

Effects of Exercise Intervention on Physical and Mental Health of Individuals with Methamphetamine Use Disorder: A Narrative Review

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Abstract

Substance use disorder has become a serious challenge in the global public health field, severely impairing patients physiological function, mental health, and social adaptability. Traditional interventions have limitations in improving long-term rehabilitation outcomes and reducing relapse rates. Exercise intervention, as a green and safe non-pharmacological therapy, has gradually gained attention from the academic community. This review systematically analyzes 15 relevant studies and summarizes the effects of different exercise types—such as high-intensity interval training (HIIT), mind-body exercises (Tai Chi, Qigong, Yoga, etc.), resistance training, and Pilates—on the physical fitness, body composition, physiological indicators, mental health, and drug craving of individuals with substance use disorder. The findings indicate that various exercise interventions can improve patients cardiorespiratory fitness, muscle strength, and body composition, relieve anxiety and depression, and reduce drug craving to varying degrees. Among them, HIIT shows significant effects on physical fitness enhancement and drug craving suppression; mind-body exercises are more suitable for improving psychological state and sleep quality; and combined exercise interventions often produce synergistic effects. This review aims to provide a scientific reference for exercise intervention in the clinical rehabilitation of individuals with substance use disorder, and to point out current research limitations and future directions. Key limitations of the reviewed studies include small sample sizes, short follow-up periods, and a predominance of male methamphetamine-dependent participants, which restrict the generalizability of the findings.

Keywords

Exercise Intervention; Substance Use Disorder; Physical And Mental Health; Rehabilitation Effect; Review.

1. Introduction

1.1. Background

Substance use disorder (SUD) is a chronic relapsing brain disease characterized by persistent craving for substances and compulsive drug-seeking behavior, which seriously threatens patients' physical health, mental health, and social functioning [1]. According to statistics, by the end of 2021, there were 1.486 million registered drug users in China, with the proportion of synthetic drugs such as methamphetamine increasing year by year, imposing a heavy burden on social security and public health. Long-term substance abuse can lead to impaired cardiorespiratory function, abnormal body composition, and neurotransmitter dysregulation, accompanied by anxiety, depression, sleep disorders, and other psychological problems [2]. Moreover, the low quality of life further increases the risk of relapse, forming a vicious cycle.

Traditional interventions mainly rely on drug detoxification and psychological therapy, but they have limitations such as side effects of medication and poor compliance with psychological interventions, making it difficult to meet the comprehensive rehabilitation needs of patients [3, 4]. In recent years, exercise intervention has been regarded as a potential adjunctive therapy for SUD rehabilitation due to its unique advantages in regulating physiological functions, improving emotional state, and reshaping healthy behavior patterns. Studies have confirmed that exercise can regulate the levels of brain-derived neurotrophic factor (BDNF), dopamine, and other neurotransmitters, repair the damaged brain reward system, and improve physical fitness and quality of life.

1.2. Purpose and Significance

By systematically reviewing 15 empirical studies focusing on the effects of exercise intervention on individuals with substance use disorder, this paper aims to integrate the intervention protocols and effects of different exercise types (HIIT, mind-body exercises, resistance training, etc.), analyze the mechanisms by which exercise intervention improves patients' physical fitness, physiological indicators, mental health, and reduces drug craving, provide a theoretical basis for developing personalized and scientific rehabilitation exercise programs in clinical practice, and indicate directions for future research in the field of exercise-based drug rehabilitation.

1.3. Literature Sources and Inclusion Criteria

1. Literature sources: The 15 articles included in this review are all empirical studies in Chinese or English focusing on exercise intervention and substance use disorder rehabilitation, including randomized controlled trials (RCTs) and original research, published in core domestic and international journals such as *Frontiers in Psychiatry*, *BMC Psychiatry*, and *China Sport Science* [5-9].

2. Inclusion criteria: (1) Participants were individuals with substance use disorder (mainly methamphetamine-dependent); (2) The intervention was a clearly defined exercise type (including HIIT, Tai Chi, Qigong, resistance training, etc.); (3) The study included clear outcome measures (physical fitness, physiological indicators, psychological state, drug craving, etc.); (4) The study design was scientific and the data were complete and traceable.

