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Research Paper

Effectiveness of Mindfulness-based Stress Reduction Therapy on Anxiety Sensitivity and Rumination in Individuals With Migraine

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ABSTRACT

Background: Migraine, a debilitating neurological disorder, frequently presents with significant psychological comorbidities, including anxiety and rumination. This pervasive co-occurrence highlights the critical need for effective non-pharmacological interventions.

Objectives: This study aimed to assess the effectiveness of an 8-week mindfulness-based stress reduction (MBSR) therapy program in reducing anxiety sensitivity (across physical, cognitive, and social concern subscales) and rumination among individuals diagnosed with migraine with comorbid anxiety.

Materials & Methods: This study utilized a quasi-experimental design with a control group and a pre-test, post-test, and follow-up framework. The statistical population comprised all female migraine patients who were referred to neurologists in Ahvaz during 2024. Forty individuals were selected through convenience sampling, limiting generalizability, and allocated to either the MBSR group or the control group, each comprising 20 participants. The MBSR group participated in eight 90-minute sessions, while the control group received no psychotherapeutic intervention. Anxiety sensitivity was quantified using the anxiety sensitivity index (ASI), analyzing physical, cognitive, and social concern subscales. Rumination was evaluated via the rumination questionnaire. Data analysis was performed using repeated measures analysis of variance (ANOVA) in SPSS software, version 27.

Results: The findings demonstrated that MBSR significantly reduced anxiety sensitivity (physical concerns, cognitive concerns, and social concerns) and rumination in patients with migraine with comorbid anxiety ($P<0.001$). These effects were sustained at the one-month follow-up ($P<0.001$).

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Conclusion: MBSR therapy significantly reduced anxiety sensitivity and rumination in individuals with migraine with comorbid anxiety, with sustained effects at one-month follow-up. However, the use of convenience sampling and the absence of long-term follow-up limit the generalizability and understanding of enduring effects. MBSR shows potential as an effective adjunctive intervention for improving psychological outcomes in this population.

Introduction

Migraine, as a chronic and debilitating neurological disorder, affects millions worldwide, exerting profound impacts on individuals' quality of life beyond mere physical pain [1]. Globally, migraine affects approximately 1.04 billion people, with a prevalence of 14-15% in the general population, and in Iran, it impacts around 14% of adults, predominantly women, contributing to significant disability and economic costs [2]. This condition, frequently characterized by recurrent, throbbing, and often unilateral headaches, can also present with other symptoms such as nausea, vomiting, and sensitivity to light and sound [3]. The term "migraine with comorbid anxiety" is used here to describe migraines where psychological factors, particularly stress and anxiety, play a prominent role in their onset or exacerbation, aligning with clinical observations of heightened psychological burden in this subgroup. The prevalence of this disorder is high, especially among the female population, imposing significant social and economic burdens on societies. A deeper understanding of the interaction between the neurological and psychological dimensions of migraine is crucial for providing comprehensive and effective interventions [4].

One of the key psychological variables playing a significant role in the pathogenesis and maintenance of migraine, particularly the type with comorbid anxiety, is anxiety sensitivity [5]. Anxiety sensitivity refers to the fear of anxiety-related symptoms (e.g. heart palpitations, shortness of breath, or dizziness) stemming from the belief that these symptoms have dangerous physical, cognitive, or social consequences. This construct is particularly critical in migraine due to its three distinct dimensions—physical concerns (e.g. fear of bodily symptoms), cognitive concerns (e.g. fear of mental incapacitation), and social concerns (e.g. fear of public embarrassment)—which may differentially exacerbate migraine symptoms and psychological distress [6]. Individuals with high anxiety sensitivity tend to pay excessive attention to their bodily changes, which may be indicative of anxiety, and interpret them catastrophically [7]. This characteristic can directly influence the experience of migraine pain, as migraine premonitory symptoms (e.g. mood or sensory changes) may be interpreted as dangerous signs of anxiety, creating a vicious cycle of fear and pain escalation [8]. Research has shown that anxiety sensitivity is not only a risk factor for anxiety disorders but also significantly correlates with chronic pain conditions, including migraine, amplifying symptom severity and frequency [9].

