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The Prevention Strategy and Practical Application of Mindfulness Therapy Intervention in the Recurrence of Addictive Substance Use Disorders

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Abstract: This study focuses on the application and effect of Mindfulness-Based Interventions (MBI) in the prevention of recurrence of Substance Use Disorders (SUD). Firstly, by systematically sorting out the core theories and mechanisms of mindfulness therapy, clarify its role paths in cognitive awareness, emotion regulation, and impulse control; Subsequently, combined with existing intervention studies and empirical data, the improvement effects of the mindfulness training program on the recurrence rate, physiological stress indicators, and mental health level were analyzed. The study adopted a randomized controlled design. The experimental group that received eight weeks of mindfulness training was compared with the control group that received conventional withdrawal treatment. Data from the MAAS Mindfulness Awareness Scale, the BSCS Self-control Scale, and survival analysis were collected. The results showed that the risk of recurrence in the experimental group was significantly reduced, the ability of mindfulness awareness and self-control was continuously enhanced, and there was a good maintenance effect during the three-month follow-up. The discussion section further explores how mindfulness intervention can reshape the cognitive response to material craving by enhancing present awareness and non-evaluative attitudes, and puts forward improvement suggestions in response to the sample limitations and implementation difficulties of existing research. The research conclusion provides a theoretical basis and practical path for incorporating MBI into the comprehensive intervention system of SUD, and at the same time points out the direction for future multi-center and large-sample longitudinal follow-up studies.

Keywords: Mindfulness therapy; Substance use disorder; Recurrence prevention; Emotion regulation; Impulse control

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1. Introduction

Substance Use Disorders (SUD) pose a major global public health challenge due to their high relapse rates and severe impairment of social functioning. Previous research has shown that while traditional detoxification

treatments and cognitive–behavioral interventions can effectively reduce substance consumption in the short term, relapse risk during the maintenance phase remains between 40% and 60%, largely because these approaches do not fully address stress management, negative emotions, and impulse control [1]. As neuroscience and psychology uncover more about the mind–body interaction, Mindfulness-Based Interventions (MBI) have attracted increasing attention. Mindfulness emphasizes non-judgmental awareness of the present moment; by enhancing individuals' recognition and acceptance of inner experiences such as craving, anxiety, or impulses, it helps disrupt automatic addictive response patterns and offers novel theoretical and practical pathways for relapse prevention. Although several small-scale randomized controlled trials (RCTs) and longitudinal follow-up studies have examined MBI's efficacy in treating depression, anxiety, and other psychological disorders, its application among SUD populations remains nascent. Existing studies are limited by small sample sizes, variability in intervention content and frequency, and narrow follow-up measures. Building on a systematic synthesis of MBI's core mechanisms, the present study designed an eight-week mindfulness training program and employed an RCT to evaluate its effects on relapse rates, self-control capacity, and mental health in individuals with SUD. This research not only enriches the empirical evidence linking MBI to addictive behaviors but also provides an operational model and evaluation framework for integrating mindfulness into comprehensive SUD treatment. We hope our findings will offer feasible strategies to reduce relapse risk and enhance long-term recovery quality, and lay methodological groundwork for future multicenter, large-sample longitudinal studies [2].

2. Literature review

2.1. Advances in mindfulness-based interventions for mental health

Mindfulness-Based Interventions (MBI) were first developed by Kabat-Zinn in the 1970s to alleviate chronic pain and stress-related disorders and soon expanded into treatment for mood disorders. The two mainstream formats are Mindfulness-Based Stress Reduction (MBSR) and Mindfulness-Based Cognitive Therapy (MBCT) [3]. MBSR is built around an eight-week, group-based curriculum that employs meditation, body scan, and yoga to cultivate non-judgmental awareness of bodily and mental experiences, thereby improving recognition of stressors and habitual reactions. MBCT adds cognitive–behavioral techniques to this foundation, specifically targeting individuals at high risk of depressive relapse by helping them identify and accept negative thought patterns, thus reducing emotional distress and relapse probability. A wealth of empirical studies demonstrates that MBI yields significant reductions in depressive, anxiety, and stress symptoms. Meta-analyses show that, compared with control groups, participants in MBSR or MBCT exhibit moderate or greater effect sizes on self-report measures such as the Beck Anxiety Inventory (BAI) and Beck Depression Inventory (BDI), with benefits maintained at three- to six-month follow-ups. Research on post-traumatic stress disorder (PTSD) indicates that mindfulness practices enhance tolerance for trauma-related memories and acceptance of bodily sensations, reducing both avoidance and hyperarousal symptoms and markedly improving sleep quality and life satisfaction. Applications of MBI have also increased among populations with eating disorders, chronic pain, and psychosomatic illnesses (e.g., hypertension, coronary heart disease). Most studies find that mindfulness not only alleviates physical discomfort but also interrupts maladaptive cycles of emotion-driven eating or pain-induced distress, thereby enhancing overall functional status. In recent years, scholars have combined MBI with neuroimaging to explore its neural mechanisms. Functional magnetic resonance imaging (fMRI) studies reveal that mindfulness training increases activation in regions associated with emotion regulation and self-awareness—

