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Mindfulness in the Digital Age Research Progress on Digital Mindfulness-Based Interventions

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Abstract: ***With the increasing social pressures leading to a growing prevalence of mental illnesses and somatic disorders, mindfulness-based interventions (MBIs) have been demonstrated to be effective in enhancing well-being and reducing perceived stress. Traditional MBIs face constraints related to time, space, and personnel, which not only increase costs but also add to the burden on patients. Digital mindfulness-based interventions (d-MBIs) offer a promising pathway for the scalable dissemination of mindfulness training in the 21st century. Smartphone applications and web-based platforms provide potential advantages over traditional face-to-face formats by enhancing the accessibility, standardization, personalization, and effectiveness of mindfulness training. However, digital mindfulness interventions also encounter challenges such as low user engagement, superficial learning, and suboptimal therapeutic outcomes. This paper synthesizes and reviews recent applications of mindfulness interventions in psychological, physiological, mental, and clinical domains, explores novel models of digital mindfulness-based therapy, and discusses their advantages and limitations, with the aim of further advancing research on mindfulness-based approaches for preventing psychological disorders and diagnosing and treating somatic dysfunctions.***

Keywords: Internet, Mindfulness, Mindfulness-Based Intervention, Digitalization**.**

1. Introduction

The Internet has transformed our lives in areas such as communication, payment, shopping, work, and leisure. Despite the existence of a "digital divide," a growing number of individuals are engaging in psychotherapy through the Internet, and mindfulness along with mindfulness-based interventions (MBIs) is gradually gaining public attention [1]. Mindfulness is widely recognized as the open and conscious awareness of one's present-moment experiences and has been applied across various domains, including psychotherapy, clinical trials, retreats, and even smartphone applications [2]. Mindfulness-based interventions refer to a range of psychological interventions rooted in mindfulness practices. While their origins can be traced back to Buddhist meditation, modern MBIs have been secularized and are now widely utilized as tools for mental health and stress management [2, 3]. These interventions involve consciously and non-judgmentally focusing on the present moment, comprising two core components: awareness and acceptance. Awareness refers to directing attention to current experiences, while acceptance entails a non-judgmental and open attitude [3, 4]. Mindfulness-based digital interventions, also known as digital mindfulness-based interventions (d-MBIs), are primarily self-guided programs delivered online. These interventions aim to foster positive change by providing well-structured health-related materials and incorporating web-based interactive components to enhance knowledge, awareness, and understanding. The term "online intervention" is also frequently used in this context [5]. Today, MBIs have garnered widespread attention among healthcare professionals, and empirical evidence supports their effectiveness in both clinical and non-clinical settings. The most commonly implemented approaches include mindfulness-based stress reduction (MBSR), mindfulness-based cognitive therapy (MBCT), mindfulness-based relapse prevention (MBRP), dialectical behavior therapy (DBT), and acceptance and commitment therapy (ACT) [2-4]. Digital mindfulness-based interventions exhibit diverse characteristics and hold significant potential for delivering mindfulness-based mental health support to larger populations at a lower cost [6]. Therefore, this review summarizes the applications of d-MBIs across various fields, further explores their practical utility and developmental prospects, and discusses their future accessibility and applicability in the era of artificial intelligence. The ultimate goal is to facilitate the development of personalized diagnostic and therapeutic strategies to better address patients' practical needs.

2. The Concept and Development of Mindfulness

Mindfulness has never had a singular definition and is more commonly regarded as the moment-to-moment awareness of thoughts, feelings, bodily sensations, and the surrounding environment. This includes focused attention on an individual's present-moment experience—encompassing both external and internal states—as well as adopting an open attitude toward one's experiences. While most scholars believe it originated within Western psychotherapeutic models, emerging research indicates that it is firmly rooted in Indian philosophy and tradition [7, 8]. Mindfulness-based interventions (MBIs) refer to practices that promote self-regulation of mind and body through techniques such as body scanning, mindful breathing, and mindful movement. It is worth noting that MBIs represent a form of cognitive training that encourages individuals to understand their thoughts, emotions, and behaviors associated with anxious feelings. Through such practice, individuals can enhance self-awareness, strengthen behavioral control, and better regulate anxiety-related thoughts, emotions, and behaviors [9]. Although psychopharmacology has played a distinctive role in alleviating psychological distress in the field of medicine, a growing number of patients seek a deeper understanding and meaning of their suffering, rather than mere symptomatic

