontal cortex. Although the ventromedial prefrontal cortex is thought to facilitate the extinction of acquired fear responses, multiple data suggest that this region plays a broader role in fear regulation [95].

Individuals with PTSD find it difficult to express their ideas, feelings, and emotions, and they continue to perceive and respond to stress in a different way than others who do not have the condition [96–98]. The orbitofrontal cortex and insula showed a positive functional connection with the amygdala to implicit happiness, while the parahippocampus and subgenual cingulate showed negative functional connectivity to implicit fear after running [99]. Prefrontal cortex activation changes have been linked to acute exercise-induced increases in cognitive ability [100]. Figure 2. Shows the influence of exercise on the brain and how it affects specific brain regions in PTSD.

Exercise is beneficial as part of a holistic approach to treating PTSD as it is believed to act as a stress buffer. Studies have found that exercise is a critical component and serves an important purpose in treating PTSD [16, 29]. Exercise of a low to moderate intensity is intended to improve mood, reduce anxiety, and act as a stress-relieving mechanism. Additionally, aerobic exercise has been shown to improve physical capacity and MH in PTSD sufferers by alleviating their symptoms of hopelessness and PTSD [17, 101–103]. Exercises that are widely known and effective at reducing anxiety and depression symptoms, like Pilates, Yoga, Therapeutic Dance, Tai Chi, or Qigong, should be prescribed to patients with PTSD. Patients with PTSD have shown these exercises to be helpful [104].

In one study, exercise and psychotherapy together led to higher reductions in PTSD symptoms than psychotherapy alone. A different investigation found that PA had a bad link with PTSD symptoms and a diagnosis [105, 106]. A meta-analysis of four randomized controlled trials (RCTs) on the

benefits of regular exercise for PTSD revealed that PA significantly reduced depressive and PTSD symptoms and that regular exercise may offer a number of benefits for those with PTSD. More investigation into this association was suggested to be done. PA appears to be effective in the treatment of PTSD, and exercise can be a fantastic approach for people with PTSD to activate their behavior [107].

According to the results, aerobic exercise is effective in reducing symptoms of PTSD. Three treatments showed effective results and shed light on the role of PA in managing PTSD symptoms. The first study examining the relationship between PA and PTSD was completed in 2005. Nine participants who had gone through traumatic events such as the sudden death of a family member or friend, sexual or physical assault, a serious auto accident, combat, or a serious illness, injury, or disease were included in the study. They did a 10-minute warm-up, followed by 30 minutes of aerobic walking or running, and a 10-minute cool-down that included stretching and bicycling. The study's findings indicate that PTSD symptoms were dramatically diminished both before and after therapy [102].

For the second experiment, which was carried out in 2007, a total of fifteen Participants (aged 14 to 17) who met the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (DSM-IV) criteria for PTSD were enlisted. For eight weeks, participants followed a three-times-per-week aerobic exercise regimen. Due to their voluntary withdrawal and discharge, 11 participants completed the entire experiment. Each 5-minute session includes 5 minutes for stretching and 1 minute for a low-impact warm-up activity. The next 20 minutes were spent participating in organized group aerobic exercises that kept each participant's heart rate between 60 and 80% of their maximum heart rate (such as dancing, Tae Bo, walk/jog). The study found that treating PTSD symptoms with exercise was successful in lessening PTSD, anxiety, and depressive symptoms [103].

The third experimental intervention in 2014 used a two-week aerobic exercise program to evaluate the effectiveness of PA in reducing PTSD symptoms. 33 study participants rode stationary bikes for two consecutive weeks of exercise (6 sessions). In one of three exercise settings, they were paired together at random. The first group received prodded attention to somatic arousal during exercise. Although group 2 evaluates distraction from bodily arousal during exercise, Group 3 evaluates directed exercise without distractions. The study's findings demonstrated that both forms of exercise significantly reduced the symptoms of PTSD. Moreover, aerobic exercise can be utilized to treat PTSD alongside other therapies and may be a useful choice for PTSD patients who face barriers to therapy [108].

A randomized controlled trial evaluated the benefits of a 12-week fitness program in conjunction with conventional therapy for PTSD. Patients were randomly assigned to one of two therapy groups by the participants. For the other half, private counseling, medication, and psychotherapy were offered in addition to standard care. A 12-week, individualized fitness program that included walking and strength-training activities was given to the other half in addition to

