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## Stress and primary headaches – Mindfulness-Based Stress Reduction (MBSR) as a novel avenue for treatment

Julia Szymonik MD<sup>1</sup>, Sebastian Szopa MD<sup>2</sup>

### 1. Corresponding author

University Clinical Hospital in Wrocław, ul. Borowska 213, 50-556 Wrocław

<https://orcid.org/0009-0005-6125-253X>

[julia\\_szymonik@op.pl](mailto:julia_szymonik@op.pl)

### 2. University Clinical Hospital in Wrocław, ul. Borowska 213, 50-556 Wrocław

<https://orcid.org/0009-0003-8106-7847>

[spatrakus.szopa@interia.pl](mailto:spatrakus.szopa@interia.pl)

## Abstract

**Introduction:** In today's fast-paced life, an increasing number of people are experiencing chronic stress, which negatively impacts our mental and physical health, leading to troublesome conditions such as primary headaches. Faced with this challenge, more individuals are turning their attention to mindfulness techniques as an effective tool for stress management. In light of this, mindfulness, focusing on the awareness of the present moment, emerges as a promising method for preventing and alleviating stress-induced headaches and the resulting aftermath.

**Purpose:** Offer a comprehensive overview of the current understanding of the efficacy of mindfulness training, particularly Mindfulness-Based Stress Reduction (MBSR), in the prevention and relief of primary headaches and their associated consequences.

**Description of the state of knowledge:** MBSR demonstrates the potential for effectively coping with stress-induced headaches and their subsequent effects, including disability related to headaches. This category of pain includes conditions like migraine and tension-type headaches. In the clinical trials conducted thus far participants in the MBSR program show noticeable improvement in headache-related disability, self-efficacy, quality of life, catastrophic pain, and depression scores.

**Summary:** Studies suggest that integrating mindfulness training could present a promising strategy for preventing and reducing the severity of primary headaches and their consequences, by mitigating stress, a crucial factor influencing the onset of these headaches. To validate these promising findings, further randomized, large-scale, placebo-controlled studies are required.

**Keywords:** mindfulness; headache; primary headaches; stress; tension-type headache; migraine.

## **Introduction**

Headache, a nearly ubiquitous human phenomenon, stands out as one of the most prevalent complaints encountered in both neurology and general medicine.[1] The term "headaches" encompasses various types of head pain, including primary headache disorders such as tension headache, migraine, and cluster headache. Additionally, it covers pain stemming from other health conditions, known as secondary headaches.[2] Headaches can also be accompanied by various associated symptoms, such as sensitivity to light, sound, nausea, or dizziness.[3,4,5,6] The causes of headaches are diverse and encompass both physical and psychological factors. From these, it is noteworthy to single out the following aspects:

1. **Muscle Tension:** Prolonged emotional tension and improper body positions can lead to muscle tension in the neck and head, which in turn triggers tension headaches.[7,8]
2. **Vision impairments:** Incorrect vision correction, prolonged reading in poor lighting conditions, or eye strain from using electronic devices can lead to headaches.[9]
3. **Hormonal Changes:** In some individuals, especially women, hormonal changes associated with menstruation, pregnancy, or menopause can trigger headaches.[10,11,12]
4. **Sinus Issues:** Sinus infections, allergies, or other sinus-related conditions can lead to headaches, especially in the forehead and nose area.[13]

5. **Temporomandibular Disorders (TMD)** can result in headaches, particularly in the face and temple regions.[14]
6. **Dehydration:** The lack of proper body hydration can lead to headaches on its own, but it can also exacerbate underlying conditions, such as primary headache disorders or other conditions dependent on fluid balance.[15]
7. **Excessive use of medications:** Regular use of certain pain relievers can lead to headaches, especially if the medications are abruptly discontinued (withdrawal effect).[16,17]
8. **Sleep disorders:** Poor sleep quality or too short duration can act as triggers for headaches.[18]

Another significant factor influencing the occurrence of headaches is chronic stress.