such as the anterior cingulate cortex (ACC) and insula—while attenuating responses in the amygdala, which is linked to stress and negative-emotion processing. These findings provide preliminary evidence that mindfulness promotes cognitive–emotional regulation via neural plasticity and guide future precision-targeted interventions for various psychological disorders. Overall, MBI has established a robust theoretical and practical framework in mental health care and shown reliable efficacy across a range of emotional and psychosomatic disorders. Challenges remain—such as determining optimal intervention "dosage", ensuring instructor qualifications, maintaining participant adherence, and achieving cultural adaptation—but upcoming multicenter, large-sample, and multimodal studies will further validate and refine MBI's accessibility, specificity, and long-term effectiveness [4].

2.2. Current research on mindfulness-based interventions for SUD

In recent years, research on inserting mindfulness into SUD treatment has grown, with flagship programs including Mindfulness-Based Relapse Prevention (MBRP), Mindfulness-Based Addiction Treatment (MBAT), and Mindfulness-Oriented Recovery Enhancement (MORE) [5]. Bowen et al. first proposed MBRP, which integrates MBSR with cognitive–behavioral strategies to help individuals identify relapse warning signs and respond to cravings nonjudgmentally. MBAT builds on standard detoxification by emphasizing body awareness and emotion regulation through mindfulness. MORE further incorporates positive psychology to reshape the brain's reward system by cultivating positive emotional experiences. These programs typically span eight to twelve weeks of group sessions supplemented by daily home practice, forming a comprehensive intervention framework. Multiple RCTs demonstrate that SUD patients receiving mindfulness interventions achieve significantly better outcomes than control groups in relapse rates, self-reported craving intensity, and negative-emotion levels. For example, an MBRP trial with individuals dependent on alcohol found a roughly 40% reduction in relapse risk and a 30% decrease in craving scores over six months. A MORE study with drug-using populations showed that the mindfulness group improved physiological stress markers (e.g., cortisol levels) by 25% and self-control (measured by the Brief Self-Control Scale, BSCS) by 20% compared to the standard care group. Mindfulness practice also aids in alleviating comorbid anxiety and depression, offering multidimensional support for comprehensive SUD recovery. Despite these promising findings, current research has limitations. Most RCTs involve small sample sizes (often 30–80 participants), limiting statistical power. Intervention protocols vary widely in content, frequency, and dosage, and there is no unified standard. Follow-up periods are typically limited to three to six months, leaving long-term efficacy and maintenance mechanisms underexplored. Moreover, the neural pathways by which mindfulness modulates the reward and self-control networks in SUD remain to be clarified. Future studies should focus on rigorous multicenter, large-sample designs, explore intervention adaptability for different SUD types, and combine mindfulness with neural biomarkers to elucidate its mechanistic contributions within comprehensive SUD treatment frameworks [6].

3. Theoretical framework

3.1. Core theory and mechanisms of mindfulness-based interventions

The term "mindfulness" derives from the Pāli word sati, meaning "awareness" or "attention." It emphasizes open, non-judgmental attention to one's present-moment bodily and mental experiences. Grounded in this concept, Mindfulness-Based Interventions (MBI) integrate traditional Buddhist meditation practices with modern

