

Meta-Analysis of the Beneficial Effects of Mindfulness-Based Interventions (MBIs) on the Neurological System and Prevalent Neurological Disorders

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Received: April 08, 2020; **Published:** April 30, 2020

DOI: 10.31080/ecne.2020.12.00694

Abstract

Mindfulness-based interventions (MBIs), such as yoga, meditation, and prayer, are utilized globally. Mindfulness meditation, yoga, and spirituality (prayer) result in diminished pain, enhanced physical movement, and improved quality of life (QoL) in those suffering from chronic illness. MBI has been found useful in treating the negative symptoms of schizophrenia. Positive results have been noted employing MBIs in attention-deficit/hyperactivity disorder (ADHD). MBIs reduced pain scores and improved QoL ratings in cancer and chronic pain patients. Meditation has been shown to ameliorate the response to stress and promote wellness. During meditation, specific brain regions are activated, indicative of opioidergic pathways. Yoga has emerged as an adjunctive treatment in schizophrenia. Prayer and spirituality are associated with a greater sense of confidence and self-esteem compared to those who do not embrace them. Spiritual belief and the use of prayer aid specific individuals in coping with daily stressors. Mindfulness practices are distinctive compared to other integrative therapies. However, further randomized control trails (RCTs) and meta-analyses are needed to determine clinically-applied protocols for MBIs in neurological disorders, neuropathic trauma, depression, nervousness, and a low QoL. This research indicates that mindfulness-based interventions (yoga, meditation, and prayer) are gaining acceptance, and their beneficial effects on the neurological system and prevalent neurological disorders hold promise for the future.

Keywords: Chronic Pain; Cognitive Decline; Meditation; Mindfulness; Opioids; Prayer; Yoga

Abbreviations

ACC: Anterior Cingulate Cortex; ADHD: Attention-Deficit/Hyperactivity Disorder; BDNF: Brain-Derived Neurotrophic Factor; BP: Blood Pressure; ECG: Electrocardiogram; EEG: electroencephalograph; fMRI: Functional Magnetic Resonance Imaging; HR: Heart Rate; HRV: Heart Rate Variability; MBI: Mindfulness-based Intervention; OFC: Orbitofrontal Cortex; QoL: Quality of Life; RCT: Randomized Controlled Trial; TM: Transcendental Meditation

Introduction

Mindfulness-based interventions (MBIs), such as yoga, meditation, and prayer, have been practiced for ages and observed throughout different cultures globally. In the early 1970s, the work of Wallace, *et al.* (1971) on transcendental meditation (TM) showed statistically significant changes in conventional medical and scientific experiments. They demonstrated that meditation had beneficial effects on oxygen consumption, heart rate, respiratory rate, serum lactate levels, and electroencephalograph (EEG) readings [1].

Citation: Abdullah Hafid and Nicholas A Kerna. "Meta-Analysis of the Beneficial Effects of Mindfulness-Based Interventions (MBIs) on the Neurological System and Prevalent Neurological Disorders". *EC Neurology* 12.5 (2020): 101-108.

The use of meditation has been shown to ameliorate the response to stress and promote wellness [2]. According to Zgierska, *et al.* (2017), nonpharmaceutical therapies, such as cognitive-behavioral therapy (CBT), mindfulness meditation, yoga, and spirituality (prayer), result in diminished pain, enhanced physical movement, and improved quality of life (QoL) in those suffering from chronic illness (i.e., low back pain) [3]. There are untold numbers of individuals currently using some form of MBIs; that number continues to increase. Barnes, *et al.* (2007) noted that nearly 20 million Americans indicated that they engage in some form of meditation alone [4]. Duerr, *et al.* (2003) wrote, in the Western world, meditation and related practices have been utilized within nonsectarian contexts, such as universities, hospitals, and clinics [5]. However, it is difficult to document the amount of meditation or other MBIs being utilized or performed off-site by the study participants [6].

Discussion

Physical activity has been shown to enhance and safeguard cognitive function and is associated with some MBI and non-MBI therapies. Thus, Hillman, *et al.* (2008) opined, that it is necessary to distinguish affective differences of a placebo, aerobic exercise, or MBI [7]. The study of the basic science of anatomy and physiology has identified the afferent pathways and signals throughout the human body that provide relay networks to the nucleus solitarius in the brain. Neurological signals are transmitted to the cerebral cortex through the thalamus, hypothalamus, and amygdala [8]. Exercise is known to promote, elevate, and disperse brain-derived neurotrophic factor (BDNF), which facilitates angiogenesis, neurogenesis, and synaptogenesis [9]. Zernicke, *et al.* (2014) noted that the analysis of readings from portable EEG recorders could help interpret a subject's state of mind by utilizing algorithms that recognize dynamic and quiet brain states [10].

Beneficial effects of MBIs on the neurological system under stress

There are many psychiatric and neurological conditions that respond minimally to moderately with the currently accepted and applied medical therapies. However, MBI has been found effective in treating the negative symptoms of schizophrenia. Thus, incorporating MBI into treatment plans of people with schizophrenia with negative symptoms might prove beneficial in clinical practice [11].