### **What is chronic stress, essentially?**

Chronic stress is a prolonged state in which the individual experiences sustained activation of the stress response, leading to persistent physical and mental tension.[19] Individuals experiencing chronic stress often feel fatigue, insomnia, irritability, and may be more susceptible to various health issues.[20,21,22] In contrast to short-term stress, which is a natural response to brief situations requiring the mobilization of the body, chronic stress persists for an extended period, and its harmful effects manifest in various health areas.[23,24,25,26]

In the context of physical health, chronic stress can contribute to inflammatory processes in the body, thereby heightened susceptibility to various diseases and interfere with wound healing.[27] It can lead to disruptions in the functioning of the immune system, an increased risk of cardiovascular diseases, sleep disorders, and even promote the development of cancer.[28,29,30,31] Additionally, it has a negative impact on concentration and cognitive functioning.[32]

Moreover, chronic stress may be associated with the occurrence of mental health problems such as depression, anxiety disorders, or burnout syndromes.[33,34,35] The impact of chronic stress on mental health can result in a reduced quality of life, difficulties in interpersonal relationships, and a loss of satisfaction in daily activities or job.[36,37]

The autonomic nervous system, regulating functions such as blood pressure and heart rhythm, can be excessively activated over a prolonged period due to chronic stress, affecting the body's homeostasis.[38]

For this reason, effective coping with chronic stress is crucial for maintaining both mental and physical health. Implementing healthy stress coping strategies, such as regular physical activity, mindfulness techniques, social support, and potentially psychological therapy, can help alleviate the negative effects of chronic stress.[39,40] In situations where chronic stress becomes challenging to control, professional help can be crucial for improving well-being and quality of life.

### **Associations between stress and primary headaches**

As mentioned earlier, chronic stress can also be one among the many factors contributing to the occurrence of primary headaches.[41]

### **Tension-type headache and chronic tension-type headache**

Tension-type headache (TTH) stands as the most widespread neurological disorder globally. It manifests with recurring headaches of mild to moderate intensity, situated bilaterally, featuring a pressing or tightening quality. Notably, routine physical activity does not exacerbate these headaches.[42] A condition that evolves from episodic tension-type headache is called chronic tension-type headache (CTTH).[43] It is characterized by daily or very frequent episodes of headache lasting minutes to days. An episode of CTTH is most commonly brought on by stress.[44] Sandrini et al. and Pielsticker et al. provided evidence that individuals with CTTH exhibit a deficiency in central pain inhibitory networks, as evaluated by the diffuse noxious inhibitory control (DNIC) paradigm.[45,46] Cathcart and colleagues carried out a series of studies examining the influence of induced stress on muscle tenderness, pain detection and tolerance thresholds, tonic pain rating, DNIC and temporal summation (TS) in individuals with tension-type headaches. The results indicated that induced stress increased pain sensitivity more in TTH sufferers than in healthy controls. This heightened sensitivity was linked to the development of stress-induced headaches, supporting the notion that stress contributes to TTH by intensifying existing pain sensitivity in these individuals. Additionally, despite individuals with TTH showing non-standard reactions in TS and DNIC, no influence of induced stress was observed on either TS or DNIC in both TTH sufferers and healthy controls.[47,48,49,50,51,52] Poor posture is also indicated as a notable factor in development of this type of headache.[53] Therapeutic approaches for managing tension-type headaches (TTH) encompass physical exercise, electromyography biofeedback, cognitive-behavioral therapy, trigger point injections and massage.[54]