In addition to anxiety sensitivity, rumination is another psychological variable extensively linked to chronic pain experiences, including migraine [10]. Rumination is defined as a repetitive and passive pattern of thinking that focuses on the causes, consequences, and symptoms of distress, without leading to constructive problem-solving [11]. This cognitive process is especially relevant in migraine with comorbid anxiety, as it heightens stress and emotional dysregulation, which can trigger or worsen migraine attacks. This cognitive process can involve persistent thinking about pain, its incapacitating effects, and worries about the future [12]. Rumination not only perpetuates and intensifies negative emotional states such as anxiety and depression but can also directly influence pain processing and lower pain tolerance thresholds [13]. In migraine patients, rumination can lead to a vicious cycle where continuous worry about future attacks or their impact on daily life increases stress levels, which in turn can exacerbate the frequency and severity of migraine attacks [14].

Given the complex and multifaceted nature of migraine, especially in cases accompanied by psychological components, the need for comprehensive and non-pharmacological interventions is increasingly evident [15]. In this regard, mindfulness-based stress reduction (MBSR) has emerged as a promising approach. MBSR is a structured program developed by Jon Kabat-Zinn in the late 1970s, involving the teaching of mindfulness meditations (e.g. sitting meditation, body scan, and mindful yoga) and daily practices to cultivate moment-to-moment, non-judgmental awareness of thoughts, feelings, and bodily sensations [16]. The primary goal of MBSR is to help individuals manage stress, pain, and illness by transforming their relationship with their inner experiences [17]. Numerous studies have dem-

onstrated the efficacy of MBSR in reducing stress, anxiety, depression, and improving the quality of life in various clinical populations, including those with chronic pain conditions [18-20]. Potential mechanisms of MBSR's effect include improved emotion regulation, increased cognitive flexibility, and reduced reactivity to stressors [21].

Despite the established efficacy of MBSR in managing psychological conditions and chronic pain, limited research has specifically investigated its impact on anxiety sensitivity (across its physical, cognitive, and social subscales) and rumination in patients with migraine with comorbid anxiety [18]. Recent studies have explored mindfulness interventions for general anxiety or pain, but few have targeted the unique interplay of these psychological factors in this population, creating a critical gap in the literature [20, 21]. Considering the high prevalence of migraine and the substantial psychological burden it imposes on affected individuals, particularly in cases of migraine with comorbid anxiety, and acknowledging the critical role of anxiety sensitivity and rumination in exacerbating symptoms, investigating effective non-pharmacological interventions is of paramount importance. While the efficacy of MBSR in managing various psychological conditions and chronic pain has been established, specific research on its impact on anxiety sensitivity and rumination in the particular population of patients with migraine with comorbid anxiety remains limited. The scarcity of such research creates a gap in the scientific literature that could hinder the optimal utilization of this effective therapeutic approach. Therefore, the present study aimed to investigate the effectiveness of MBSR on anxiety sensitivity (including its physical, cognitive, and social dimensions) and rumination in women with migraine with comorbid anxiety.

Materials and Methods

Design and participants

This study utilized a quasi-experimental design featuring a control group and a pre-test, post-test, and one-month follow-up framework. The statistical population for the current research comprised all female patients diagnosed with migraine who sought treatment from neurologists in Ahvaz during the 2024 period. Migraine was operationally defined based on the international classification of headache disorders (ICHD-3) criteria, requiring recurrent headaches lasting 4-72 hours with at least two of the following criteria: Unilateral location, pulsating quality, moderate to severe intensity, or aggravation by routine physical activity, accompanied by nausea, vomiting, or sensitivity to light and sound. A total of 63 eligible individuals were identified through referrals to neurological clinics and permission from relevant physicians. From this pool, 40 participants were selected via convenience sampling and subsequently randomized into either the MBSR experimental group or the control group, with each group consisting of 20 participants. The sample size was determined using G*Power software, version 3.1 targeting a medium effect size (f=0.25), 80% power, and a 95% confidence interval (CI), yielding a minimum of 34 participants, with 40 recruited to account for potential attrition. The control group did not receive any psychotherapeutic intervention during the study period; however, to mitigate potential threats to internal validity, such as compensatory rivalry or participant demoralization, they were assured that they would receive the MBSR intervention upon the completion of data collection. Written informed consent was obtained from all participants during the initial screening session, prior to randomization, following a detailed explanation of the study's purpose, procedures, and potential risks, in accordance with ethical guidelines.