relief. As a result, MBIs have gained popularity among diverse populations in healthcare, education, and various workplace settings [10]. Despite these benefits, numerous challenges remain in the accessibility and delivery of MBIs, such as geographical, time, and financial constraints, as well as a shortage of well-trained professionals. Traditional mindfulness-based interventions are typically delivered face-to-face in multiple sessions, while digital mindfulness-based interventions (d-MBIs) have the potential to overcome these limitations [11]. As digital technologies become increasingly entrenched in our daily lives, researchers are embarking on a practical journey to explore their multifaceted impacts on mental health and overall well-being.

3. Digital Mindfulness-Based Interventions (d-MBIs)

d-MBIs refer to internet-self-guided intervention programs implemented through structured online protocols delivered via websites and utilized by individuals seeking health and mental health-related support [12]. Since the emergence of mindfulness applications, digital mindfulness training has reached millions of people worldwide. There are now thousands of mindfulness apps available on the market, which attracted over US$150 million in venture capital funding in 2017 alone [5]. Traditional face-to-face mindfulness-based stress reduction programs are also transitioning to online formats, and digital mindfulness teacher training programs are gaining increasing popularity. This rapid rise of digital mindfulness-based interventions offers unprecedented opportunities to provide high-quality training to a growing number of internet-connected individuals [13]. However, d-MBIs also face multiple challenges. While expanding their user base, they encounter issues related to diverse interests, varying needs, and different religious beliefs. Personalized programs assisted by artificial intelligence can better address these variations [14]. Differences in the selection of intervention methods may lead to a lack of clear objectives in d-MBIs, preventing them from fully realizing their potential. Achieving effective learning under any circumstances is challenging, and this holds true for d-MBIs as well [15]. Participants have reported difficulties in grasping the core concepts of mindfulness, expressing uncertainty about whether their practice is correct, or completely misunderstanding the purpose of the intervention, which inevitably leads to obstacles and frustrations [13, 14]. Despite these challenges, a growing number of professionals are engaging in and refining d-MBIs, seeking appropriate intervention measures, developing optimal treatment plans, and delivering care and support to patients across the globe.

4. Practice of Digital Mindfulness Interventions

4.1 Mindfulness-Based Stress Reduction (MBSR)

MBSR is an 8-week mindfulness-based stress reduction program developed by Jon Kabat-Zinn. Initially designed and standardized for patients with chronic pain, it has demonstrated the benefits of mindfulness interventions in helping individuals cope with various illnesses on both mental and physical levels [16]. A significant focus of the MBSR program is learning to attentively observe bodily sensations through practices such as body scan meditation, gentle stretching, and mindful yoga, as well as discussions and exercises aimed at applying mindful awareness to daily life experiences and stress management [17]. MBSR encourages patients to acknowledge their present emotions with an open and accepting attitude toward themselves. This enhances patients' confidence in their disease prognosis, improves self- and environmental-awareness, and facilitates objective evaluation, thereby promoting their physical and mental well-being [18]. A study by Gu Z [19] indicated that internet-based MBSR can effectively improve psychological well-being in cervical cancer patients, with the positive effects of the intervention persisting in the short term. Kevin R et al [20] conducted an 11-week digital mindfulness-based intervention (d-MBIs) in French rural secondary schools using a 5-minute audio test and found correlations with mindfulness, creative potential, and responsibility among students with an average age of 11. Research by Fan M's team condensed online MBSR courses into six sessions to alleviate anxiety and related symptoms in the general population. The therapeutic benefits of the intervention lasted for up to six months, suggesting that this low-resource intervention may help address the challenge of providing psychotherapy to large populations and provides positive evidence for the effectiveness and feasibility of online, briefly modified MBSR programs [21]. Additionally, Bossi et al. found that online mindfulness-based interventions improved well-being and reduced stress following the COVID-19 lockdown [22].