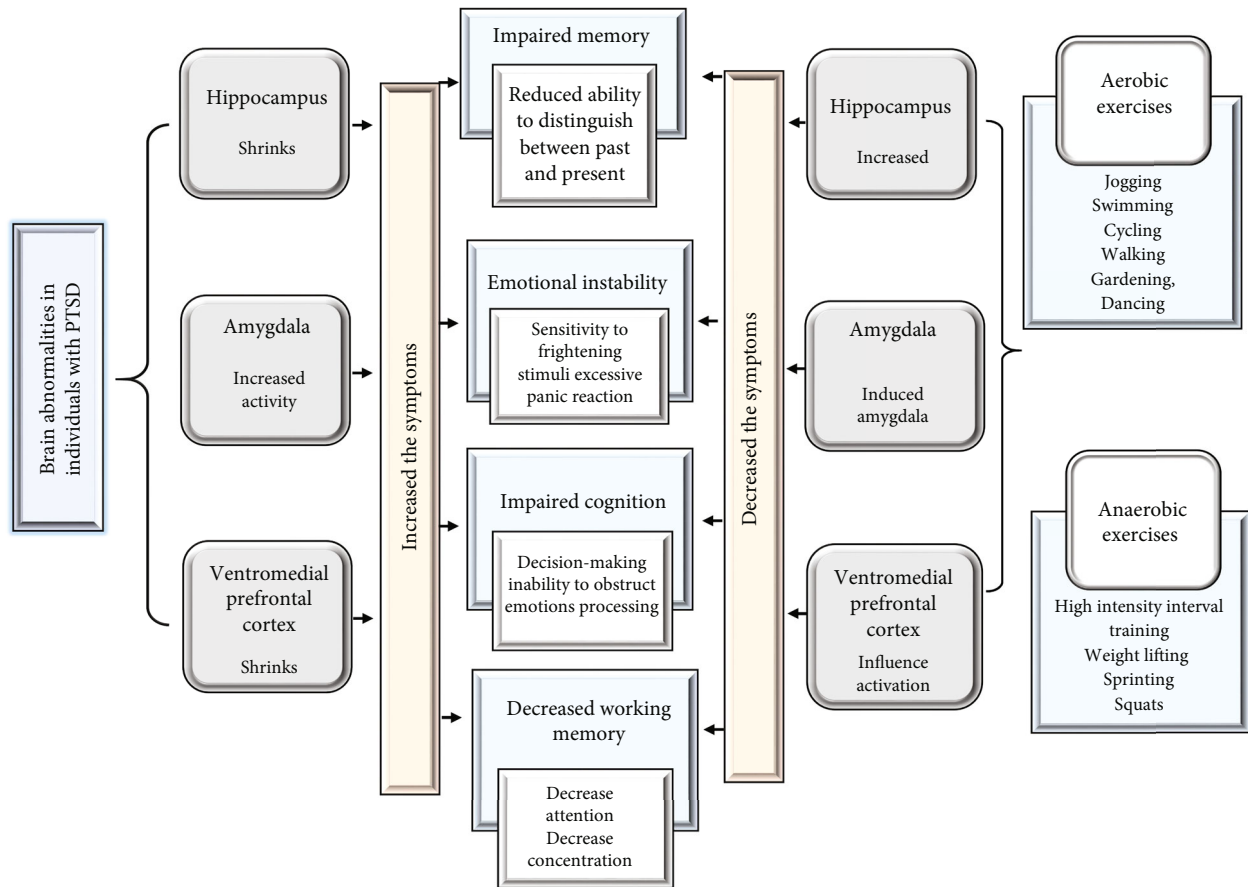


FIGURE 2: Describes the effects of exercise on the brain and how various brain regions are altered in PTSD.

conventional treatment. Patients who underwent the exercise program in addition to conventional care fared better than those who received only standard care in terms of PTSD, depression, anxiety, and stress [109].

This indicates that PA is a useful adjunctive therapy that can be used to reduce the severity of PTSD symptoms and that documented research has shown an encouraging association between PA and PTSD in relieving PTSD symptoms. Some of the main effects of PA and exercise for PTSD include the following:

- (i) The physical and MH of PTSD patients appear to be improved by aerobic exercise, which appears to actively contribute to lowering PTSD symptoms
- (ii) In the management of PTSD, low to moderate levels of PA aid to reduce symptoms and serve as a stress buffer
- (iii) Exercise significantly reduces PTSD symptoms and has a higher impact when paired with psychotherapy
- (iv) Contrary to individuals who just got conventional care, the exercise program led to more favorable outcomes and showed better improvement in PTSD, depression, anxiety, and stress symptoms

- (v) The results showed that a consistent PA program offers PTSD sufferers a lot of health advantages and considerably lowers PTSD

3. Exercise (Interventions) to Cure Anxiety and PTSD

The effectiveness of exercise therapy in treating PTSD and anxiety has been extensively studied [77, 104, 110]. An early literature review found an association between exercise therapy and the treatment of anxiety and PTSD [16, 111, 112], but also revealed a number of methodological issues [78, 103, 108]. However, the results suggest that PA and exercise are helpful adjunctive treatments that can be used to reduce the severity of anxiety and PTSD symptoms, and that there is a positive association between PA, anxiety, and PTSD in terms of healing the symptoms of these conditions [27, 68, 102, 108].

A number of studies have found a favorable association between exercise and anxiety and depression. Although anxiety disorders receive less attention than depression [113], PTSD can also benefit from physical training. The researchers hypothesized that adding additional, regularly used PTSD treatment modalities to exercise programs would increase their therapeutic effectiveness. Exercise programs are considered beneficial for the treatment of PTSD and can reduce anxiety and distress [102, 114].

Exercise is meant to help alleviate anxiety by reducing symptoms and feelings associated with anxiety. A mixed patient sample revealed that a home-based walking program significantly increased the therapeutic effectiveness of a group receiving cognitive behavioral therapy in comparison to educational sessions with a healthy diet emphasis [115]. Patients with high trait anxiety and GAD were found to benefit more from aerobic exercise training than from strength and mobility activities [116]. Exercise generally works well to reduce the effects of anxiety. Interestingly, both an acute PA event and a regular activity plan showed a significant improvement in symptoms.

The aim of the present study is to offer a well-founded and insightful examination of the subject. To this end, we carefully analysed 29 studies, 14 of which included a total of 1889 people, to examine the effects of PA/exercise on anxiety. To draw conclusions, we thoroughly reviewed the results of each study. Eight of the 14 included studies had 506 participants and focused on aerobic and anaerobic activity. According to a randomized pilot group study by Merom et al. [115], walking was promoted as an adjunctive intervention to group cognitive behavioral therapy for anxiety disorder to reduce anxiety symptoms and improve QOL. Compared to the placebo group, both aerobic exercise and the antidepressant clomipramine significantly reduced panic attack symptoms. This suggests that aerobic exercise can be a useful therapeutic option for individuals suffering from panic disorder [117].