Inclusion and exclusion criteria

Inclusion criteria for participation were rigorously defined as: 1) Female patients with migraine aged 20-50 years; 2) No concurrent participation in other psychotherapy sessions for at least one month prior to the study; 3) Provision of written informed consent to participate and demonstrated adherence to the treatment protocol; 4) Absence of substance abuse, psychotic symptoms, or a history of brain diseases (e.g. brain tumors); 5) A documented history of headaches for at least the past six months; and 6) Having sought treatment from a specialist physician on more than one occasion. Exclusion criteria included: 1) Absence from more than two intervention sessions; 2) Simultaneous engagement in other psychological treatments; 3) Unwillingness to continue the treatment protocol; 4) Presence of co-occurring conditions such as substance abuse or psychotic disorders; 5) non-compliance with assigned mindfulness homework tasks; and 6) Incomplete pre-test or post-test questionnaires.

Research instruments

Anxiety sensitivity was quantified using the anxiety sensitivity index (ASI), a measure developed by Floyd et al. [22]. This 16-item scale employs a five-point Likert response format, ranging from 1 (very little) to 5 (very much). Each item on the ASI reflects the conviction that anxiety symptoms are experienced aversively and possess the potential to result in detrimental

outcomes. The ASI comprises three subscales: physical concerns (8 items, score range 8-40, e.g. fear of bodily sensations like heart palpitations), cognitive concerns (4 items, score range 4-20, e.g. fear of mental incapacitation), and social concerns (4 items, score range 4-20, e.g. fear of public embarrassment due to anxiety symptoms), with higher scores indicating greater fear of anxiety symptoms [22]. Consequently, higher scores on the ASI denote a greater degree of fear associated with anxiety symptoms, with the total score ranging from 16 to 80. The factorial structure of the ASI is composed of three distinct dimensions: fear of bodily concerns, fear of cognitive uncontrollability, and fear of anxiety being observed by others. Psychometric evaluations of this inventory have consistently demonstrated its robust internal consistency, as evidenced by a Cronbach's α coefficient of 0.90 [23]. In the present study, the Cronbach's α for the questionnaire was 0.88.

Rumination was assessed using the Rumination Questionnaire, originally developed by Nolen-Hoeksema et al. [24]. This scale is designed to evaluate negative retrospective responses and consists of two subscales: ruminative responses and distraction responses, each comprising 11 items. The questionnaire encompasses a total of 22 items, which are scored on a four-point Likert scale ranging from 1 (never) to 4 (often). The minimum and maximum possible scores for the questionnaire are 22 and 88, respectively. Higher scores on the rumination questionnaire indicate greater levels of ruminative thinking, reflecting a stronger tendency to engage in repetitive, negative thought patterns focused on distress and its consequences. In a study conducted by Aghebati et al. [25], the internal consistency reliability for the entire questionnaire, as measured by Cronbach's α, was reported as 0.81. Consistent with these findings, the Cronbach's α coefficient for the entire questionnaire in the present study was found to be 0.88.

Intervention

The experimental group underwent an eight-week MBSR therapy program, consisting of eight 90-minute sessions, whereas the control group received no psychotherapeutic intervention during the study period. The MBSR program was meticulously delivered in a structured format, adhering closely to the established standard MBSR protocol [26]. This comprehensive curriculum systematically introduced participants to a diverse array of mindfulness practices and core concepts. These were specifically designed to foster present-moment awareness, cultivate an attitude of non-judgmental acceptance, and promote a more adaptive and healthier relationship with stress, pain, and challenging emotions. Each successive session was thoughtfully structured to build upon the preceding one, thereby gradually deepening the participants' conceptual understanding and experiential engagement with mindfulness principles and practices. A more exhaustive description of the MBSR sessions, detailing their primary focus and key practices, is delineated in Table 1.