## **Migraine**

Migraine is a widespread and persistent condition characterized by repeated, incapacitating headache episodes and accompanying symptoms, frequently including aura.[55] It remains the second leading cause of disability globally.[56] Factors that trigger migraines are either internal or external elements linked to a higher chance of an attack within a short timeframe and they are reported by as many as 75.9% of patients.[57] Various factors triggering migraine attacks have been identified through patient surveys, diary studies, and clinical trials. Stress, weather fluctuations, changes in the menstrual cycle, sleep disruptions, certain foods and alcohol consumption are frequently mentioned as common triggers. While avoiding triggers may not always be practical, adopting a healthy lifestyle, including regular exercise, sufficient sleep, stress management, and consistent eating patterns, can potentially prevent triggers and the progression to chronic migraine over time.[58,59,60] The relationship between stress and migraines is intricate. Numerous studies show that stress is reported as a triggering factor for migraine headaches by 50 to 80% of patients.[61] The biological alterations induced by acute stress may lower an individual's threshold, making them more susceptible to a migraine attack.[62] Furthermore, it has been demonstrated that increased stress levels correlate with a greater burden of migraine symptoms. This implies that, in addition to the role of being a trigger for an attack, stress can also act as a factor exacerbating the course of the disease in susceptible individuals. Furthermore, the transformation from episodic to chronic migraine seems to be preceded by significant stressful life events, indicating that stress can induce the chronicity of migraines.[63] Acute migraine treatments focus on stopping the headache stage of migraine within 1–2 hours. While they are effective for this purpose, they do not provide significant relief for the aura, prodromal, or postdromal stages. Frequently utilized drugs encompass aspirin, or other non-steroidal anti-inflammatory drugs (NSAIDs), paracetamol, antiemetics, and triptans.[64,65] Innovative preventive treatments, like monoclonal antibodies targeting CGRP, should be taken into consideration as targeted therapies.[66] OnabotulinumtoxinA (BoNT-A) offers an alternative therapeutic approach, lowering the monthly occurrence of migraine attacks and alleviating pain intensity.[67]

## **Cluster headache**

Cluster headache occurs less frequently than other primary headache disorders.[68] It involves severe, unilateral pain in the orbital, supraorbital, or/and temporal region. These attacks can occur every other day up to eight times per day and last from 15 to 180 minutes.[69] Among diagnostic criteria for cluster headaches, there is also mention of a sense of agitation or restlessness, along with the following signs/symptoms ipsilateral to the headache: conjunctival injection and/or lacrimation, forehead and facial sweating, nasal congestion and/or rhinorrhea, eyelid edema, and miosis and/or ptosis.[70] The exact cause of cluster headaches is not fully understood. There are certain triggers that may initiate cluster headaches and they appear to be linked to the sudden release of histamine or serotonin in the body. Among these factors, alcohol use or smoking cigarettes, changes to a high altitude, exposure to bright light, exercise or exertion, heat (from either the weather or a bath), consumption of foods that contain nitrates, such as bacon or lunch meat, strong smells, and cocaine use are distinguished.[71,72,73] Although cluster headaches show a weaker correlation with stress compared to other primary headache disorders, Sandor PS and collaborators documented an instance where a patient underwent a cluster headache induced by an emotional impact. This occurred when, as patient highlighted “totally unexpectedly”, his son announced his decision to move back in with the patient's ex-wife. In the early evening of the same day, following a worrisome afternoon, patient developed a previously unexperienced type of headache. This new headache manifested regularly, occurring one to two times every 24 hours, predominantly during the night, disrupting his sleep. The pain, localized strictly on the left temporoparietal side, commenced suddenly, reaching its peak within minutes, and was accompanied by tearing and redness of the conjunctiva. In contrast to his previous headaches that worsened with movement, these new headaches were not aggravated by activity; instead, he felt restless and paced around. A diagnosis of cluster headache was established, leading to the initiation of a steroid course with prednisolone starting at 60 mg daily for 5 days, followed by a tapering down period of 5 days.[74] In case of cluster headache treatment verapamil and lithium are the most extensively documented drugs for the preventive treatment of cluster headaches, while potentially effective medications include topiramate, gabapentin and melatonin divalproex sodium.[75]

## **Mindfulness-Based Stress Reduction (MBSR)**

Mindfulness entails purposefully directing one's focus to the current moment without passing judgment. It emphasizes awareness of thoughts, feelings, bodily sensations, and the surrounding environment.[76]

Stress management, on the other hand, refers to a set of techniques and strategies aimed at reducing or coping with the negative effects of stress on both the mind and body.[77]

When combined, mindfulness becomes a valuable tool in stress management. Practicing mindfulness allows individuals to cultivate a heightened sense of awareness and presence, which can help break the cycle of anxious or overwhelming thoughts associated with stress.[78,79] By bringing attention to the current moment and accepting it without judgment, individuals can develop a more balanced and calm perspective.