Broman-Fulks and Storey [78] showed that aerobic exercise was successful in reducing anxiety sensitivity, which is the fear of anxiety-related symptoms and the belief that they could have adverse effects. Similarly, Katula, Blissmer, and McAuley [118] suggest that older people with higher exercise intensity and greater self-efficacy in exercise showed greater reductions in anxiety. In addition, pediatric patients with type 1 diabetes who participated in resistance aerobic exercise reported reduced anxiety, higher serum cortisol levels, and better QOL. Combining aerobic exercise and cognitive behavioral therapy has improved the effectiveness of treating panic disorders [119]. Aerobic and nonaerobic exercise have been shown to be beneficial in the treatment of anxiety disorders [120].

In 5 studies, the exact exercise modules were not specified; therefore, we counted them as mixed activities (light and vigorous exercise, housework, walking, push-ups, and strengthening) by the total of 1233 participants involved in these studies. According to another study, among older women in the community, frequent exercise is linked to better MH, specifically lower anxiety levels and maintaining social relationships [85]. Regardless of athletic background, Backmand, Kaprio, Kujala, and Sarna [86] found that frequent PA is associated with lower levels of anxiety and may improve mood and daily functioning in middle and old age. The study by Sexton, Maere, and Dahl [121] found a significant decrease in anxiety. In addition, PA supported the release of brain chemicals that elevate mood, serve as a temporary distraction from stress and worry, and improve social relationships and overall well-being. Studies have reported that telerehabilitation improves anxiety levels.

Anxiety symptoms were reduced in both caregivers and cystic fibrosis patients, improving everyone's QOL. Regular PA helped victims of child abuse alleviate their anxiety issues. This suggests that introducing exercise to treat anxiety in this population may be effective [122, 123]. The effect of yoga is examined in a study with 150 participants. Zhang et al. [73] found no significant differences in anxiety symptoms after the intervention. Table 1 summarizes some of the specific studies that evaluated the effectiveness of exercise programs in treating anxiety symptoms.

Many studies on the link between PA and PTSD have found a positive association between the two [16, 108]. The effectiveness of drugs in treating PTSD is undeniable. Research, however, indicates that a number of veterans of the armed forces experience treatment difficulties such as price, availability, inadequacy, and prejudice. Therefore, innovative therapy modalities that circumvent these challenges would be attractive. Because training can be done at will and is often inexpensive or free, it also reduces therapeutic barriers such as care costs, scheduling conflicts, or transportation difficulties [124, 125]. In a research of young individuals, it was observed that hyperarousal symptoms were strongly and adversely associated to exercise and that PA levels declined as PTSD symptoms were more severe. A long-term decline in activity is associated with a delayed onset of PTSD, which is correlated with a negative outcome for recovery from PTSD [106, 126, 127].

We carefully analysed 29 studies, 15 of which examined the effects of PA/exercise on PTSD with a total of 714 participants; 4 of these included studies specifically examined the effects of aerobic/anaerobic exercise (165 participants). Several studies have shown that regular aerobic exercise can be beneficial for people with PTSD. According to research by Newman and Motta [103], aerobic exercise can be used as a stress reduction technique and coping mechanism because it releases feel-good endorphins and gives the mind a break from compulsive thinking. Similarly, Fetzner and Asmundson [108] stated that aerobic exercise reduces anxiety, painful memories, intrusive thoughts, negative emotions, and depression commonly associated with PTSD while improving mood, self-esteem, and self-awareness. Harte, Vujanovic, and Potter [128] suggested that exercise can help people avoid painful memories and thoughts related to the trauma while improving mood, overall physical well-being, and sleep quality. In addition, Powers et al. [129] examined the association between PA and exposure to traumatic stimuli, which appear to help eliminate PTSD and anxiety, increase emotional control, and improve treatment outcome.

Two studies claim that exercise programs have the potential to reduce symptoms of PTSD, improve emotional well-being, and generally improve QOL. In 4 studies, the individual exercise modules were not described, so we count them among the mixed exercises (211 participants). These results demonstrate the potential of PA as a nonpharmacological strategy to control and alleviate PTSD symptoms [109, 111, 130]. Research on therapeutic riding suggests that people may find it easier to control their emotions, feel safer, and have a better QOL when interacting with horses in a planned and encouraging environment [131].

TABLE 1: Summary of specific studies to assess the effects of exercise on anxiety.