Data analysis

In this study, data were analyzed using a combination of descriptive and inferential statistical approaches. Descriptive statistics, including means and standard deviations, were calculated to summarize the data. The normality of data distribution was assessed using the Kolmogorov-Smirnov test to ensure the appropriateness of parametric tests. For inferential analyses, repeated measures analysis of variance (ANOVA) was employed to examine differences across time points and between groups. Independent t-tests were used to compare anxiety sensitivity and rumination scores between the experimental and control groups at each measurement stage (pre-test, post-test, and follow-up), as presented in Table 2. Bonferroni post-hoc tests were conducted to identify specific group differences where applicable. All statistical analyses were performed using SPSS software, version 27.

Results

The mean age of participants was 29.84±7.82 in the experimental group and 30.81±8.13 years in the control group, with no significant difference (P=0.714). Education levels showed 20% (n=4) of the experimental group and 25% (n=5) of the control group had a high school education, while 80% (n=16) and 75% (n=15), respectively, held a university degree, with no significant difference (P=0.617). Marital status indicated 35% (n=7) single and 65% (n=13) married in the experimental group, compared to 30% (n=6) single and 70% (n=14) married in the control group, with no significant difference (P=0.739). These demographic characteristics, presented in Table 2, suggest a relatively well-educated sample with comparable baseline characteristics across groups, ensuring homogeneity.

Descriptive statistics for anxiety sensitivity (total and subscales: Physical, cognitive, and social concerns) and rumination, including within- and between-group p-values, are presented in Table 3. In the experimental group, anxiety sensitivity (total) decreased significantly from 54.70±3.27 at pre-test to 30.83±5.22 at post-test and 28.15±4.89 at follow-up (P<0.001). Subscales

Table 1. Detailed summary of MBSR session content

Sessions	Content
1	This foundational session introduces the core concept of mindfulness as moment-to-moment, non-judgmental awareness. Participants learn how living on "automatic pilot" can lead to missing out on life experiences and reacting habitually to stressors. The session sets the stage for shifting from automatic reactions to conscious responses.
2	This session explores the nature of perception and how our interpretations shape our experiences. Participants learn to recognize common mental habits that serve as barriers to present-moment awareness, such as judgment and distraction, and to approach them with curiosity and patience.
3	This session emphasizes grounding oneself in direct sensory experience. Participants are guided to observe sights, sounds, and physical sensations as they arise, fostering a richer and more immediate connection to the present moment, which can be particularly helpful in detaching from rumination.
4	This session delves into the physiological and psychological patterns of stress reactivity. Participants learn to distinguish between automatic, often unhelpful, reactions to stress and more conscious, skillful responses, creating a pause before reacting.
5	This session focuses on the principle of acceptance, which in mindfulness is not about resignation or approval, but about a willingness to acknowledge and experience things as they are, without resisting or trying to change them. This is crucial for reducing anxiety sensitivity by reframing the experience of uncomfortable sensations.
6	The session addresses the nature of thoughts, emphasizing that they are mental events rather than absolute truths or commands. Participants learn to relate to their thoughts more skillfully. It also introduces the practice of self-compassion, extending kindness and understanding towards oneself, especially in moments of difficulty or perceived inadequacy.
7	This session consolidates the learning from previous weeks, encouraging participants to reflect on how they can integrate mindfulness into their daily lives as a continuous practice for well-being. It focuses on developing a personalized approach to self-care and maintaining the benefits gained.
8	The final session serves as a transition, reviewing the journey of the MBSR program and providing guidance for continuing mindfulness practice as a lifelong endeavor. It reinforces the skills learned and encourages ongoing self-exploration and development.

showed similar reductions: Physical concerns from 22.10±1.85 to 13.05±2.10 and 11.80±1.95, cognitive concerns from 15.50±1.12 to 8.70±1.25 and 7.95±1.18, and social concerns from 17.10±1.00 to 9.08±1.00 and 8.40±0.95 (all P<0.001). Rumination decreased from 66.13±2.68 to 50.03±1.36 and 48.10±1.20 (P<0.001). In contrast, the control group showed no significant changes: Anxiety sensitivity (total) remained stable at 55.61±3.47, 54.79±4.73, and 54.90±4.27 (P=0.824), with physical concerns at 22.35±1.90, 22.20±1.88, and 22.45±1.92 (P=0.897), cognitive concerns at 15.75±1.05, 15.60±1.08, and 15.80±1.02 (P=0.912), and social concerns at 17.05±1.08 across all stages (P=0.965). Rumination was stable at 65.49±2.53, 65.04±2.34, and 65.30±2.41 (P=0.883). Between-group comparisons showed no significant differences at pre-test (P=0.368) but significant differences at post-test and follow-up (all P<0.001).