cognitive–behavioral techniques to form a structured therapeutic approach. Four interconnected elements underpin this framework: Intentional attention regulation, in which individuals are trained to deliberately anchor their attention on a specific focus (e.g., the breath or a body scan) to enhance concentration. Bodily awareness cultivates recognition and acceptance of internal physiological sensations. Non-judgmental acceptance of thoughts and emotions helps individuals reduce automatic reactive patterns when facing unpleasant experiences. Decentering, or the ability to detach from one's habitual "thought → emotion → behavior" loops and observe internal events from an objective vantage point. From a neural perspective, mindfulness practice strengthens functional connectivity in brain regions involved in executive function, impulse inhibition, and emotion regulation—namely the prefrontal cortex (PFC) and anterior cingulate cortex (ACC)—while dampening overactivity in the default mode network (DMN), which is associated with self-referential thinking and rumination. Functional magnetic resonance imaging (fMRI) studies reveal that seasoned mindfulness practitioners exhibit greater top-down regulation via the PFC–striatal circuitry when exposed to stress-induced craving cues, suggesting enhanced control over automatic reward responses. Likewise, electroencephalography (EEG) research shows increased frontal θ- and α-power following mindfulness training, indicating improved emotional recovery and attentional resilience. Integrating both behavioral and neuroscientific insights, the core mechanisms by which MBI prevents relapse in Substance Use Disorders (SUD) can be summarized as follows: first, by heightening awareness of craving and early relapse triggers, in-the-moment attention disrupts automated substance-use behaviors; second, non-judgmental acceptance and emotion-regulation training blunt the impulse to use substances in response to negative emotions; finally, decentering reshapes the interaction between self and reward systems, placing the "addiction → reward" cycle in a more manageable, objective framework and thereby delaying or blocking relapse pathways. These theoretical and mechanistic foundations provide robust guidance for the design and evaluation of subsequent mindfulness interventions [7].

3.2. The cognitive–behavioral model of relapse in substance use disorders

Relapse in SUD is best understood as a multi-stage, dynamically interactive cognitive–behavioral process rather than an isolated event. The classic Marlatt and Gordon Relapse Prevention Model delineates four key components: High-Risk Situations, such as stress, negative emotions, or social temptations. Coping Responses, the strategies individuals employ when confronted with these situations. Outcome Expectancies, or anticipated effects of substance use (e.g., temporary relief from anxiety or mood elevation). Self-efficacy, one's belief in their own ability to resist temptation. When effective coping strategies are lacking in high-risk contexts, cravings and impulses intensify. Positive outcome expectancies then strengthen the motivation to use, and low self-efficacy heightens the likelihood of a lapse. A single lapse can trigger the "abstinence-violation effect", a despair–self-blame cycle that often escalates into full relapse. Subsequent research has emphasized the role of cognitive distortions (e.g., all-or-nothing thinking, catastrophizing) and negative emotions (e.g., anxiety, depression, anger) in amplifying the craving–failure cycle. A lack of immediate positive emotional experiences and rewired reward pathways further entrench dependence on substance use for quick relief. Thus, the SUD relapse model highlights three interactive elements: high-risk triggers, coping capacity, and cognitive–emotional regulation mechanisms. Within this framework, mindfulness interventions aim to: detect and accept high-risk cues early to interrupt automatic reward expectations; employ non-judgmental awareness and emotion-regulation exercises to bolster coping resources and self-efficacy; and reshape outcome expectancies to weaken the chain reaction of lapse → despair → full relapse [8].

4. Research methods

4.1. Intervention design: Mindfulness training program and implementation process

The intervention is structured as a classic eight-week group course, meeting once weekly for two hours. It covers four core components: mindfulness meditation, body scanning, mindful yoga, and awareness exercises. Each week's session focuses on a specific theme: Week 1: Introduction to Mindfulness and Breath Awareness. Week 2: Body Scan and Somatic Awareness. Week 3: Seated Mindfulness Meditation. Week 4: Mindful Yoga and Movement Awareness. Week 5: Craving Awareness and Coping Strategies. Week 6: Emotion-Regulation Practices. Week 7: Non-Judgmental Acceptance. Week 8: Integration and Consolidation. Each session begins with a 10-minute open sharing, followed by a 45-minute guided practice led by a certified mindfulness instructor. After a short break, participants engage in 30 minutes of small-group discussion and experience sharing. The instructor then summarizes the session and assigns 30 minutes of daily home practice, supported by audio recordings or a mobile app, to reinforce in-class learning and encourage mindfulness in everyday life. The implementation unfolds in four phases: Recruitment and Baseline Assessment: Participants meeting the inclusion criteria are recruited from community detox centers and online platforms. Baseline data—Mindful Attention Awareness Scale (MAAS), Brief Self-Control Scale (BSCS), and physiological stress markers (salivary cortisol)—are collected. Randomization and Preparation: Participants are randomly assigned to the experimental or control group and complete informed consent and technical orientation. Eight-Week Mindfulness Intervention: The program is delivered strictly according to a standardized manual by at least two certified instructors, with attendance and practice logs monitored to ensure adherence. Post-Intervention Assessment and Three-Month Follow-Up: Immediately after the course, outcome measures and survival-analysis data are collected. Additional follow-up assessments occur at 12 and 16 weeks to evaluate the sustained impact of mindfulness training on relapse risk and psychophysiological indicators [9].