Studies/ design	Time duration/participants	Assessment scale	Intervention details	Results
Merom et al., [115] Group randomized trial	Duration = January 2004 to May 2005 N = 74	DASS-21	8 weeks of 30-minute walking sessions, recorded with a pedometer, gradually increased to 5 sessions per week. The intensity was not measured.	According to the research, GCBT+EX significantly and favorably affected the signs and symptoms of stress, anxiety, and depression.
Cassidy et al., [85] Cross-sectional study	N = 278 Age = 74.6 years (mean)	BDI, BAI, SF-36, CAMCOG	PA, ranging from light exercise (e.g., doing housework, walking the dog) to vigorous exercise, such as aerobics. Get 30 minutes of exercise most days of the week.	Women who exercised regularly had a lower risk of depression and anxiety (BDI score greater than or equal to 10) (BAI score greater than or equal to 8). Those who engaged in PA had a lower likelihood of experiencing clinically severe anxiety symptoms (OR = 0.5, 95% CI = 0.3-0.8). The results also demonstrate a link between greater anxiety and a sedentary lifestyle.
Backmand et al., [86] Longitudinal study	Duration = 6 years of follow – up N = 853 Mean age = 68.6	BSI-53 MEI	PA was defined by values of the MET. PA was calculated from the product of intensity times, duration times, and activity frequency. The activity MET index was expressed as the number of MET hours per day.	A rise in PA between 1985 and 1995 served as a deterrent against the emergence of anxiety between 1995 and 2001. The evolution of physical functioning impairments in the elderly and the onset of anxiety appear to be significantly slowed by PA.
Sexton et al., [121] A controlled follow-up study	Duration = 8 weeks, subsequent 6 months of follow-up N = 52 Age = 20-60 years	SCL-90R STAI, BDI BPRS, GAS.	The subjects were randomly assigned to either walk or jog. Over a period of 8 weeks, the groups trained three to four times a week for 30 minutes. The joggers were told to jog at a pace appropriate to their PA. Walkers were instructed to walk at their own pace.	Frequent mild exercise like walking has similar psychological benefits as frequent vigorous activity like jogging. Both groups experienced a marked reduction in symptoms of anxiety, depression, and all other symptoms. Six months later, those with stronger aerobic fitness had much lower anxiety levels. Studies have found the value of exercise as an auxiliary therapy for the treatment of general neurotic symptoms, persistent anxiety, and depressive symptoms.

TABLE 1: Continued.

Studies/ design	Time duration/participants	Assessment scale	Intervention details	Results
Zhang et al., [73] Randomized control study	Duration = 18 months N = 150 Age = 60-70	HAMA, HAMD	The subjects were divided into five groups of 30 people each (swimming group, jogging group, square dance group, Tai Chi group, and control group). In groups, the elderly were taught exercise sports such as swimming, tai chi, running, and square dancing. Weekly exercise for four days, ranging from 30 to 60 minutes per day, and an 18-month continuous exercise intervention were carried out at a moderate intensity.	After a 12-month intervention, the results showed a significantly lower level of depressive symptoms in comparison to the control group. Several PA techniques for lowering anxiety symptoms did not show any discernible differences.
Broocks et al., [117] Randomized control trial	Duration = 10 weeks N = 46 Age = 18-50 years	Diagnosis of panic disorder and agoraphobia according to the DSM-III-R and ICD-10 criteria	A four-mile walk followed by three weeks of running three times a week. Also, a training session every week.	Regular aerobic activity and clomipramine were linked to a significant reduction in symptoms compared to a placebo. Exercise did not efficiently or promptly relieve anxiety symptoms like clomipramine did.
Kenis-Coskun et al., [122] A single-blind randomized trial	Duration = 12 weeks N = 28 Age = 6-13	CFQ-R, RCADS, and STAI	Multiple rehabilitation exercises repetitions 10 times each: corner pectoral stretch; retraction of the scapula with external rotation; triceps brachii strengthening; bicep strengthening exercise; bicep strengthening exercise; exercise to strengthen the lateral abdominal muscles; pushing up; strengthening of the back extensors.	Significant changes in body image improvement occurred in the telerehabilitation group. Similar significant changes were not observed in the control group. The anxiety and depression levels of the caregivers did not change significantly.
Nazari et al., [138]. Randomized control trial	Duration = 16 weeks N = 40 Age = 8-14	RCMAS & PedsQL	20 minutes of pilate exercises, 20 minutes of bodyweight exercises, and 20 minutes of aerobic exercises (V forward, V backward, and march exercises).	A 16-week program that includes strength-aerobic exercise can improve QOL and reduce anxiety in children with type 1 diabetes.
Romero-Pérez et al., [145] Randomized control trial	Duration = 20 weeks N = 105 Age = 10.02 (SD ± 0.79)	RCMAS	5-minute warm-up, 40-minute aerobic exercise, weekly 2 sessions.	Implementing a physical exercise program in overweight children encourages the emergence of positive thoughts and leads to improvements in their emotional well-being, self-awareness, and self-image. However, it does not result in significant changes in weight, height, anxiety levels, or depressive thoughts.

TABLE 1: Continued.

Studies/ design	Time duration/participants	Assessment scale	Intervention details	Results
Naderi et al., [123] Longitudinal study	Duration = 8 weeks N = 22 Age= 8-11	STAI	Aerobic dancing: warm-up (10–15 minutes); basic movements (35–40 minutes); cool-down (10 minutes); weekly 3 sessions.	As a result, it is recommended that PA and extracurricular sports activities be designed and implemented in ways that minimize anxiety in child victims of child abuse, consistent with the evidence supporting the benefits of PA in reducing anxiety prove in these people.
Broman-Fulks et al., [78] Randomized control trial	Duration= 2 weeks N = 35 Age = 18-27	ASI-R	Weekly 3 sessions, 20 minutes of aerobic exercise: treadmill running.	Results showed that those assigned to the aerobic exercise condition reported significantly lower levels of anxiety sensitivity after exercise, while scores for those who did not exercise did not change significantly.
Katula et al., [118] Randomized controlled exercise trial	Duration = 6 months N = 80 Mean Age= 67.06	SAI	Light intensity, moderate intensity, and high intensity	Anxiety decreased after the low-intensity condition; there were no significant changes in anxiety after the moderate-intensity condition; and anxiety increased after the high-intensity condition.
Gaudlitz et al., [119] Randomized controlled double-blind design	Duration = 8 weeks, 7 months of follow-up N = 47 Age= 18–70	HAMA	30 minutes on the treadmill three times a week for 8 weeks.	Both high-intensity exercise and low-intensity exercise reduced anxiety levels. Anxiety continued to improve over time, with the effect being moderate in the endurance training group but not in the control group.
Martinsen et al., [120] Randomized control trial	Duration = 8 weeks N = 79	CPRS, PARS	Brisk walking or jogging up to 70% VO ₂ max, exercised 3 times per week for 8 weeks.	At the end of the study, both groups achieved significantly lower values than their starting values. The differences between the groups were not statistically significant as they were minimal. $p > 0.1$

