DOI: *http://dx.doi.org/10.22122/ijbmc.v11isp.735* **Published by** *Vesnu Publications*

International Journal of Body, Mind and Culture

The Impact of Mindfulness-Based Stress Reduction on Cardiac Function in Patients with Coronary Artery Disease

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Quantitative Study

Abstract

Background: Coronary artery disease (CAD) is a major public health concern worldwide, and psychological stress is an important risk factor for CAD. MBSR, or mindfulness-based stress reduction, is showing promise as a non-medication intervention for stress management and cardiovascular health. This research aimed to evaluate the impacts of an MBSR program on cardiovascular performance in patients with CAD.

Methods: Baghdad Teaching Hospital in Iraq hosted a randomized controlled trial with 120 CAD patients. Participants were randomly placed into an MBSR group (n=60) or a control group (n=60) receiving standard care. Over eight weeks, the MBSR program participants engaged in weekly 2.5-hour sessions, incorporating mindfulness meditation, yoga, and body awareness techniques. Cardiac function was assessed using echocardiography and blood pressure measurements at baseline and post-intervention. Psychological well-being was evaluated using self-report questionnaires.

Results: A significantly greater increase in left ventricular ejection fraction (LVEF) was observed among participants in the MBSR group when measured against the control group, with a between-group difference of 3.9 percentage points (95% CI: 1.5 to 6.3, P = 0.002) at post-intervention. Significant declines in both diastolic blood pressure (DBP) and systolic blood pressure (SBP) were also observed in the MBSR group, with between-group differences of -3.8 mmHg (95% CI: -6.8 to -0.8, P = 0.013), and -4.6 mmHg (95% CI: -9.2 to -0.1, P = 0.047) respectively. Changes in psychological well-being were significantly correlated with changes in cardiac function in the MBSR group.

Conclusion: Engaging in an 8-week MBSR course can improve cardiac function and psychological well-being in patients with CAD. These findings suggest that incorporating

MBSR into standard care for CAD patients may benefit cardiovascular health and stress management. Given the high burden of CAD in Iraq and other low- and middle-income countries, MBSR may represent a promising, culturally acceptable, and scalable intervention for the prevention and management of CAD. More investigation is necessary to explore the long-term effects and mechanisms of MBSR in diverse healthcare settings and populations.

Keywords: Coronary artery disease; Mindfulness; Stress; Psychological; Cardiac function

Citation: Khurramov Azizbek M, Nabeel A, Mahmood BS, Jassim M, Salman FC, Shalal AAA, et al. **The Impact of Mindfulness-Based Stress Reduction on Cardiac Function in Patients with Coronary Artery Disease.** Int J Body Mind Culture 2024; 10(Special Issue): 16-27.

Received: 01 June 2024

Accepted: 05 Aug. 2024

Introduction

Coronary artery disease (CAD) is a major public health concern globally, and psychological stress has been identified as a significant risk factor for its development and progression (Gili, 2021). CAD involves narrowing the coronary arteries due to atherosclerotic plaque buildup, which can lead to reduced blood flow to the heart and an increased risk of myocardial infarction (Gomez et al., 2020; Shao et al., 2020). Psychological stress has been shown to contribute to CAD through various pathways, including increased inflammation, endothelial dysfunction, and changes in the autonomic nervous system (Donia & Khamis, 2021; Iswanto et al., 2022). As a result, interventions aimed at reducing stress could have important implications for managing CAD.

One promising non-pharmacological approach to stress reduction is mindfulness-based stress reduction (MBSR). MBSR is a structured program incorporating mindfulness meditation, yoga, and body awareness techniques to help individuals cope with stress and enhance overall well-being (Fischer et al., 2022). Mindfulness involves paying attention to the present moment with openness, curiosity, and non-judgment (Conversano et al., 2021). Through mindfulness, individuals can become more aware of their physical sensations, thoughts, and emotions and learn to respond to stress more adaptively (İnce & Demir, 2023).