Positive results (e.g., lessening of inattention) have been noted by employing MBIs in attention-deficit/hyperactivity disorder (ADHD). Thus, patients who have inattentive-vs-hyperactive ADHD might benefit from the addition of MBIs to their therapeutic regime. Inattentive-type ADHD is more commonly observed in adults, suggesting attention-associated spheres of neural activity [12]. ADHD is a complex condition to diagnose and treat; it is considered to have interactions among various behavioral and neuronal systems [13].

When implementing MBIs into a patient's treatment, there should be an adequate understanding of the feasibility, acceptability, and safety for a given patient population or specific condition [14]. Davidson and Kaszniak (2015) noted that many studies support MBI intervention; however, some studies use questionnaires and other qualitative data points, which reduce MBIs' validity and possible application [15].

The cardiovascular and neurological systems use several chemical, structural, and physiological pathways to communicate with each other. Thus, Appelhans and Luecken (2006) suggested the measuring of heart and brain function simultaneously—utilizing a 24-hour active electrocardiogram (ECG) and quantitative EEG recorder—which might aid researchers in determining any beneficial changes during MBI [16]. Although it cannot be stated how MBIs work exactly, randomized controlled trials (RCTs), over time, have revealed diminished nervousness and improved QoL with meditation in breast cancer patients. Nevertheless, information on which phase of the condition or treatment is impacted by meditation remains scarce [17].

Using advanced image recording, Zeidan, *et al.* (2015) demonstrated that, in chronic pain conditions, MBI was associated with the activation of the anterior cingulate cortex (ACC), orbitofrontal cortex (OFC), and anterior insula [18]. Researchers examined the effect of MBI

in the presence of an opioid antagonist, naloxone, in an attempt to determine if the primary effect of MBI on pain modulation mimicked the mechanism of opioid medication. With naloxone, pain perception and rating with MBI remained unchanged. Thus, MBI-associated pain reduction seemed to work outside of an opioid agonist pathway [19].

Hodgins and Adair (2010) reported that there was significance in an individual's level of mindfulness training; experienced meditation practitioners demonstrated enhanced attention and cognitive adaptability when compared with control subjects [20]. Cairncross and Miller (2016) stated that MBIs assisted participants in cultivating nonjudgmental awareness of the present moment. Clinical trials have evidenced MBIs' effectiveness in treating depression, anxiety, addictions, and mood disorders [21]. The effectiveness of MBI in depression was variable, as there were positive effects [22] as well as no effect [23].

Beneficial effects yoga on the neurological system under stress

Many individuals with severe and painful conditions struggle, at times, to find relief from and the resilience to traumas, malignancies, and terminal illness. Rajguru., *et al.* (2015) reported, in a limited number of RCTs, that MBIs reduced pain scores and improved QoL ratings in cancer and chronic pain patients [24]. Scientists utilized functional magnetic resonance imaging (fMRI) to observe alterations in neuroactivity during active yoga. Data from these fMRIs were interpreted as yoga promoting various elements of cognition and the ability to disconnect consciously from stress and alleviate or ameliorate stress-related symptoms [25].

Yoga has emerged as an adjunctive treatment in schizophrenia, spawning enhanced social awareness and less negative symptoms, per a systematic review and meta-analysis by Cramer., *et al.* (2013) [26]. Hearn and Cross (2020) noted that programs in research typically follow a forty-five minute to one-hour session, performed once or twice weekly over 8–12 weeks [27]. Yoga lessened depressive symptomatology and improved QoL and cognition. Regular yoga practitioners reported lower stress, mood normalization, and improved emotional regulation [28]. Typically, only one form of MBI is studied. There have been studies using a combined approach (e.g., meditation and yoga); however, the details of the therapy protocol were undefined [29].

Beneficial effects meditation on the neurological system under stress

Kabat-Zinn (1990) noted that nonpharmacological therapies are sometimes categorized within a group of interventions that leads to misidentification of the nonpharmacological treatment being applied in the research. Consider meditation and CBT. While both affect mental aspects, meditation encourages present-moment awareness and acceptance, while CBT involves challenging convictions, striving to change maladaptive behaviors, and redirecting behavioral reactions [30].

Fundamentally, meditation aims to alter and fine-tune personal observation, attention, and comprehension [31]. Studies on meditation therapy are typically carried out by face-to-face sessions over 2–3 months [32]. Meditation, when done consistently over months, has resulted in enhanced energy levels and improved QoLs in the practicing subjects compared to controls [33].

Diagnosis- or complaint-specific meditation programs, while measuring clinical results, might be an effective method to reveal an MBI's healthy effects and specific mechanisms of action [34]. According to Sachdeva (2015), meditative practices promote mental resistance, improve attention, and widen cognitive limits [35]. In a systematic review by Gard., *et al.* (2014), meditation showed positive outcomes in cognitive decline [36]. Also, the application of meditation elicited improved concentration, memory, executive function, processing pace, and general cognition in age-related cognitive disorders when compared to controls [36].