GCBT+EX: group cognitive behavioral therapy+exercise; GCBT+ED: group cognitive behavioral therapy+educational sessions; DASS-21: Depression, Anxiety, and Stress Scale 21; BDI: Beck Depression Inventory; BAI: Beck Anxiety Inventory; CAMCOG: Cambridge Cognitive Examination for Mental Disorders of Elderly, BSI-53: brief symptom inventory; (MEI) Metabolic Equivalent Index; SCL-90-R: Symptom Checklist-90-R; STAI: State-Trait Anxiety Inventory; BPRS: brief psychiatric rating scale; GAS: Global Assessment Scale; HAMA: Hamilton Anxiety Scale; HAMD: Hamilton Depression Scale; ICD-10: International Classification of Diseases, Tenth Revision; MET: Metabolic Equivalent Index; CFQ-R: Cystic Fibrosis Revised Questionnaire; RCADS: Anxiety and Depression Scale in Children-Revised; RCMAS: Revised Children's Manifest Anxiety Scale; PedsQL: Pediatric Quality of Life; ASI-R: anxiety sensitivity index-revised; CPRS: Comprehensive Psychopathological Rating Scale; PARS: Phobic Avoidance Rating Scale.

The effects of yoga are examined in 5 studies with 286 participants. With its gentle and flexible approach, Kripalu Yoga has proven to be an effective therapy method; both the intensity of PTSD symptoms and overall MH have improved significantly. Encouraging calm, mindfulness, and self-awareness while promoting a holistic and body-centered approach to healing and well-being. Yoga is specifically tailored to the unique needs of people with PTSD caused by military sexual

trauma (trauma-sensitive yoga) [132, 133]. With its emphasis on postures, breathing techniques, and mindfulness, yoga has proven to be a helpful adjunctive treatment for PTSD. A planned and comprehensive approach to symptom reduction was the mindfulness-based stretching and breathing exercises, which also promoted relaxation, self-awareness, and emotional control. These results suggest that yoga may be an effective adjunct to traditional PTSD therapy for patients [134–136].

TABLE 2: Overview of particular researches to assess the impact of exercise on PTSD.

Studies/design	Time duration/ participants	Assessment scale	Intervention design	Results
Rosenbaum et al., [107] Randomized control trial	Duration = 12 weeks N = 81 Age = +18	PCL-C, DASS, IPAQ-SF, PSQI	1 WSES, 2 UHES, and a walk program (with pedometer and exercise journal), 3 sets of 10 repetitions of up to six exercises, with a rest period of between 30 and 60 seconds between sets.	A research-backed fitness strategy has been linked to decreased PTSD and depression symptoms as well as better sleep. For those with PTSD, structured exercise might be considered as an additional therapeutic method.
Newman and Motta, [103] Preliminary study	Duration = 8 N = 15 Ages = 14-17	PTSD-RI, CDI, RCMAS	An aerobic exercise program lasting 40 minutes three times a week for eight weeks.	The results confirmed the beneficial effects of aerobic exercise on PTSD, sadness, and anxiety symptoms. The findings demonstrated that aerobic exercise helps to treat PTSD symptoms and is directly linked to a decrease in the severity of PTSD symptoms.
Fetzner and Asmundson [108] Randomized controlled trial	Duration = 2 weeks N = 33 Age = 36.9 years (SD = 11.2)	TLEC, PCL-C	Participants rode six 20-minute aerobic sessions using a stationary bicycle with a heart rate reserve of 60–80% (no more than four sessions per week) over a two-week period. Participants stretched for 10 minutes before taking outcome measurements.	The majority of patients (89%) reported clinically significant decreases in PTSD severity following the two-week intervention. Exercise sharply reduced PTSD symptoms, both with and without the designated diversions. The results show that aerobic exercise greatly lessens the symptoms of PTSD.
Harte et al., [128] Cross-sectional design	Duration = 12 week N = 108 Age = 18-62	PDS, EHQR	Light-intensity exercise. Moderate-intensity exercise. Vigorous-intensity exercise.	The results showed that vigorous exercise was significantly inversely related to the severity of hyperarousal symptom clusters, but light and moderate exercise were not.
Mitchell et al., [135] Pilot study of a randomized controlled trial	Duration = 6 or 12 weeks N = 38 Aged = 18-65	PCL, STAI, CES-D	75 minutes, 12 weekly sessions, or twice weekly sessions spread over 6 weeks, with no group rotation.	Revival and hyperarousal symptoms decreased in yoga practitioners.
Kim et al., [134] Randomized controlled trial	Duration = 8 weeks N = 29 Aged = 45-66	PCL	60-minute MBX sessions were conducted every six weeks for eight weeks.	The results suggest that MBX appears to reduce the prevalence of PTSD-like symptoms in people with subclinical PTSD.
Hall et al., [111] Pilot randomized controlled trial	Duration = 12 weeks N = 54 Age ≥ 60 years	PCL-5	Individual exercise sessions 60-90 minutes, 3 sessions per week.	PTSD and related diseases showed statistically significant improvements. PA/exercise is acceptable and safe for older people with PTSD, can reduce PTSD symptoms, and has a significant impact on PTSD-related disorders.
Whitworth et al., [137] Randomized controlled trial	Duration = 3 weeks N = 30 Age = 29.10 (mean)	PCL-5	30 minute lesson with films on a variety of educational topics other than exercise and MH, followed by three weekly strength training sessions.	Compared to the control condition, strength training significantly reduced avoidance and overarousal symptoms. Significant improvements were also shown in dangerous alcohol consumption and sleep quality after strength training.
Goldstein et al., [130] A randomized pilot trial	Duration = 12 weeks N = 47 Age = 18-69	PTSD-CAPS	Weekly 3, one-hour group exercises, waitlist control received the same intervention after 12 weeks.	High feasibility and acceptability were reflected in a greater decrease in PTSD symptom intensity, an increase in psychological QOL, and a smaller relative improvement in physical QOL.