Normality of data distribution was confirmed using the Kolmogorov-Smirnov test, with all P>0.10. Independent samples t-tests at pre-test confirmed baseline equivalence: Anxiety sensitivity total (P=0.368), physical concerns (P=0.660), cognitive concerns (P=0.460), social

Table 2. Demographic characteristics of experimental and control groups (n=20)

Variables		Mean±SD/ No. (%)		P
		Experimental Group	Control Group	
Age		29.84±7.82	30.81±8.13	0.714
Education level	High school	4(20.0)	5(25.0)	0.617
	University	16(80.0)	15(75.0)	
Marital status	Single	7(35.0)	6(30.0)	0.739
	Married	13(65.0)	14(70.0)	

Table 3. Descriptive statistics of anxiety sensitivity and rumination across measurement stages

Variables	Group	Mean±SD			Within-group P
		Pre-test	Post-test	Follow-up	
Anxiety sensitivity (total)	Experimental	54.70±3.27	30.83±5.22	28.15±4.89	<0.001
	Control	55.61±3.47	54.79±4.73	54.90±4.27	0.824
	Between-group P	0.368	<0.001	<0.001	-
Physical concerns	Experimental	22.10±1.85	13.05±2.10	11.80±1.95	<0.001
	Control	22.35±1.90	22.20±1.88	22.45±1.92	0.897
	Between-group P	0.660	<0.001	<0.001	-
Cognitive concerns	Experimental	15.50±1.12	8.70±1.25	7.95±1.18	<0.001
	Control	15.75±1.05	15.60±1.08	15.80±1.02	0.912
	Between-group P	0.460	<0.001	<0.001	-
Social concerns	Experimental	17.10±1.00	9.08±1.00	8.40±0.95	<0.001
	Control	17.05±1.08	17.10±1.03	17.05±1.10	0.965
	Between-group P	0.874	<0.001	<0.001	-
Rumination	Experimental	66.13±2.68	50.03±1.36	48.10±1.20	<0.001
	Control	65.49±2.53	65.04±2.34	65.30±2.41	0.883
	Between-group P	0.426	<0.001	<0.001	-

concerns (P=0.874), and rumination (P=0.426). Repeated measures ANOVA revealed significant group×time interactions for all variables: Anxiety sensitivity total, F=89.32, P<0.001, partial η^2=0.702; physical concerns, F=52.66, P<0.001, partial η^2=0.581; cognitive concerns, F=46.33, P<0.001, partial η^2=0.548; social concerns, F=43.00, P<0.001, partial η^2=0.532; and rumination, F=64.01, P<0.001, partial η^2=0.627. These findings indicated that the pattern of change over time differed between the groups. Therefore, group comparisons were conducted separately at each time point rather than as an overall time trend, to account for this interaction

Table 4 presents the within-group and between-group comparisons of anxiety sensitivity (total and subscales: Physical, cognitive, and social concerns) and rumination in a quasi-experimental study evaluating the effectiveness of an 8-week MBSR therapy program for women with migraine and comorbid anxiety. The results indicate significant within-group reductions in the experimental group for all variables from pre-test to post-test and pre-test to follow-up (e.g. anxiety sensitivity total: Mean difference=23.87, 95% CI; 21.57%, 26.17%, P<0.001; rumination: 16.10, 95% CI; 14.80%, 17.40%, P<0.001, with no significant changes in the control group (e.g. anxiety sensitivity total: 0.82, 95% CI; -1.50%, 2.14%, P=0.824). Between-group comparisons at post-test and follow-up further demonstrate significant differences favoring the MBSR group (e.g. anxiety sensitivity total: -23.05, 95% CI; -27.61%, -18.49% at post-test; rumination: -17.84, 95% CI; -19.69%, -15.99% at follow-up, all P<0.001). These findings, supported by robust confidence intervals and highly significant p-values, confirm that MBSR effectively reduces anxiety sensitivity and rumination, with sustained effects at the one-month follow-up, highlighting its potential as a valuable non-pharmacological intervention for this population.