Zeidan., *et al.* (2011) observe that during meditation, specific brain regions are activated, indicative of opioidergic pathways being activated. Also, other noted regional activation suggested alternative pathways might be involved in mindfulness-meditation-induced pain relief. Neuroimaging data, gathered during mindfulness meditation, illustrated—while associated opioid regions were influenced during meditation—a deactivation in the thalamus might be partially responsible for pain modulation; sensory information appeared reduced [37].

Beneficial effects prayer on the neurological system under stress

Despite any preconceptions of religion or spiritual belief, prayer and spirituality are associated with a greater sense of confidence and self-esteem compared to those who do not embrace them. Anthony (2004) revealed that many neurologically-afflicted individuals, who incorporate prayer in their lives, seem able to counter the burden of stigma and stereotypes associated with a neurological disorder or condition [38]. Baer (2003) postulated that mindfulness practices and spiritual engagement foster a nonjudgmental perspective regardless of condition-associated physical sensations, thoughts, ideas, or feelings [39].

Generally, prayer and spirituality are considered significant factors in an individual's sense of well-being. Blazer (2007) noted that spiritual belief and the use of prayer aided specific individuals in coping with daily stressors [40] and in improving cognition. Kendra (2014) described cognition as the ability to harness specific elements of brain function, such as thinking, language, memory, discernment, perception, planning, knowledge, and critical thinking [41]. Although there is interest in how prayer, religion, and spirituality play a role in the treatment of mental and neurological disorders, only a few studies have explored these interventions in those regards [35].

Cheong, *et al.* (2018) suggested that the combined use and analysis of ECG, EEG, heart rate (HR), heart rate variability (HRV), blood pressure (BP), cortisol levels, and other serum markers, might demonstrate an MBI's beneficial effects on neurological disorders [42]. Preliminary studies have indicated that prayer and spirituality might help diminish depression-associated symptoms and improve cognitive capacity [35]. According to Grabovac, *et al.* (2008), patients holding a religious or spiritual belief reported enhanced well-being, increased coping ability, and reduced levels of distress, depression, and nervousness compared to controls [43]. Kaufman, *et al.* (2007) observed that people with solid religious practices often utilize positive religious coping behaviors to decrease stress and regulate emotions [44].

Mindfulness practices are distinctive compared to other integrative therapies. MBIs incorporate a purposeful commitment to awareness of the present moment with a nonjudgmental focus on ideas, feelings, and thoughts [45]. Harris (2014) stated that prayer and spiritual practices have the potential to safely reduce pain severity and sensitivity in patients with chronic pain [46]. Mindfulness, prayer, and spiritual practices are becoming popular therapies, particularly among patients afflicted with chronic conditions that lack a gold standard of therapy [47].

Bridging the research gap regarding MBIs and neurological disorders

According to the Cochrane Database of Systematic Reviews (Henschke, *et al.* 2010), MBI was effective in moderating short-term pain relief in chronic pain sufferers when compared to the medical standard of care alone but did not appear to have long-term superiority [48]. Meditation was shown to be as effective in reducing anxiety as other nonpharmaceutical therapies [49]. While some studies have addressed components of mindfulness, further RCTs and meta-analyses are needed to determine clinically-applied protocols for MBIs in neurological disorders, neuropathic trauma, depression, nervousness, and a low QoL [50]. Also, it remains challenging to track the length of treatment, mindfulness techniques, outside interventions, and at-home compliance with MBIs [51].

Conclusion

Mindfulness-based interventions have been shown to ameliorate stress and promote wellness. While there are positives to take from the research on MBI in chronic pain, the neurological system, and prevalent neurological disorders, the data is limited; additional RCTs are needed. Mindfulness-based intervention (in the form of yoga, meditation, or prayer) is a safe mind-body modality that fosters noncritical attitudes and present-moment experience; MBI lessens the intensity of chronic pain and enhances coping abilities. MBI is a tool that can be used to address daily stress and hardship. While some research outcomes support MBI in specific psychiatric and neurological disorders (e.g., negative symptoms in schizophrenia and cognitive decline, respectfully), the results of the research have been ambiguous.

Nonetheless, MBI is becoming a practical option for patients seeking relief from chronic pain. While opioids and other pain medications offer pain relief, their side effects and risks of dependency remain a barrier and drawback to their prescriptive use. Thus, selecting a less-risk and low-cost option, such as MBI, as monotherapy or in combined therapy (with established medical treatments) is gaining acceptance for chronic pain patients. MBI's positive effects on the neurological system and prevalent neurological disorders hold promise for the future.

Conflict of Interest Statement

The authors declare that this paper was written in the absence of any commercial or financial relationship that could be construed as a potential conflict of interest.

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Volume 12 Issue 5 May 2020

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