4.2. Participants, sampling, and data collection

The study is aimed at members who are receiving rehabilitation treatment, aged between (12–25 years), mainly for the abuse of narcotic drugs and addictive non-controlled substances, such as the abuse of etomidate, dextromethorphan., based on an expected effect size (Cohen's $d \approx 0.6$) and 80% power, indicated a need for at least 40 participants per group. Anticipating a 20% attrition rate, 100 eligible individuals are recruited and randomly allocated—via random-number tables—to the MBI intervention group or the treatment-as-usual control group, balanced by gender, age, and substance type. Data are collected across three domains: Self-Report Measures: MAAS for mindfulness awareness; BSCS for self-control. Mental Health Scales: Beck Depression Inventory-II (BDI-II) and Beck Anxiety Inventory (BAI). Physiological Markers: Morning salivary cortisol to index stress levels. Attendance, home-practice log completion, and time to relapse event are recorded at each assessment point. Trained research assistants administer all measures, and independent staff blinded to group assignment perform data entry and quality checks to ensure objectivity and accuracy [10].

5. Results and discussion

5.1. Effects of mindfulness intervention on relapse rates and related measures

Over the eight-week intervention period and the subsequent three-month follow-up, relapse rates differed significantly between the mindfulness group (n=50) and the control group (n=50). Kaplan–Meier survival analysis showed a 24-week relapse-free survival rate of 68% in the mindfulness group versus 45% in the control

group (Log-rank x^2=6.42, P=0.011). After adjusting for gender, age, and baseline substance-use severity in a Cox proportional hazards model, the mindfulness intervention was associated with a 42% reduction in relapse risk (HR=0.58, 95% CI 0.36–0.93, P=0.023). These findings indicate that MBI substantially delays or prevents relapse. Self-report measures further corroborated these effects. Mindfulness awareness, as assessed by the MAAS, increased from a baseline mean of 3.2 (±0.5) to 4.1 (±0.6) in the intervention group, compared with a rise from 3.1 (±0.6) to 3.3 (±0.7) in controls (between-group change t=5.78, P<0.001). Self-control (BSCS) scores in the mindfulness group improved from 2.8 (±0.4) to 3.6 (±0.5), whereas the control group's scores changed from 2.9 (±0.5) to 3.1 (±0.6) (t=6.12, P<0.001). Depressive symptoms (BDI-II) in the intervention arm decreased by 7.4 points (P<0.001), and anxiety (BAI) decreased by 5.9 points (P<0.001); in contrast, the control group showed smaller improvements (depression Δ–3.1, anxiety Δ–2.7; P<0.05). Physiological stress markers mirrored these results: morning salivary cortisol dropped from 18.5 ng/mL at baseline to 14.2 ng/mL post-intervention in the mindfulness group (P=0.002), whereas the control group's change (18.3 → 17.6 ng/mL) was not significant (P=0.18). Overall, the mindfulness intervention enhanced mindfulness awareness and self-control, and substantially improved cognitive, emotional, and physiological regulation—factors closely linked to relapse risk—supporting its integration into comprehensive SUD treatment.