TABLE 2: Continued.

Studies/design	Time duration/ participants	Assessment scale	Intervention design	Results
Powers et al., [129] Rationale and pilot efficacy data	Duration = 12 weeks N = 9 Age = 34 (mean)	PLC-C	30-minute continuous aerobic workout, a short, intermediate-level treadmill workout.	As expected, the prolonged exposure +exercise (PE+E) group showed better recovery of PTSD symptoms ($d = 2.65$) and increased neurotrophic factor levels from the brain compared to the PE condition only ($d = 1.08$).
Whitworth et al., [23] Randomized controlled feasibility trial	Duration = 3 weeks N = 22 Age = 33.0 (mean age)	PDSS	30-month session, 3-week strength training (i.e., 9 sessions total), or a timed attentional review.	The results of this study suggest that people who test positive for PTSD may benefit from three weeks of high-intensity resistance training in terms of sleep quality and anxiety reduction.
Johnson et al., [131] Randomized wait-list controlled design	Duration = 6 weeks N = 29 Age = 18+	PCL-M	Therapeutic riding (THR): 40 minutes, once a week.	The results suggest that THR could be a therapeutically effective intervention for PTSD symptoms in combat veterans. Social and emotional isolation, emotion control, and self-efficacy in coping did not approach statistical significance.
van der Kolk et al., [136] Randomized controlled trial	Duration = 10 weeks N = 64 women	CAPS	60 minutes, each as a weekly one-hour lesson spread over ten weeks.	Yoga can help traumatized people function better by allowing them to accept the physical and sensory sensations associated with fear and helplessness, as well as increasing emotional awareness and affect tolerance.
Reinhardt et al., [133] A randomized trial	Duration = 10 weeks N = 51	PCL-M PCL_C	90 minute yoga session, 2 sessions per week.	In contrast to their involvement in the control group, within-group analyses of a self-selected wait-list yoga group ($n = 7$) revealed a significant decrease in PTSD symptoms after participating in yoga.
Kelly et al., [132] Randomized controlled trial	Duration = 10 weeks N = 104 Mean age = 48.46	CAPS-5, PCL-5	Weekly group sessions lasting 60 minutes, 10 sessions in total.	According to the findings of this study, trauma-sensitive yoga may be a successful treatment for PTSD since it produces faster symptom reduction, has higher retention than cognitive processing therapy, and has a longer-lasting effect. Women veterans with PTSD brought on by wartime sexual trauma may find trauma-sensitive yoga to be a useful substitute for trauma-focused treatment.

PCL-C: PTSD checklist civilian version; DASS: Depression Anxiety and Stress Scale; IPAQ-SF: International PA Questionnaire Short Form; PSQI: Pittsburgh Sleep Quality Index; CES-D: Center for Epidemiological Studies Depression Scale; IES-R: Impact of Events Scale-Revised; BHSS: Barriers to Help Seeking Scale; CDI: Children's Depression Inventory; RCMAS-2: Revised Children's Manifest Anxiety Scale; SCQ: Stages of Change Questionnaire; PAR-Q: PA Readiness Questionnaire; CESD: Center for Epidemiological Studies-Depression Scale; TLEC: traumatic life events checklist; WSES: weekly supervised exercise sessions; UHES: unsupervised home-based exercise sessions; CAPS: Clinician-Administered PTSD Scale; CAPS-5: Clinician-Administered PTSD Scale for DSM-5; PCL-5: PTSD checklist for DSM-5; CPTSD-I: Children's PTSD Inventory; CDI: Children's Depression Inventory; PTSD-RI: Post-Traumatic Stress Disorder Reaction Index; RCMAS: Revised Children's Manifest Anxiety Scale; STAI: State-Trait Anxiety Inventory; CES-D: Center for Epidemiological Studies-Depression Scale; PDS: Posttraumatic Diagnostic Scale; EHQ-R: Exercise Habits Questionnaire-Revised; PCL-M: PTSD Checklist-Military Version; PDSS: Panic Disorder Severity Scale.

With 52 participants across 2 researches on strength training, the feasibility and effectiveness of resistance training were evaluated in two randomized, controlled pilot trials. The first study showed that PTSD and anxiety symptoms could be reduced. The results of the second study, which showed that high-intensity strength training improved sleep

quality and reduced anxiety, further supported these findings [23, 137]. The results of an exercise intervention to treat the symptoms of PTSD are presented in Table 2.