Discussion

The objective of the present study was to investigate the effectiveness of an 8-week MBSR therapy program in reducing anxiety sensitivity and rumination among women diagnosed with migraine. The findings

Table 4. Within-group and between-group comparison of study variables

Variable	Group	Mean Difference (95% CI)			
		Within-group		Between-group	
		Pre-test, Post-test	Pre-test, Follow-up	Pre-test, Post-test	Pre-test, Follow-up
Anxiety sensitivity (total)	Experimental	23.87 (21.57, 26.17)*	26.55 (24.17, 28.93)*	-23.05 (-27.61, -18.49)*	-25.84 (-30.35, -21.33)*
	Control	0.82 (-1.50, 2.14)	0.71 (-1.60, 2.02)		
Physical concerns	Experimental	9.05 (8.12, 9.98)*	10.30 (9.32, 11.28)*	-8.90 (-10.59, -7.21)*	-10.40 (-12.07, -8.73)*
	Control	0.15 (-0.78, 0.88)	-0.10 (-1.03, 0.83)		
Cognitive concerns	Experimental	6.80 (6.09, 7.51)*	7.55 (6.80, 8.30)*	-6.65 (-7.92, -5.38)*	-7.60 (-8.85, -6.35)*
	Control	0.15 (-0.56, 0.86)	-0.05 (-0.76, 0.66)		
Social concerns	Experimental	8.02 (7.37, 8.67)*	8.70 (8.03, 9.37)*	-8.02 (-8.99, -7.05)*	-8.70 (-9.65, -7.75)*
	Control	-0.05 (-0.70, 0.60)	0.00 (-0.65, 0.65)		
Rumination	Experimental	16.10 (14.80, 17.40)*	18.03 (16.71, 19.35)*	-15.65 (-17.52, -13.78)*	-17.84 (-19.69, -15.99)*
	Control	0.45 (-0.80, 1.70)	0.19 (-1.06, 1.44)		

*P<0.001

unequivocally support the hypothesis, demonstrating a significant reduction in both anxiety sensitivity and rumination in the experimental group compared to the control group, with these effects sustained at the one-month follow-up. This robust outcome suggests that MBSR can serve as an effective non-pharmacological intervention for addressing the psychological burden in individuals with migraine, particularly those experiencing elevated anxiety and ruminative tendencies.

The observed efficacy of MBSR in reducing anxiety sensitivity can be theoretically explained through several interconnected mechanisms inherent to mindfulness practice, with particular relevance to the experience of migraine [27, 28]. Mindfulness cultivates a heightened, non-judgmental awareness of present-moment experiences, including internal bodily sensations [16]. For individuals with migraine, who often experience somatic symptoms (e.g. aura, head pain, nausea) that can trigger catastrophic interpretations, MBSR teaches skills such as decentering and non-reactivity [29]. Decentering allows participants to observe thoughts and sensations as transient mental events rather than identifying with them as absolute truths or dangers. This is crucial for anxiety sensitivity, as it directly challenges the core fear of anxiety-related symptoms [6]. By fostering a sense of detached observation, MBSR helps to dismantle the associative link between physiological arousal (migraine symptoms) and fear responses, thereby reducing the "fear of fear" that defines anxiety sensitivity [30]. Furthermore, the practice of body scan meditation within MBSR specifically enhances interoceptive awareness, enabling individuals to develop a more accurate and less catastrophic appraisal of bodily sensations, thereby targeting the "physical concerns" subscale of anxiety sensitivity [31]. The cultivation of acceptance, another cornerstone of MBSR, empowers individuals to tolerate discomfort and uncertainty, diminishing avoidance behaviors that typically fuel anxiety, which is particularly relevant for addressing both "cognitive concerns" (fear of mental uncontrollability) and "social concerns" (fear of anxiety being observed by others) by reducing self-consciousness and the perceived need for rigid control [17].