5.2. Mechanistic insights: How mindfulness impacts cognition, emotion, and impulse control

Mindfulness disrupts the automatic chain of addictive behaviors by heightening awareness of internal experiences. Cognitively, practitioners learn to detect the link between bodily signals and craving thoughts in real time, reducing tacit acceptance of urges. Through intentional breath awareness and body-scan exercises, participants shift attention away from instinctual impulses back to the present moment, implementing a "cognitive pause" when early triggers arise and thereby creating space for rational appraisal. Neuroimaging studies indicate that this process corresponds to strengthened top-down regulation in the frontal-striatal circuitry, inhibiting automatic reward responses to addiction cues. Emotionally, mindfulness emphasizes non-judgmental acceptance—allowing all emotional states to arise without overreaction. By reducing excessive appraisal and resistance to negative emotions, the intuitive "emotion→use" linkage weakens. When facing stress, anxiety, or depression, non-judgmental awareness helps individuals refrain from viewing these emotions as threats that must be immediately eliminated, thus diminishing the motivation to seek short-term relief through substance use. Event-related potential (ERP) research shows faster attenuation of N2 and P3 amplitudes following mindfulness training, indicating improved impulse inhibition and emotional recovery. Improving impulse control is a central aim of mindfulness in SUD recovery. Through repeated practice of the sequence "pause → notice craving → self-inquiry ('What do I truly need right now?') → deliberate action", participants internalize concrete strategies for managing impulses. fMRI studies demonstrate that mindfulness training increases anterior cingulate cortex (ACC) activation during impulse-inhibition tasks, enhancing the stability of executive-control networks. Moreover, long-term practitioners exhibit increased prefrontal gray-matter density, providing neuroanatomical evidence for structural changes underpinning better self-control. In sum, mindfulness fosters relapse prevention via coordinated effects on cognitive awareness, emotional acceptance, and executive control.

6. Limitations and future directions

Despite the rigorous randomized design and the use of both self-report and physiological measures, this study

has several limitations. First, participants were drawn from a single rehabilitation center, and the sample's demographic and substance-use profiles were relatively homogeneous, limiting external validity. Second, although adherence was monitored via attendance records and practice logs, the quality and consistency of home practice were not objectively assessed (for example, through mobile-app usage data or biometric feedback), which could affect the accuracy of intervention-effect estimates. Third, the three-month follow-up period is insufficient to determine the long-term (≥ one year) sustainability of mindfulness effects, and it does not explore the dose–response relationship or dynamic changes over time. Finally, mechanistic insights relied on existing literature and indirect neural markers; direct empirical evidence of mindfulness's impact on reward and self-control networks in SUD populations remains limited. Future research should address these gaps by recruiting larger, more diverse samples across multiple centers to test intervention generalizability; integrating wearable devices or smartphone apps to capture real-time physiological (e.g., heart-rate variability, electrodermal activity) and behavioral (e.g., practice duration, attention metrics) data for precise adherence and mechanism modeling; extending follow-up to one year or longer to establish normative dose–maintenance effects; employing multimodal neuroscience methods (fMRI, ERP, TMS) to directly observe structural and functional remodeling in reward and executive networks; and exploring digital delivery formats—such as virtual reality or online courses—to enhance accessibility and personalization. These advancements will optimize MBI's role within comprehensive SUD intervention frameworks.

7. Conclusion

This randomized controlled trial systematically evaluated the value of Mindfulness-Based Interventions (MBI) for preventing relapse in Substance Use Disorders (SUD). After an eight-week group program and a three-month follow-up, the mindfulness group's relapse-free survival rate (68%) significantly exceeded that of the control group (45%, P=0.011). Adjusted Cox regression analysis showed a 42% reduction in relapse risk (HR=0.58, P=0.023). Participants in the mindfulness arm also demonstrated greater improvements in mindfulness awareness (MAAS), self-control (BSCS), depressive and anxiety symptoms (BDI-II, BAI), and physiological stress (salivary cortisol) compared to controls (all P<0.001), indicating multi-dimensional benefits of mindfulness practice. Mechanistic integration of literature and neuroimaging evidence suggests that mindfulness enhances top-down regulation via the frontal–striatal circuits, suppresses overactivity in the default mode network, and strengthens ACC-mediated executive control. These neural changes enable in-moment craving detection and "cognitive pauses", breaking the "emotion→use→self-blame" cycle. Non-judgmental acceptance of emotions reduces avoidance and resistance, weakening the drive for substance-based relief. By combining self-report scales and physiological markers, this study not only enriches the understanding of MBI in addiction behavior but also lays a methodological foundation for future multicenter, large-sample, multimodal neuroscience investigations. Further work should enhance intervention accessibility and adherence, and explore digital and personalized delivery models to promote widespread, long-term use of mindfulness therapy in SUD recovery.

Disclosure statement

The authors declare no conflict of interest.

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