Exercise and PA therapies have so far shown constructive benefit in treating anxiety and PTSD and appear to be useful adjunctive therapies that can be used to reduce the

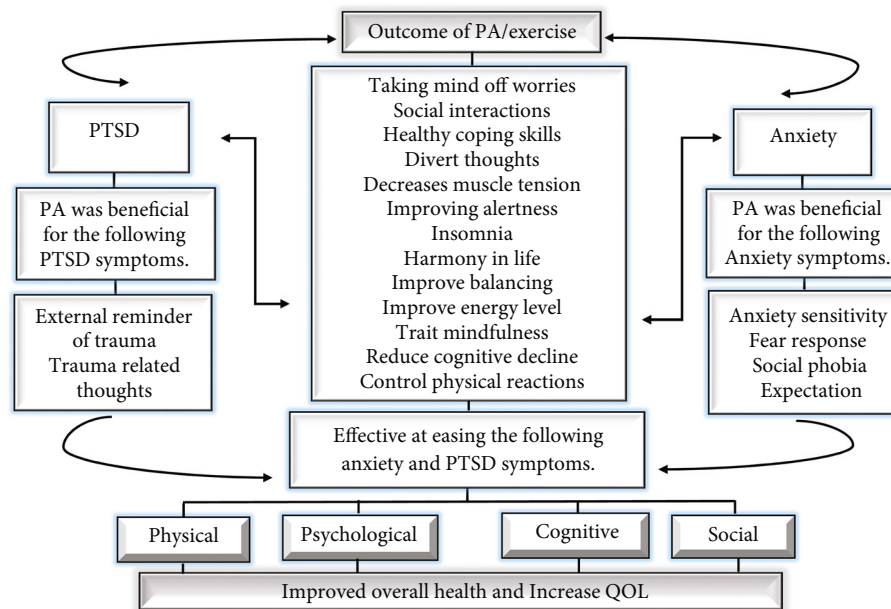


FIGURE 3: Depicts the impact of PA/exercise on anxiety and PTSD.

intensity of these disorder symptoms. There are still some issues with the study, such as incomplete sample sizes, lack of appropriate control groups, low retention rates, and the need for more data before the results can be widely applied.

3.1. Fitness Regimens (Low-Intensity Vs. Moderate-Intensity Vs. High-Intensity Exercises). The effects of different exercise modalities on anxiety and PTSD symptoms vary. Some of the publications included in this review compare and describe exercise intensity, while others merely refer to different modalities. We found that high-intensity or moderate-intensity exercise reduced anxiety symptoms faster and for longer periods of time. For example, jogging and walking both reduced anxiety, but jogging was more efficient at doing so. Panic sufferers also confirmed the observation that symptoms improved with intense or moderate-intensity exercise [85, 117–122, 138]. According to the results of one study, the level of anxiety decreased after the light intensity condition. There were no discernible differences in the relief of anxiety symptoms when moderate-intensity exercise was performed [118]. Other studies showed that both high-intensity and low-intensity exercise reduced anxiety [119, 120].

The specific contribution of high-intensity activity compared to other forms of activity is important for PTSD, while the magnitude of the impact is rather small: strenuous exercise accounts for about 4% of the variance in hyperarousal symptomatology of PTSD [128, 139]. According to other studies, three weeks of intense resistance training can reduce PTSD symptoms in PTSD-positive individuals who are not seeking treatment while improving sleep [23, 108, 129, 137]. PA, particularly low-intensity body-mind and aerobic exercise, as well as low-to-moderate PA and body-conscious movement activities (such as Pilates, yoga, therapeutic dance, tai chi, or qigong) have been shown to help cure symptoms of PTSD and improve overall well-being [103, 109, 129, 131, 133–136].

According to the selected studies, different types of PA/exercise modalities have different effects on the symptomatology of anxiety and PTSD. When it comes to anxiety, most research suggests that lower-intensity exercise may not be as effective as higher-intensity exercise. In the case of PTSD, previous research has shown that low- to moderate-intensity exercise can be more effective than high-intensity exercise in relieving PTSD symptoms. Individual preferences and talents as well as methodological peculiarities, exercise approaches, and implementation tactics should be taken into account when determining the most suitable training intensity for a specific disease.

4. Outcomes of PA/Exercise on Anxiety and PTSD

Exercise promotes MH by reducing anxiety and depression and increasing cognitive performance and self-esteem [43]. PA reduces negative thoughts, fear sensitivity, fear response, social phobia, and expectations. Exercise is considered a useful way to treat or relieve social anxiety disorder in general [110, 112, 140]. Similar results were found in patients with GAD, in whom worry and anxiety symptoms were moderately to significantly reduced by both high- and low-intensity aerobic exercises [141, 142]. A two-week aerobic exercise program was tested in a randomized control experiment to see how it affected the symptoms of PTSD patients. Compared to preintervention levels, aerobic exercise drastically reduced patients' PTSD symptoms [108]. Exercise and PA can help with PTSD symptoms such as low self-esteem, social isolation, and issues with the mind, brain, and general health, as well as with balance, coordination, and physical strength. Positive changes and better QOL result from participation in the PA program [29, 143].

TABLE 3: Key recommendations for contrasting the effects of exercise on anxiety and PTSD.