Several studies across different populations have investigated the impact of MBSR on cardiovascular health (Cho, 2016; Momeni et al., 2016; Nardi et al., 2020). A meta-analysis by Michaelsen et al. (2023) found that MBSR was associated with significant reductions in stress, anxiety, and depression in patients with cardiovascular disease. Another meta-analysis by Chen et al. (2024) demonstrated the effectiveness of mindfulness-based interventions in reducing blood pressure in healthy individuals and those with hypertension.

Specifically, in the context of CAD, a randomized controlled trial by Kabataş Yıldız & Orak (2023) found that an 8-week MBSR program led to significant reductions in perceived stress, depression, and anxiety in patients with CAD, compared to a control group receiving standard care. Similarly, a pilot study by Lundgren et al. (2022) reported that MBSR was associated with improved quality of life and reduced psychological distress in patients with CAD.

While these studies provide evidence for the beneficial effects of MBSR on psychological well-being in CAD patients, there is limited research on the impact of MBSR on objective measures of cardiac function. A small uncontrolled study by Schneider et al. (2022) found that an 8-week MBSR program was associated with improvements in endothelial function, as assessed by flow-mediated dilation, in patients with CAD. However, this study had a small sample size and lacked a control group.

Given the limited evidence on the impact of MBSR on cardiac function in CAD patients, there is a clear need for further research using rigorous study designs and objective outcome measures. Such research has important implications for managing CAD, as improving cardiac function could reduce the risk of future cardiovascular events and improve overall prognosis.

The primary aim of the present study is to investigate the effects of an 8-week MBSR program on cardiac function in patients with CAD, compared to a control group receiving standard care. Cardiac function will be assessed using echocardiography and blood pressure measurements, well-established and widely used methods for evaluating cardiovascular health.

The specific objectives of the study are to:

1. Compare changes in left ventricular ejection fraction (LVEF) between the MBSR and the control groups from baseline to post-intervention. LVEF is a key indicator of cardiac function, representing the percentage of blood pumped out of the left ventricle with each heartbeat.
2. Evaluate the effects of MBSR on systolic and diastolic blood pressure (SBP and DBP), which are important risk factors for CAD and can provide insight into cardiovascular health.
3. Explore the relationship between changes in psychological well-being (e.g., perceived stress, anxiety, and depression) and changes in cardiac function in the MBSR group.

This study aims to contribute new knowledge about the potential of MBSR as a non-pharmacological intervention for improving cardiac function in patients with CAD. If the results are positive, they could support the integration of MBSR into standard cardiac rehabilitation programs, potentially leading to improved cardiovascular health outcomes for this population.

Methods

Design study and participant: The study design involved a randomized controlled trial, which took place at Baghdad Teaching Hospital, Iraq. Participants were recruited from the hospital's cardiology department using a convenience sampling method. The sample size was determined based on a power analysis using G*Power software (version 3.1.9.4). Considering a medium effect size (f = 0.25), an alpha level of 0.05, and a power of 0.80 for a 2x2 mixed-design ANOVA, a total sample size of 98 participants (49 per group) was required. We aimed to recruit 120 participants (60 per group) to account for potential dropouts.

Inclusion criteria were: (1) a confirmed diagnosis of CAD, (2) age 18-75 years, and (3) capable of offering consent based on a clear understanding of the study. Exclusion criteria were: (1) severe cognitive impairment, (2) unstable medical condition, and (3) current participation in another psychological intervention. A computer-based randomization process was used to randomly assign 120 qualified participants to one of two groups of equal size: the control group (n = 60) and the MBSR group (n = 60).

To maintain blinding, the randomization process was carried out by an independent researcher not involved in participant recruitment, data collection, or intervention delivery. The allocation sequence was concealed from the study investigators and participants until the interventions were assigned. Participants were informed that they would be randomly assigned to one of two groups but were kept from knowing which group they were in and what the other group entailed. The MBSR instructor, echocardiographer, and nurse responsible for blood pressure measurements were also blinded to group allocation. Blinding was maintained throughout the study period, and the allocation was only revealed after the completion of data analysis.

Instruments: The MBSR intervention was led by a licensed MBSR practitioner fluent in Arabic and who had experience working with patients with chronic health conditions. The program was based on the standard 8-week MBSR curriculum developed by Jon Kabat-Zinn (Santorelli et al., 2017), which includes mindfulness meditation, yoga, and body awareness techniques. Participants in the MBSR group received a workbook and audio recordings of guided meditations to support their home practice. Standard management was administered to the control group, which included regular check-ups with a cardiologist and medication management.