2. Methods

2.1. Literature Search Strategy

In this study, a combination of subject terms and free words was adopted for literature retrieval. For English databases, the retrieval formula was set as ("exercise" OR "physical activity" OR "sports") AND ("substance use disorder" OR "drug dependence" OR "addiction" OR "substance abuse"). For Chinese databases, the retrieval formula was ("运动干预" OR "体育锻炼") AND ("物质使用障碍" OR "药物依赖" OR "成瘾"). The specific retrieval strategies were adjusted in accordance with the characteristics of each database. The retrieved databases covered English databases including PubMed, Web of Science, Embase and Cochrane Library, as well as Chinese databases such as China National Knowledge Infrastructure (CNKI) and Wanfang Data Knowledge Service Platform. The retrieval time frame was from the establishment of each database to June 2025, and the languages of retrieved literatures were limited to Chinese and English.

2.2. Data Extraction and Analysis Methods

This study employed a literature review method to systematically analyze the 15 included articles. First, key information was extracted from each article, including participant characteristics, exercise intervention protocols (type, duration, frequency, and intensity),

outcome measures, and main findings. Second, the extracted data were categorized and integrated according to exercise intervention types to summarize the intervention characteristics and common effects of different exercise modalities. Finally, a comparative analysis was conducted to evaluate the advantages and applicable scenarios of various exercise interventions, and the limitations reported in the literature were discussed to identify research gaps and future directions.

2.3. Basic Characteristics of the Included Literature

The 15 included articles are all empirical studies (in both Chinese and English) focusing on exercise interventions for the rehabilitation of substance use disorder, comprising randomized controlled trials (RCTs) and quasi-experimental studies, published in core domestic and international journals such as *Frontiers in Psychiatry*, *BMC Psychiatry*, and *China Sport Science and Technology*. The study participants were predominantly individuals with methamphetamine dependence, covering both male and female addicted populations. The intervention types included high-intensity interval training (HIIT), mind-body exercises (Tai Chi, Qigong, Yoga), resistance training, Pilates, and combined exercise programs. Outcome measures encompassed physical fitness indicators (maximal oxygen uptake, grip strength, flexibility, etc.), physiological indicators (body composition, heart rate, oxidative stress markers, etc.), psychological indicators (anxiety, depression, sleep quality), and drug craving levels.

3. Results and Analysis

3.1. Main Types of Exercise Intervention and Intervention Protocols

The exercise interventions covered in the included studies can be divided into five major categories. Typical intervention protocols for each type are as follows:

1. High-Intensity Interval Training (HIIT). Intervention duration ranged from 8 weeks to 8 months, frequency 3-4 times per week, each session about 60 minutes (including 10 minutes warm-up, 40 minutes core training, 10 minutes cool-down). Intensity was controlled at 70%-96% of maximum heart rate (HR_{max}). Core training often adopted patterns such as "20 seconds exercise + 10 seconds rest" or "4 minutes high intensity + 3 minutes recovery," including running, rope skipping, basketball training, and strength equipment [10].
2. Mind-Body Exercises (MBE). Mainly Tai Chi, Qigong, and Yoga. Intervention duration ranged from 3 months to 4 years, frequency 5 times per week to 3 times per day, each session 30-60 minutes, intensity low to moderate (about 3.5 METs). Emphasis was placed on the coordination of movements with breathing and meditation, and some studies used tailored simplified movements to improve patient compliance.
3. Resistance Training. Intervention duration 8-12 weeks, frequency 3 times per week, each session about 60 minutes. Equipment included elastic bands, barbells, dumbbells, etc., targeting upper and lower limbs and core muscle groups. Intensity was 8-12 repetitions maximum (RM), with progressive load increases across stages.
4. Pilates. Intervention duration 24 weeks, frequency 2 times per week, each session 60 minutes (including 5 minutes warm-up, 45 minutes core training, 10 minutes relaxation and meditation). Intensity started at 40%-50% of maximum heart rate and progressed through four stages: adaptation, autonomous, proficient, and mind-body integration.
5. Combined Exercise. Included combinations such as Zhan Zhuang (stake standing) with resistance training, and Health Qigong with closed motor exercise. Intervention duration ranged from 8 to 24 weeks, frequency 3-5 times per week, combining the advantages of different exercise types.