Mindfulness-based stress reduction (MBSR), developed in the late 1970s, is a standardized method for instructing mindfulness and meditation. It draws on Buddhist techniques to cultivate a mindful and nonjudgmental awareness.[80] This structured format is well-established for effectively teaching mindfulness. MBSR programs often incorporate various techniques such as mindful breathing or meditation.[81] These practices enable individuals to become more attuned to their reactions to stressors, fostering a non-reactive and composed mindset, which leads to improvements seen across a spectrum of standardized mental health measures including psychological dimensions of quality of life scales, anxiety, depression, coping style and other affective dimensions of disability. Similarly, comparable positive outcomes were observed regarding health indicators related to physical wellness, including sensory pain, medical symptoms, assessments of functional quality of life and physical limitations.[82,83]

In summary, mindfulness, when integrated into stress management approaches, provides a holistic means of addressing stress by promoting self-awareness, resilience and a healthier relationship with one's thoughts and emotions.

### **Mindfulness-Based Stress Reduction in the management of chronic pain**

Traditionally, the treatment of chronic pain through Mindfulness-Based Therapy (MBT) has encompassed an 8-week program rooted in Mindfulness-Based Stress Reduction. Marske C et al. conducted research evaluating the clinical effectiveness of an 8-week Mindfulness-Based Stress Reduction (MBSR) course in a semi-rural population with chronic pain and coexisting depression. The findings revealed that MBSR sessions were beneficial for participants with chronic pain and depression, leading to significant improvements in their mood, perception of pain and functional capacity.[84] Merkes M. in her article published in the Australian Journal of Primary Health discussed the impact of the MBSR program on individuals with chronic diseases. Her review encompasses fifteen original studies, published in English and subjected to peer review, analyzing outcomes for adults with various chronic conditions participating in the MBSR program.

Participants had diverse diagnoses including type 2 diabetes, fibromyalgia, rheumatoid arthritis, chronic fatigue syndrome, chemical sensitivity cardiovascular diseases and chronic pain. All 15 studies indicated that participation in the MBSR program led to improvement, with no reported negative changes between baseline and follow up. Chronic diseases typically associate with adverse psychological and physical consequences, yet participation in the MBSR program is likely to bring benefits, improving symptom management, overall well-being, and quality of life. Therefore, it serves as an ideal complement to standard healthcare.[85]

### **Mindfulness-Based Stress Reduction and primary headaches**

Mindfulness-Based Stress Reduction has shown promise in addressing and managing primary headaches, especially migraines and tension-type headaches.

In a study by Seminowicz et al., the effectiveness of Mindfulness-Based Stress Reduction (MBSR+) for episodic migraine patients was investigated, comparing it to a stress management control group (SMH). Data points were gathered both at the study's onset and after 20 weeks (post-therapy). Additionally, long-term clinical results were evaluated at the 52-week mark. Their MBSR intervention extended beyond the standard 8-week weekly format, incorporating an additional 8 weeks of biweekly visits, thus referred to as MBSR+. The stress management control intervention comprised 12 didactic sessions spread over 4 months, differing from MBSR+ by not incorporating a retreat. The researchers evaluated various MRI brain imaging measures, including gray matter volume and fMRI resting brain connectivity metrics for the dorsal lateral prefrontal cortex (DLPFC), a key region involved in pain regulation. In adults experiencing episodic migraines, augmented Mindfulness-Based Stress Reduction (MBSR+) led to a reduction in both headache and migraine days, along with a decrease in headache-related disability (evaluated using the six-item Headache Impact Text) – a crucial measure of functional outcomes. It demonstrated a notably higher treatment response rate compared to the active control (SMH). Specifically, the response, defined as a 50% reduction in headache frequency, with MBSR+ in relation to SMH resulted in a Number Needed to Treat (NNT) of 3.4, a figure similar to that of valproic acid—commonly prescribed for episodic migraine prophylaxis. Crucially, the MBSR+ group maintained a decreased headache frequency from 20 to 52 weeks, whereas the control group exhibited a slower reduction, resulting in a non-significant difference at 52 weeks. Regrettably, the initially hypothesized primary structural and functional MRI results did not reveal a significant interaction between group and time.