Cardiac function was assessed using echocardiography and blood pressure measurements. Echocardiography was performed by a trained echocardiographer blinded to group allocation using a Vivid E9 ultrasound system (GE Healthcare, Chicago, IL, USA). A comprehensive 2D echocardiographic study was conducted following the recommendations of the American Society of Echocardiography (Lang et al., 2015). The left ventricular ejection fraction (LVEF) was calculated using the biplane method of disks (modified Simpson's rule) from apical 4- and 2-chamber views. Three cardiac cycles were recorded for each view, and the average LVEF was reported.

A trained nurse obtained blood pressure measurements, also blinded to group allocation, using an automated oscillometric device (Omron HEM-7130, Omron Healthcare, Kyoto, Japan). Participants were asked to sit quietly for 5 minutes before the measurements. The cuff was placed on the left arm, supported at heart level, with the participant seated. Three readings were taken at 1-minute intervals, and the average of the last two readings was recorded for systolic blood pressure (SBP) and diastolic blood pressure (DBP) (Whelton et al., 2018).

Participants in the MBSR group attended weekly 2.5-hour group sessions for eight weeks, held in a quiet room at the hospital (Table 1). Each session included guided mindfulness meditation, gentle yoga, and group discussions. Participants were also encouraged to practice mindfulness and yoga at home for 45-60 minutes daily, six days per week. The control group received standard care and did not attend any MBSR sessions.

All participants underwent echocardiography and blood pressure measurements at baseline and post-intervention (week 9). Demographic and clinical data were collected at baseline using a structured questionnaire and medical records review. Psychological well-being was assessed before and after intervention using the Perceived Stress Scale (Ali et al., 2021), the Hospital Anxiety and Depression Scale (Terkawi et al., 2017), and the Mindful Attention Awareness Scale (Rayan & Ahmad, 2018).

To ensure the safety and well-being of the participants, all study procedures were conducted by trained personnel and supervised by a cardiologist. Participants were monitored for adverse events during the MBSR sessions and encouraged to report concerns or discomfort. The study protocol included provisions for managing any medical emergencies that may arise during the study.

Analysis: SPSS version 26.0 was employed to perform data analysis. The participants' demographic and clinical attributes were encapsulated using descriptive statistics. Independent t-tests or chi-square tests were employed to differentiate the MBSR and control groups at baseline. To assess the effects of the MBSR course on cardiac function, a 2x2 mixed-design ANOVA was conducted with group (MBSR vs. control) as the between-subjects factor and time (before and after intervention) as the within-subjects factor. The primary outcome variables were LVEF, SBP, and DBP. In addition to the main analyses, we conducted sensitivity analyses adjusting for potential confounders, such as age, sex, body mass index, smoking status, and medication use, using analysis of covariance (ANCOVA) models. Pearson correlation coefficients were calculated to explore the relationship between mental well-being changes and cardiac function changes in the MBSR group.

A two-tailed approach was employed for all statistical tests, and statistical significance was established at a p-value of <0.05. The data analysis plan was developed in consultation with a biostatistician and was tailored to the specific objectives and design of the study.

Table 1. MBSR program session overview

Session	Topic	Content and activities
1	Introduction to Mindfulness	- Overview of the MBSR program and expectations - Introduction to mindfulness and its benefits - Raisin exercise - Body scan meditation
2	Insightful Reactions and Perceptual Processes	- Discussion of homework experiences - Breath awareness during seated meditation - Standing and supine yoga postures - Creative responding and perception exercise
3	Mindfulness of the Breath and Body	- Body scan meditation - Seated meditation practice (focusing on breath and body sensations) - Yoga (standing, lying, and sitting poses) - Mindful walking
4	Stress: Responding vs. Reacting	- Seated meditation practice (focusing on breath, physical sensations, auditory stimuli, and mental activity) - Yoga (standing, lying, and sitting poses) - Stress reaction exercise - Responding vs. reacting to discussion
5	Dealing with Difficult Emotions	- Sitting meditation (awareness of breath, body, sounds, thoughts, and emotions) - Yoga (standing, lying, and sitting poses) - Exploring difficult emotional exercise - Mountain meditation
6	Mindful Communication	- Sitting meditation (choiceless awareness) - Yoga (standing, lying, and sitting poses) - Mindful communication exercise - Aikido (mindful movement)
7	Mindfulness and Compassion	- Loving-kindness meditation - Yoga (standing, lying, and sitting poses) - Compassion and self-compassion exercise - Mindful walking
8	Integrating Mindfulness into Daily Life	- Body scan meditation - Sitting meditation (choiceless awareness) - Yoga (standing, lying, and sitting poses) - Developing a personal mindfulness practice plan - Course review and closing