3.2. Effects of Exercise Intervention on Physical and Mental Health of Individuals with Substance Use Disorder

3.2.1. Effects on Physical Health

(1) Physical fitness improvement. All types of exercise intervention significantly improved patients' physical fitness. HIIT increased patients' maximal oxygen uptake ($VO_2\text{max}$) by 21%-30%, and significantly improved grip strength, push-ups, and quadrant jump performance. Mind-body exercises improved flexibility (sit-and-reach), balance (one-leg standing with eyes closed), and cardiorespiratory fitness (vital capacity). Resistance training increased lower limb push strength by 40% and upper limb bench press strength by 49%. After 24 weeks of Pilates intervention, the number of push-ups and one-leg standing time doubled compared to baseline [11].

(2) Body composition optimization. Long-term exercise intervention effectively regulated patients' body composition. HIIT reduced body fat percentage by 15%-18% and increased skeletal muscle mass. Pilates reduced body fat percentage and increased skeletal muscle mass. Aerobic combined with resistance training controlled weight gain and prevented fat accumulation during withdrawal.

(3) Improvement in physiological indicators. Exercise intervention improved patients' cardiovascular function. HIIT and Tai Chi reduced resting heart rate, systolic blood pressure, and diastolic blood pressure. Regarding blood biochemical indicators, HIIT increased superoxide dismutase (SOD) activity and decreased malondialdehyde (MDA) content, improving oxidative stress status. After Pilates intervention, white blood cell count and neutrophil count significantly increased, indicating activation of immune function [12].

3.2.2. Effects on Mental Health

(1) Mood regulation. Mind-body exercises (Tai Chi, Qigong, Yoga) and Pilates showed significant effects on improving anxiety and depression. After 24 weeks of Pilates intervention, scores on the Self-Rating Depression Scale (SDS) and Self-Rating Anxiety Scale (SAS) decreased significantly, and the degree of improvement was negatively correlated with improvements in flexibility and balance. After 4 years of Tai Chi intervention, patients' anxiety and depression symptoms were relieved, and the relapse rate was only 9.5%, significantly lower than the 26.3% in the conventional treatment group.

(2) Sleep quality improvement. Most exercise interventions improved patients' sleep disorders. HIIT reduced Pittsburgh Sleep Quality Index (PSQI) scores. The combination of Health Qigong and closed motor exercise significantly improved sleep quality. Pilates regulated autonomic nervous function and improved sleep structure through relaxation and meditation components.

(3) Cognitive function improvement. Exercises such as Zhan Zhuang and Tai Chi improved patients' attention and reaction speed. HIIT shortened choice reaction time, improved neurotransmitter balance, and repaired damage to the central nervous system. Resistance training enhanced executive function and improved self-control ability.

3.2.3. Effects on Drug Craving and Relapse

HIIT was particularly effective in suppressing drug craving. After 8 months of HIIT intervention, Visual Analog Scale (VAS) scores decreased significantly, and there was a significant negative correlation between $VO_2\text{max}$ and drug craving. Mind-body exercises reduced cue-induced drug craving by regulating plasma oxytocin levels. Resistance training reduced dopaminergic nerve damage and lowered relapse risk. Combined exercise interventions were superior to single exercise types in inhibiting relapse tendency.