Furthermore, these imaging outcomes were not explicitly linked to clinical advancements, thus constraining our comprehension of potential brain-based mechanisms underlying the noteworthy clinical improvements.[86,87]

Wells RE and colleagues conducted a study comparing the effectiveness of Mindfulness-Based Stress Reduction vs headache education in adults suffering from migraines. The 89 adults were divided into two groups; participants underwent Mindfulness-Based Stress Reduction (MBSR), a standardized mindfulness/yoga training, or headache education (migraine information) conducted in groups, meeting for 2 hours weekly over 8 weeks. Compared to headache education, participants in Mindfulness-Based Stress Reduction (MBSR) exhibited significant improvements in headache-related disability, self-efficacy, quality of life, pain catastrophizing, and depression scores at all follow-up time points, showing medium to large effect sizes. Additionally, in the MBSR group, a decrease in experimentally induced pain was observed, suggesting a potential shift in pain appraisal. Interestingly, MBSR did not result in a higher decrease in migraine frequency compared to headache education, as both groups exhibited similar reductions.[88]

Furthermore Wells RE spearheaded a small randomized controlled trial aimed at evaluating the safety, feasibility, and impacts of an 8-week standardized Mindfulness-Based Stress Reduction course in adults dealing with migraines. Nineteen individuals with migraines were randomly assigned to either MBSR (n = 10) or standard care (n = 9) and the outcomes were analyzed following an intention-to-treat approach. MBSR demonstrated safety with no reported adverse events, boasting a 0% dropout rate and outstanding adherence. Despite limited statistical power due to a small sample size, MBSR participants exhibited a reduction of 1.4 migraines per month (from 3.5 to 1.0 migraines/month in MBSR vs. 1.2 to 0 migraines/month in the control group) from baseline to the initial follow-up. In comparison to the control group, disability decreased in the MBSR group based on HIT-6 and 1-month MIDAS assessments. Lower HIT-6 and MIDAS scores indicate reduced headache impact and disability, with a change of 2.3 points on HIT-6 representing a clinically meaningful difference. Additionally, self-efficacy and mindfulness scores increased. Improvement was also observed in effect sizes for migraine-specific quality of life, anxiety and perceived stress. These effect sizes remained consistent across all outcomes at the final follow-up.[89]

Cathcart and team conducted a randomized controlled trial of a concise MBT (6-session, 3-week) for chronic tension-type headaches to assess its effectiveness. Out of 94 volunteers, 58 qualified for inclusion and were enrolled in the study.

Six participants dropped out from the Treatment group, while 10 participants withdrew from the wait-list Control group, leading to a final completion sample of 42 participants. The intervention, derived from a combination of MBSR and Mindfulness-Based Cognitive Therapy, spanned three weeks and included group classes twice a week along with daily individual practice. The findings demonstrated a notable reduction in the frequency of headaches and an improvement in the observational aspect of mindfulness within the treatment group, as opposed to the wait-list control group. There were no observed alterations in stress, depression, or anxiety levels in either the treatment or wait-list control groups.[90]

### **Summary**

Mindfulness-Based Interventions, especially Mindfulness-Based Stress Reduction emerges as a promising approach for reducing the frequency of stress-related headache episodes. The conducted studies indicate that MBSR not only effectively diminishes the occurrence of stress-induced headaches but also enhances the overall quality of life for patients. MSBR has demonstrated a notable impact on decreasing headache-related disability. This aspect adds a valuable dimension to the effectiveness of MBSR, showcasing its potential not only in alleviating the physical symptoms of headaches but also in enhancing individuals' functional abilities and overall daily functioning. The findings suggest that MBSR may serve as a valuable method with the potential to not only alleviate the physical symptoms but also contribute to the holistic well-being of individuals experiencing stress-related headaches.

### **Author's contribution**

Conceptualization, Julia Szymonik; methodology, Julia Szymonik and Sebastian Szopa; software, Sebastian Szopa; check, Julia Szymonik and Sebastian Szopa; formal analysis, Sebastian Szopa; investigation, Julia Szymonik; resources, Julia Szymonik; data curation, Julia Szymonik and Sebastian Szopa; writing - rough preparation, Julia Szymonik; writing - review and editing, Julia Szymonik; visualization, Sebastian Szopa; supervision, Sebastian Szopa; project administration, Julia Szymonik; All authors have read and agreed with the published version of the manuscript.

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### **Data Availability Statement**

The data presented in this study is available upon request from the corresponding author.

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### **Conflict of Interest Statement**

All authors declare that they have no conflicts of interest.

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