Ethics: The research adhered to the ethical guidelines outlined in the Declaration of Helsinki. Before their inclusion in the study, all participants supplied written informed consent. The informed consent process involved a detailed explanation of the study procedures, risks, and benefits, and participants were given the chance to raise queries and address any uncertainties.

Results

120 CAD patients were randomized to the MBSR (n=60) or control group (n=60). The baseline attributes of the subjects are summarized in Table 2. No notable distinctions were observed between the control and MBSR groups regarding medication use, smoking status, body mass index, gender, or age (all $P > 0.05$).

The primary outcome measures of cardiac function, including LVEF, SBP, and DBP, were assessed at baseline and post-intervention (week 9). The results are presented in Table 3.

The MBSR group showed significant improvements in LVEF compared to the control group, with a between-group difference of 3.9 percentage points (95% CI: 1.5 to 6.3, $P = 0.002$) post-intervention.

Table 2. Preliminary features of the study cohort

Characteristic	MBSR group (n = 60)	Control group (n = 60)	P-value
Age (years)	57.9 ± 9.1	58.8 ± 8.4	0.58
Male, n (%)	43 (71.7%)	41 (68.3%)	0.69
Body Mass Index (kg/m²)	27.3 ± 4.2	26.9 ± 3.9	0.59
Current Smokers, n (%)	18 (30.0%)	21 (35.0%)	0.55
Medications, n (%)			
Aspirin	58 (96.7%)	57 (95.0%)	0.65
Beta-blockers	48 (80.0%)	51 (85.0%)	0.46
ACE inhibitors/ARBs	39 (65.0%)	42 (70.0%)	0.55
Statins	55 (91.7%)	53 (88.3%)	0.54

ACE is an angiotensin-converting enzyme; ARBs are angiotensin receptor blockers

This indicates that, with 95% confidence, the true population difference in LVEF between the MBSR and control groups lies between 1.5 and 6.3 percentage points. The p-value of 0.002 suggests that the observed difference is unlikely to have occurred by chance, providing strong evidence for the effectiveness of MBSR in improving LVEF.

The MBSR group also demonstrated significant reductions in SBP and DBP in comparison with the control group, with between-group differences of -4.6 mmHg (95% CI: -9.2 to -0.1, p = 0.047) and -3.8 mmHg (95% CI: -6.8 to -0.8, p = 0.013), respectively. This indicates that, with 95% confidence, the true population differences in SBP and DBP between the MBSR and control groups lie between -9.2 and -0.1 mmHg and -6.8 and -0.8 mmHg, respectively. The p-values of 0.047 for SBP and 0.013 for DBP suggest that these observed differences are unlikely to have occurred by chance, providing evidence of MBSR's effectiveness in reducing blood pressure.

Pearson correlation coefficients were calculated for the MBSR group to explore the relationship between psychological well-being changes and cardiac function changes. The results are presented in Table 4.

Changes in perceived stress, anxiety, and depression were negatively correlated with changes in LVEF and positively correlated with changes in SBP and DBP. Conversely, changes in mindful attention awareness were positively correlated with changes in LVEF and negatively correlated with changes in SBP and DBP.

Discussion

The present study investigated the effects of an 8-week MBSR course on cardiac function in patients with CAD. The results demonstrated that MBSR led to significant improvements in LVEF and reductions in SBP and DBP compared to a control group receiving standard care.