Exercise modalities	Findings
Aerobic versus anaerobic exercise	Previous research from the last two decades found that regular aerobic exercise is associated with a variety of positive physical and MH outcomes, such as reduced anxiety, anxiety sensitivity, GAD, and depressive symptoms [42, 68, 78, 146]. There is currently a dearth of research supporting the positive effects of aerobic exercise on MH outcomes. Despite the scant evidence, aerobic exercise has been linked to lowered anxiety sensitivity, personality traits, and anxiety [147–149]. According to earlier studies, aerobic exercise has higher benefits than anaerobic exercise for treating PTSD. According to studies, aerobic exercise can help reduce the signs and symptoms of depression and PTSD and may even enhance the physical and emotional well-being of PTSD patients [17, 101–103].
Moderate/high intensity exercise versus low intensity exercise	Low PA levels have been linked to an increase in anxiety prevalence, according to research, but moderate to vigorous exercise shows more effective anxiety symptom reduction and improves well-being [84]. When Sexton, et al. [121] contrasted light exercise (walking) with vigorous or hard exercise (jogging), they found that the jogging group experienced a higher nonsignificant reduction in anxiety symptoms than the walking group. Exercise, particularly mind-body and low-intensity aerobic exercise, as well as low to moderate levels of PA and body awareness movement activities (such as Pilates, Yoga, Therapeutic Dance, Tai Chi, or Qigong), has been shown to help treat the symptoms of PTSD and enhance general wellness [17, 104].
Exercise versus antipsychotic versus placebo	For patients with panic disorder or agoraphobia, one randomized controlled trial was conducted to compare structured exercise with antidepressant medication. According to the results, regular aerobic activity and clomipramine were linked to a significantly lower incidence of symptoms than a placebo. Clomipramine reduced anxiety symptoms earlier and more effectively than exercise compared to both [117]. One study used the Mind Your Heart Study's baseline data, which included information on a sizable cohort of U.S. military veteran outpatients, to assess risk factors for obesity (such as sedentary lifestyle) in 735 U.S. military veterans with and without PTSD. According to the study's findings, exercise has been demonstrated to lower the risk of obesity in veterans with present and lifetime prevalence of PTSD after adjusting for sex, ethnicity, use of antipsychotic drugs, and depression [150].

Exercise is touted as a successful treatment for PTSD, anxiety, and depression. In addition, since PA does not produce the same level of avoidance as traditional psychotherapies, it becomes a valuable potential tool in the treatment of PTSD [144]. Figure 3 gives an in-depth review of the benefits of PA/exercise for PTSD and anxiety symptomology.

5. Comparative Effects of Exercise on Anxiety and PTSD

Exercise's effectiveness in treating anxiety and PTSD has been backed up by a variety of experiments, and more research is being done to compare exercise's effects on anxiety and PTSD. The results of exercise on PTSD and anxiety are compared in Table 3.

6. Conclusion

Anxiety and PTSD are two well-known psychiatric disorders. In comparison to the extensive body of research on the benefits of exercise in treating depression, anxiety, and PTSD disorders, they have received less attention. However, exercise has been found to reduce the symptoms of these conditions and is believed to play an important role in the prevention and treatment of MH problems. There are studies that suggest that PA and exercise can be used to treat PTSD and anxiety. While the exact mechanisms underlying

the reduction in anxiety and PTSD symptoms associated with exercise are unknown, it is most likely a complex combination of psychological and neurobiological regulatory mechanisms.

Increased self-efficacy, anxiety sensitivity, and diversion have all been suggested as psychological elements that may contribute to exercise training's therapeutic benefits. According to some research, regular exercise can have long-lasting impacts on certain people's anxiety and PTSD symptoms and can be just as effective as medicine. Engaging in healthy activities like regular exercise appears to have a positive effect on those with PTSD and anxiety. Aerobic exercise appears to be an effective way to reduce the severity of both anxiety and PTSD symptoms. Additionally, when combined with other treatments that are frequently used to treat PTSD and anxiety, exercise intervention had larger positive effects. Patients who received the exercise program in addition to usual care improved more than those who received only usual care in terms of PTSD, depression, and anxiety symptoms. Furthermore, by producing tangible effects, targeted exercise programs can improve the physical and MH of PTSD patients.

However, the existing body of evidence lacks sufficient scientific rigor to recommend it as a treatment for anxiety and PTSD. More research is needed to develop exercise training programs for patients with anxiety and PTSD symptoms, which require a multidisciplinary approach to robust experimental designs, as well as greater attention to

critical methodological details and strategies such as an applicable control group, adequate sample sizes, the use of intent-to-treat analysis, monitoring of exercise adherence and intensity, scientists and practitioners in psychiatry, sport medicine, documentation of training effects, and the selection of validated instruments.

Data Availability

The datasets used and analyzed during this review paper are available in the supplementary material.

Additional Points

Key Messages. (1) As anxiety and PTSD are the two most prevalent mental disorders, PA and exercise can be utilized as an adjuvant therapy to treat their symptoms. Yet, compared to anxiety, PTSD has received less attention. (2) Long-term interventions are more successful compared to short-term interventions in alleviating the symptoms of anxiety, while aerobic exercises appear to be more helpful than anaerobic workouts in reducing the signs and symptoms of anxiety and PTSD. (3) The body of data now available, however, is insufficiently supported by science to suggest it as a treatment for anxiety and PTSD. In order to create exercise training programs for patients with anxiety and PTSD, further study is required.

Conflicts of Interest

The authors found no conflict of interest.

Authors' Contributions

The concept and the design of the manuscript were created by Saima Sabri and Zhi-Xiong Mao. Saima Sabri and Nadia Rashid helped with the collection, evaluation, and analysis of literature data. The first draft of the work was written by Saima Sabri under the direction and supervision of Zhi-Xiong Mao. After reading and modifying the original text, Zhi-Xiong Mao approved the final version. The money required to cover the publication fees was secured by Zhi-Xiong Mao. The final manuscript was read and accepted by all authors, who also agreed to accept full responsibility for the work as a whole.

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Supplementary Materials

The supplementary material provides a detailed account of electronic searches across various search engines, revealing a wide range of relevant data. Tables 1–7 provide details of studies downloaded from the PubMed, PsycINFO, Science Direct Engine, Semantic Scholar, Google Scholar, Online Library, and other sources like various journals, etc. Table 8 provides a clear and concise overview for each reference used in the study. Each reference is assigned a unique code for easy identification and cross-referencing. (*Supplementary Materials*)

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