3.3. Advantages and Applicable Scenarios of Different Exercise Types

3.3.1. High-Intensity Interval Training (HIIT)

HIIT is characterized by a “short-duration high-intensity exercise + low-intensity recovery” pattern. Its core advantages lie in rapidly improving cardiorespiratory fitness, significantly enhancing physical fitness, and effectively suppressing drug craving by stimulating the release of large amounts of endorphins that bind to opioid receptors in the brain. It is an important intervention for mid-stage rehabilitation. This type is suitable for patients in mid-stage rehabilitation who have a good fitness base and no severe organic diseases. In practice, a cycle of “30 seconds of high-intensity movement (e.g., jumping jacks, high knees, burpees) + 60 seconds of low-intensity recovery (e.g., slow walking, deep breathing)” is recommended, with each session lasting 15-20 minutes, and intensity controlled at 70%-85% of maximum heart rate (220-age). Safety considerations: avoid training on an empty stomach to prevent hypoglycemia-induced discomfort; patients with cardiovascular disease, hypertension, or other underlying conditions must undergo a comprehensive assessment including ECG before training, and train under medical supervision when necessary [13].

3.3.2. Mind-Body Exercises (Yoga, Tai Chi, Baduanjin, etc.)

Mind-body exercises are characterized by low intensity. Their core advantages lie in mood regulation and sleep improvement—through low-intensity limb stretching combined with breathing control, they reduce sympathetic nervous system excitability, relieve negative emotions such as anxiety and irritability during withdrawal, and regulate autonomic nervous function to improve sleep quality. This type is suitable for patients with poor fitness who are just entering early rehabilitation, especially female patients or those with low tolerance for high-intensity exercise. In practice, basic yoga postures, simplified Tai Chi, or Baduanjin can be selected, with each session lasting 30-45 minutes, 3-5 times per week, emphasizing breathing training (e.g., diaphragmatic breathing) and focusing on mind-body connection and concentration. Attention should be paid to performing movements within a comfortable range of motion to avoid muscle strain from overstretching; the training environment should be quiet and well-ventilated to reduce external interference and enhance mood regulation effects.

3.3.3. Resistance Training

The core value of resistance training lies in enhancing muscle strength and endurance, reversing muscle atrophy caused by drug abuse, improving body composition, and helping patients rebuild self-efficacy through achieving progressive goals (e.g., increased load, improved movement completion), thereby alleviating low self-confidence during rehabilitation. This type is suitable for patients with significant muscle loss and low self-identity after drug withdrawal. In practice, follow the principle of progressive overload. Begin with bodyweight exercises (e.g., squats, lunges, planks), gradually transition to small-weight equipment (e.g., elastic bands, light dumbbells), focus on training large muscle groups such as legs and core, complete 8-12 repetitions per set, train 2-3 times per week with at least 48 hours between sessions to allow muscle recovery. Safety points include: strictly standardize movement form to avoid compensatory injury to the lower back or joints; consume 0.8-1.2 g/kg body weight of high-quality protein (e.g., eggs, milk, chicken breast) within 30 minutes after training to promote muscle protein synthesis; initial training should be guided by a professional coach, with load adjusted according to fitness level.

3.3.4. Pilates

Pilates integrates core strength training with psychological relaxation techniques. Its core advantages include both muscle control training and mood regulation. Through precise body control exercises, it enhances core stability and balance, while meditation guidance and breathing regulation alleviate negative emotions such as anxiety and depression [14].

Moreover, its movement intensity is gentle and safety is high. This type is suitable for patients with anxiety and depression symptoms, poor balance, or elderly rehabilitation patients. In practice, mat-based exercises such as curls, bridges, and side planks are recommended, with each session lasting 20-30 minutes, emphasizing coordination of breath and movement and focusing on muscle activation perception. Precautions: patients with lumbar disc herniation or knee joint injury should avoid excessive lumbar flexion or weighted movements; patients with extremely poor balance may use assistive devices (e.g., yoga blocks) or train under supervision to gradually improve body control.