Table 3. Changes in Cardiac Function from Baseline to Post-Intervention

Outcome measure	MBSR group (n = 60)	Control group (n = 60)	Between-group difference	P-value
LVEF (%)				
Baseline	52.4 ± 6.8	53.1 ± 7.2		
Post-Intervention	57.8 ± 6.5	53.9 ± 7.1	3.9 (1.5 to 6.3)	0.002
SBP (mmHg)				
Baseline	138.2 ± 15.4	136.9 ± 14.8		
Post-Intervention	130.5 ± 13.7	135.1 ± 14.2	-4.6 (-9.2 to -0.1)	0.047
DBP (mmHg)				
Baseline	82.6 ± 9.3	83.1 ± 10.1		
Post-Intervention	78.4 ± 8.5	82.2 ± 9.7	-3.8 (-6.8 to -0.8)	0.013

Data are presented as mean ± SD or mean difference (95% confidence interval); SBP: systolic blood pressure; DBP: diastolic blood pressure

Table 4. Correlations between Changes in Psychological Well-being and Changes in Cardiac Function in the MBSR Group

Psychological measure	Change in LVEF	Change in SBP	Change in DBP
Perceived Stress Scale	-0.38*	0.42**	0.35*
Hospital Anxiety Scale	-0.41**	0.37*	0.31*
Hospital Depression Scale	-0.35*	0.33*	0.29*
Mindful Attention Awareness Scale	0.44**	-0.39*	-0.36*

*P < 0.05, **P < 0.01

The results indicate that MBSR could be a potent non-pharmacological intervention for improving cardiac function in CAD patients.

The improvements in LVEF observed in the MBSR group are clinically meaningful, as LVEF is a key indicator of cardiac function and a predictor of cardiovascular outcomes. The magnitude of the between-group difference in LVEF (3.9 percentage points) is comparable to the effects of some pharmacological interventions, such as beta-blockers and ACE inhibitors, which have been shown to improve LVEF by 3-5 percentage points in patients with heart failure (Cleland et al., 2018).

The reductions in SBP and DBP in the MBSR group are also notable, as high blood pressure is a major risk factor for CAD and cardiovascular events. The between-group differences in SBP (-4.6 mmHg) and DBP (-3.8 mmHg) are similar to the effects of lifestyle interventions, such as exercise and dietary modifications, which have been shown to reduce blood pressure by 4-9 mmHg (Moreira-Rosário et al., 2023).

The correlational analyses revealed that changes in psychological well-being were associated with changes in cardiac function in the MBSR group. These findings suggest that the improvements in cardiac function observed in the MBSR group may be mediated, at least in part, by reductions in stress, anxiety, and depression and increases in mindfulness. Previous studies have shown that psychological stress can contribute to the development and progression of CAD through various mechanisms, including increased inflammation, endothelial dysfunction, and autonomic imbalance (Guarneri & Stone, 2022). By reducing stress and promoting relaxation, mindfulness can mitigate these pathophysiological processes and improve cardiovascular health.

The correlational findings between changes in psychological well-being and changes in cardiac function in the MBSR group suggest potential causal mechanisms underlying the observed benefits of MBSR. Stress, anxiety, and depression have been shown to contribute to the development and progression of CAD through various pathophysiological pathways, such as increased inflammation, endothelial dysfunction, and autonomic imbalance (Guarneri & Stone, 2022).

Mindfulness-based interventions, like MBSR, may improve cardiac function by reducing stress and promoting relaxation, decreasing inflammation, improving endothelial function, and improving autonomic regulation (Fischer et al., 2022). For example, mindfulness practices have been shown to reduce levels of pro-inflammatory cytokines, such as interleukin-6 and C-reactive protein, which are associated with increased cardiovascular risk (Michaelsen et al., 2023). Additionally, mindfulness may enhance endothelial function by reducing oxidative stress and improving nitric oxide bioavailability, leading to better vasodilation and blood flow (Schneider et al., 2022).

Furthermore, mindfulness practices have been shown to influence the autonomic nervous system by increasing parasympathetic activity and decreasing sympathetic dominance, leading to lower blood pressure, reduced heart rate, and improved heart rate variability (Nardi et al., 2020). These autonomic changes may contribute to the observed improvements in cardiac function in the MBSR group.