Similarly, the significant reduction in rumination observed post-MBSR can be attributed to mindfulness's direct impact on cognitive processes. Rumination is characterized by a repetitive, passive focus on distress and its consequences, often leading to prolonged negative affect [11]. MBSR directly counters this by training attentional control and cognitive flexibility [21]. Through practices like focused attention meditation, individuals learn to direct and sustain attention, and gently redirect it when the mind wanders into ruminative cycles. This enhanced attentional control weakens the habitual loops of repetitive negative thinking [19]. Moreover, the non-judgmental

stance cultivated in MBSR helps individuals observe their ruminative thoughts without becoming entangled in them, thereby reducing their emotional reactivity and capacity to prolong distress [17]. By fostering a present-moment orientation, MBSR shifts focus away from past regrets or future worries (common themes in rumination) and toward immediate experience, interrupting the cyclical nature of ruminative processing [16].

These findings are consistent with a growing body of literature demonstrating the efficacy of mindfulness-based interventions in managing chronic pain and associated psychological comorbidities. While prior research has established MBSR's effectiveness in general anxiety and depression [27, 28], this study specifically highlights its impact on anxiety sensitivity and rumination in the context of migraine, a population where these psychological variables profoundly influence disease burden and quality of life [8, 14]. Our results build upon and extend previous MBSR trials in chronic pain populations [18-20] by providing targeted evidence for its utility in addressing specific cognitive-affective mechanisms relevant to migraine pathophysiology. For instance, the observed reductions in anxiety sensitivity and rumination are not merely statistically significant but also hold considerable clinical significance. A decrease in these variables can lead to tangible improvements in patients' daily functioning, a reduced fear of future migraine attacks, enhanced coping strategies, and ultimately, a better overall quality of life, potentially reducing healthcare utilization and the economic burden associated with chronic migraine management [14].

Conclusion

In conclusion, this study provides compelling evidence for the effectiveness of MBSR therapy in reducing anxiety sensitivity and rumination in women with migraine, highlighting its potential as a valuable adjunctive treatment. The sustained effects observed at follow-up underscore its long-term benefits. Future research should aim to replicate these findings with larger, more diverse samples, including males and individuals across different age groups. Implementing randomized controlled trials with active control groups would further strengthen causal inferences. Additionally, exploring the neurobiological and cognitive mechanisms underlying MBSR's effects on migraine-related psychological distress, perhaps through neuroimaging or psychophysiological measures, would provide deeper insights. Investigating the cost-effectiveness and long-term maintenance of treatment gains beyond the one-month follow-up period are also important avenues for future inquiry.

Limitations

Despite its significant contributions, this study is not without limitations. Firstly, the reliance on a convenience sample of female patients from a specific geographical area (Ahvaz, Iran) may limit the generalizability of the findings to broader migraine populations, including males or those from different cultural contexts, and potentially introduced selection bias. Secondly, the absence of an active control group (e.g. an alternative psychological intervention or a sham intervention) means that the observed improvements cannot definitively be attributed solely to the specific components of MBSR. Non-specific factors, such as therapist attention, group support, or placebo effects, may have contributed to the outcomes. Future research would benefit from employing an active control condition to isolate the unique effects of mindfulness training. Thirdly, while the study demonstrated reductions in anxiety sensitivity and rumination, it did not directly assess the mediating mechanisms through which MBSR produced these changes. Future studies should investigate potential mediating variables such as increased mindfulness skills (e.g. decentering, present moment awareness), improved emotional regulation strategies, and changes in brain connectivity or physiological reactivity, to gain a more comprehensive understanding of the intervention's effects. Lastly, the study's reliance on self-report measures, although commonly used, may be subject to response biases. Future research could incorporate physiological measures or behavioral tasks to complement self-report data.

Ethical Considerations

Compliance with ethical guidelines

The study was approved by the Ethical Committee of Islamic Azad University, Ahvaz Branch, Ahvaz, Iran (Code: IR.IAU.AHVAZ.REC.1403.457).

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Authors' contributions

All authors contributed equally to the conception and design of the study, data collection and analysis, interpretation of the results, and drafting of the manuscript. Each author approved the final version of the manuscript for submission.

Conflict of interest

The authors declared no conflict of interest.

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