4.2 Mindfulness-Based Cognitive Therapy (MBCT)

MBCT, developed by Zindel Segal et al. in the 1990s, is a psychotherapeutic approach that integrates cognitive behavioral therapy with mindfulness-based stress reduction. It was initially designed to address relapse in chronic depression and has been widely applied in the treatment and alleviation of various emotional and psychological issues such as anxiety, depression, obsessive-compulsive tendencies, and impulsivity [23]. A randomized controlled trial conducted by Paul Ritvo [24] involving adolescents with major depressive disorder demonstrated that online MBCT intervention significantly reduced scores on the Beck Depression Inventory-II (BDI-II), Quick Inventory of Depressive Symptoms (QIDS), Beck Anxiety Inventory (BAI), and Brief Pain Inventory (BPI), indicating the beneficial effects of online MBIT. In another randomized clinical trial by Segal et al. [25] involving 460 participants with residual depressive symptoms, results revealed that those who received online mindfulness-based cognitive therapy in addition to treatment as usual showed greater reductions in depressive and anxiety symptoms, higher remission rates, and improved quality of life compared to those receiving treatment as usual alone. These findings support the value of online mindfulness-based cognitive therapy as an adjunctive and scalable approach for managing residual depressive symptoms.

4.3 Mindfulness-Based Relapse Prevention (MBRP)

This is a psychological intervention technique initially developed by members of the Psychology Research Team at the University of Washington's Addictive Behaviors Research Center. MBRP integrates mindfulness meditation

with cognitive-behavioral therapy as a comprehensive treatment approach, primarily used to prevent relapse in individuals recovering from substance dependence. The objective is to enhance self-awareness of triggers, habitual patterns, and automatic responses through mindfulness practice, fostering the ability to accept present experiences and break free from deeply ingrained, often catastrophic, habitual thought and behavior patterns [26, 27]. MBRP is suitable for individuals who have completed inpatient or outpatient treatment, possess motivation to maintain treatment goals, and are willing to adopt lifestyle changes to achieve well-being and recovery [28]. Brown et al. demonstrated that MBRP combined with transcranial direct current stimulation can reduce alcohol craving in patients with alcohol use disorder, with the degree of craving reduction in response to alcohol-related images correlating with the number of MBRP group sessions attended [29]. Chen's team [30] explored the effects of MBRP combined with virtual reality technology on reducing craving, cue reactivity, and negative emotions in patients with methamphetamine use disorder, proving that the integration effectively decreased both craving and negative emotions. The findings from this study may hold significant implications for future research on relapse prevention.

4.4 Dialectical Behavior Therapy (DBT)

Dialectical Behavior Therapy (DBT) is an empirically supported cognitive-behavioral treatment originally developed for individuals with borderline personality disorder. Its core component involves mindfulness meditation, which encourages self-acceptance, acceptance of one's past, and current circumstances, while simultaneously promoting efforts to change behaviors and environments [31]. A study by Asarnow [32] on dialectical behavior therapy for suicidal adolescents demonstrated that DBT yielded superior outcomes in reducing suicidal planning and self-harm behaviors post-treatment, along with higher rates of self-harm remission during active treatment and follow-up periods. In a study by Leeuwen et al. on the usability, efficacy, and clinical utility of digital DBT, it was indicated that if transitioning to video conferences and online training is the only feasible approach to deliver evidence-based treatments like DBT to patients in need, such a shift is justifiable. However, current research evidence does not support a permanent transition to fully online or hybrid DBT formats. Compared to standard face-to-face DBT, it remains crucial to intensify investigations into the effectiveness of online and hybrid DBT models. Further advancements in this area are essential to enhance the scope and efficacy of existing methodologies, address the high demand for specialized support, and anticipate the needs of both clinicians and individuals with emotion dysregulation [33].