While the present study provides evidence for the potential causal role of psychological well-being in mediating the effects of MBSR on cardiac function, further research using experimental designs and mechanistic studies is needed to establish causal relationships and elucidate the underlying biological pathways.

The present study has several strengths, including the randomized controlled design, the use of objective measures of cardiac function, and the adaptation of the MBSR program to the cultural context of Iraq. However, some limitations should be acknowledged. The first limitation was the small number of subjects involved, which may have limited the power to detect smaller effects. Second, the analysis was executed at a single establishment in Baghdad, possibly curbing the external validity of the results. Third, the follow-up period was relatively short (8 weeks), and it is unclear whether the benefits of MBSR would be maintained over a longer period.

In addition to the limitations mentioned earlier, it is important to acknowledge the potential biases and the reliance on self-reported measures for psychological outcomes. Self-report questionnaires, such as the Perceived Stress Scale, Hospital Anxiety and Depression Scale, and Mindful Attention Awareness Scale, may be subject to response, social desirability, and recall bias. Participants may have responded in a way that they believed was expected or socially acceptable, or they may have had difficulty accurately recalling their experiences over the past weeks or months. These biases could have influenced the results and should be considered when interpreting the findings.

Moreover, the use of self-reported measures may not fully capture the complexity of psychological constructs, such as stress, anxiety, and mindfulness. Objective measures, such as physiological markers of stress (e.g., cortisol levels) or behavioral assessments of mindfulness, could provide additional insights into the mechanisms underlying the benefits of MBSR. Future studies should consider incorporating a combination of self-report and objective measures to gain a more comprehensive understanding of the psychological effects of MBSR in CAD patients.

Despite these limitations, the findings of this study have important implications for the management of CAD in Iraq and other low- and middle-income countries. CAD is a major public health problem in Iraq, and the prevalence of risk factors, such as hypertension, diabetes, and smoking, is high (Al-Asadi & Al-Lami, 2015). However, access to effective treatments, such as cardiac rehabilitation and psychological interventions, is limited in Iraq due to resource constraints and cultural barriers (Al-Asadi & Al-Lami, 2015). MBSR may offer a low-cost, culturally acceptable, and scalable intervention that could be integrated into standard care for CAD patients.

Subsequent investigations should strive to confirm and extend these findings in larger, multi-center trials with longer follow-up periods. It would also be valuable to explore the mechanisms underlying the benefits of MBSR for cardiac function, such as changes in inflammatory markers, endothelial function, and heart rate variability. Finally, future studies should investigate the feasibility and effectiveness of adapting MBSR to other cultural contexts and healthcare settings in nations with lower and moderate financial resources.

Future research should also explore the potential for scaling and adapting the MBSR intervention to different cultural contexts. While the present study demonstrated the effectiveness of MBSR in a sample of Iraqi CAD patients, it is important to investigate whether these findings can be replicated in other low- and middle-income countries with diverse cultural, social, and healthcare settings. Researchers should engage with local communities and stakeholders to identify culturally relevant adaptations of the MBSR program, such as incorporating traditional practices or modifying the language and examples used in the intervention.

Moreover, future studies should investigate the feasibility and cost-effectiveness of integrating MBSR into existing healthcare systems and cardiac rehabilitation programs. This may involve training healthcare providers, such as nurses or community health workers, to deliver the intervention or developing digital platforms for remote delivery of MBSR. By scaling the intervention and adapting it to different contexts, researchers can work towards making MBSR more accessible and sustainable for CAD patients in resource-limited settings.

Conclusion

The findings of this research suggest that MBSR can improve cardiovascular performance in patients with CAD. These findings indicate that incorporating MBSR into standard care for CAD patients may significantly benefit cardiovascular health and well-being. Given the high burden of CAD in Iraq and other low- and middle-income countries, there is an urgent need for accessible, effective, and culturally appropriate interventions to prevent and manage this condition. MBSR may represent a promising approach to addressing this need, and further research is warranted to explore its potential in diverse healthcare settings and populations.

Conflict of Interests

Authors have no conflict of interests.

Acknowledgments

The authors wish to thank all the participants in the study.

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