3.3.5. Combined Exercise

Combined exercise integrates the advantages of multiple exercise types to achieve synergistic effects of “cardiorespiratory fitness enhancement + muscle strength improvement + psychological state regulation,” comprehensively addressing multidimensional rehabilitation needs. In particular, diverse training reduces the monotony of exercise and improves patient compliance, effectively lowering relapse risk. This type is suitable for patients with high comprehensive rehabilitation needs and high assessed relapse risk. In practice, a combination model such as “10 minutes HIIT + 20 minutes resistance training + 15 minutes mind-body exercise” can be adopted, with each total session lasting 45-60 minutes, arranged twice per week, complemented by single exercise types (e.g., mind-body exercises, low-intensity aerobic) on other days to avoid excessive fatigue. A training log should be kept to record post-training physical changes and drug craving scores (e.g., Visual Analog Scale), with training intensity and component ratios adjusted dynamically based on feedback. Adequate rest intervals should be arranged, ensuring 7-8 hours of sleep per day to avoid overtraining that may reduce immunity [15].

3.4. Discussion

3.4.1. Possible Mechanisms by Which Exercise Intervention Improves Physical and Mental Health in Individuals with Substance Use Disorder

(1) Physiological mechanisms. Exercise improves cardiorespiratory endurance and body composition by regulating cardiovascular system function; enhances antioxidant capacity and reduces oxidative stress damage caused by substance abuse; increases neurotransmitter (dopamine, serotonin) levels and repairs the damaged brain reward system, thereby reducing drug craving.

(2) Psychological mechanisms. Exercise releases endorphins and other pleasure-related hormones, alleviating anxiety and depression; improves physical self-efficacy and sense of control, reducing feelings of helplessness; structured exercise programs help patients establish regular lifestyle patterns, reshape healthy behavioral habits, and reduce relapse risk.

(3) Social mechanisms. Group exercise (e.g., basketball training, group Tai Chi) increases social interaction among patients, reduces loneliness, improves social adaptability, and provides social support for long-term rehabilitation.

3.4.2. Limitations of Current Research

Homogeneous sample characteristics. Most studies focused on male methamphetamine-dependent individuals, with insufficient samples of females or individuals dependent on other substances, limiting the generalizability of the findings.

2. Lack of standardized intervention protocols. The duration, frequency, and intensity of exercise varied greatly across studies, making it difficult to form a unified clinical exercise prescription.

3. Insufficient long-term follow-up. Most studies had short follow-up periods (<1 year) and lacked data on the long-term effects of exercise intervention and its impact on relapse rates.

4. Mechanism studies need to be deepened. Most existing research focuses on phenomenological descriptions, with insufficient exploration of the deep molecular mechanisms by which exercise intervention affects drug craving and neural repair.

3.4.3. Future Research Directions

1. Conduct sex-specific studies. Focus on the effects of exercise intervention in females and special populations (e.g., SUD patients with comorbid mental illness) to optimize personalized protocols.
2. Develop standardized exercise prescriptions. Use multicenter randomized controlled trials to explore optimal exercise intervention parameters for different rehabilitation stages (detoxification, rehabilitation, maintenance).
3. Strengthen long-term follow-up and mechanism research. Extend follow-up periods to track the long-term effects of exercise intervention on relapse rates; combine neuroimaging and molecular biology techniques to reveal the internal mechanisms by which exercise improves brain function.
4. Explore technology-integrated models. Combine wearable devices (heart rate monitors), remote guidance, and other technologies to improve the accessibility and compliance of exercise interventions.

4. Conclusion

Exercise intervention, as an effective adjunctive therapy for the rehabilitation of individuals with substance use disorder, can improve patients' physical fitness, physiological indicators, and mental health, and reduce drug craving and relapse risk through multiple mechanisms. Different exercise types have respective advantages: HIIT is suitable for enhancing physical fitness and suppressing drug craving; mind-body exercises are suitable for regulating mood and improving sleep; resistance training helps increase muscle strength and self-efficacy; Pilates balances safety with mind-body synergistic improvement; and combined exercise can achieve multidimensional rehabilitation goals. In clinical practice, individualized exercise intervention protocols should be developed based on the patient's fitness level, rehabilitation stage, and individual needs. Future research should further conduct standardized, long-term, and multidimensional studies to provide a stronger scientific basis for the clinical promotion of exercise-based drug rehabilitation.

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