4.5 Acceptance and Commitment Therapy (ACT)

Acceptance and Commitment Therapy (ACT) is an empirically based psychological intervention that integrates acceptance and mindfulness strategies with commitment and behavior change techniques. It aims to help individuals cope with stress and adversity, improve interpersonal relationships, and address various forms of addiction [34]. Recent studies have found that ACT can enhance mindfulness, allowing individuals to cultivate awareness of their own behaviors through techniques such as mindfulness and self-as-context. This helps focus attention on what matters, thereby facilitating acceptance and improvement of negative emotions and enhancing cognitive function [35]. A study on chronic pain indicated that online ACT interventions effectively improve pain interference, acceptance, and fibromyalgia impact. However, neuropathic and nociceptive pain involve distinct sensory experiences, suggesting that future research should focus on specific types of chronic pain [36]. Clinical research has shown that flare-ups of inflammatory bowel disease (IBD) are closely associated with depressive and anxiety symptoms. Online ACT interventions for individuals with IBD have been demonstrated to be feasible and acceptable [37]. A randomized controlled trial examining online ACT for diet and physical activity among overweight or obese adults found that combining online ACT with dietary education effectively targeted key psychological variables related to health behavior change, such as psychological inflexibility and weight self-stigma. However, further research is needed to determine the long-term effects of self-administered ACT, whether supplementary guidance is necessary to ensure adequate engagement and outcomes, and how to optimize online ACT interventions to maximize their reach and effectiveness [38].

5. Conclusions

With the widespread use of mindfulness applications and digital courses, digital mindfulness-based interventions (d-MBIs) are rapidly becoming a primary means for people worldwide to practice mindfulness. Although a substantial evidence base already exists for internet-based therapeutic trials, numerous issues remain to be investigated. To ensure the effectiveness of interventions, important considerations such as privacy, confidentiality, security, accessibility, engagement, retention, and problem-solving must be kept in mind. Due to the lack of existing guidelines for online delivery, there are significant knowledge gaps in using digital technologies to treat and support patients with complex needs, particularly regarding implement ability, acceptability, efficacy, and long-term outcomes compared to face-to-face therapy. For some patients, online therapy may be as effective as in-person sessions, while for others, it may not be suitable.

At the same time, compared to traditional mindfulness interventions, d-MBIs demonstrate better outcomes in treating psychosomatic conditions and can provide users with immediate personalized feedback, along with tailored course plans. However, the extent to which mindfulness research leads and integrates with practice still requires strengthening. Additionally, the limited availability of qualified mindfulness instructors and the high time demands placed on participants restrict the popularization and application of mindfulness interventions. During mindfulness training, individuals inevitably encounter obstacles and setbacks. Patients using d-MBIs have reported experiencing negative thoughts and feelings of anxiety during meditation, along with a desire to discuss these emerging thoughts and intentions with physicians or peers. Other challenges include discomfort, difficulty sustaining attention, self-criticism, and skepticism about the usefulness of mindfulness. Neglecting these challenges may lead to decreased engagement.

Currently, the propensity of patients to react negatively to their mindfulness experiences and applications represents a dilemma for d-MBIs, highlighting the necessity of consistent practice and the effort required from patients. Therefore, greater consideration must be given to individual suitability and the pursuit of professional guidance. Meanwhile, integrating d-MBIs into programs for diverse populations has become increasingly important, as they can exert beneficial effects on health. Future research needs to further explore the long-term effects of d-MBIs and how to refine intervention methods to broaden their applicability. The ever-evolving digital revolution can not only successfully improve the accessibility of mindfulness training but also enhance its effectiveness. If d-MBIs are designed guided by emerging best-practice literature and combined with iterative and improved empirical approaches, in the era of artificial intelligence development, more patients will benefit from high-quality mindfulness training.

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