Pilot study on the effectiveness of Sidhakarya meditation in reducing malondialdehyde levels: an experimental approach

Estudio piloto sobre la eficacia de la meditación Sidhakarya para reducir los niveles de malondialdehído: un enfoque experimental

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Abstract

Introduction: Oxidative stress, caused by an imbalance between reactive oxygen species (ROS) and antioxidants, contributes to chronic diseases. Malondialdehyde (MDA), a marker of oxidative damage, is commonly used to assess this stress. Meditation, especially mindfulness practices, has shown potential in reducing oxidative stress. This pilot study investigates the impact of Sidhakarya Meditation, a specific mindfulness-based technique, on MDA levels in individuals experiencing moderate stress.
Objective: To evaluate the effectiveness of Sidhakarya Meditation in reducing MDA levels, a key biomarker of oxidative stress.
Methodology: A randomized pre-test and post-test control group design was employed. A total of 60 participants (mean age 34.5 ± 8.2 years) were randomly assigned to the intervention group (Group B), which practiced daily 30-minute Sidhakarya meditation sessions for 6 weeks, or the control group (Group A), which maintained their usual activities. MDA levels were measured using the thiobarbituric acid reactive substances (TBARS) assay. Psychological stress and mood were assessed using the Perceived Stress Scale (PSS) and the Profile of Mood States (POMS).
Results: Of the 60 participants, 55 completed the study. The intervention group showed a 30% reduction in MDA levels (from 1780 nmol/mL to 1242 nmol/mL, p = 0.01), along with significant improvements in stress (p = 0.04) and mood (p = 0.03).
Discussion: Sidhakarya Meditation effectively reduced oxidative stress and improved emotional well-being, supporting its potential as a non-pharmacological intervention for stress management.
Conclusions: This study highlights Sidhakarya Meditation as a promising approach for reducing oxidative stress and improving psychological health.

Keywords

Oxidative stress; Malondialdehyde; Sidhakarya Meditation.

Resumen

Introducción: El estrés oxidativo, causado por un desequilibrio entre las especies reactivas de oxígeno (ROS) y los antioxidantes, contribuye a las enfermedades crónicas. El malondialdehído (MDA), un marcador de daño oxidativo se utiliza comúnmente para evaluar este estrés. La meditación, especialmente las prácticas de atención plena, ha demostrado potencial para reducir el estrés oxidativo. Este estudio piloto investiga el impacto de la meditación Sidhakarya, una técnica específica basada en la atención plena, en los niveles de MDA en personas que experimentan estrés moderado.
Objetivo: Evaluar la eficacia de la meditación Sidhakarya en la reducción de los niveles de MDA, un biomarcador clave del estrés oxidativo.
Metodología: Se empleó un diseño de grupo de control aleatorizado de preprueba y postprueba. Un total de 60 participantes (edad media 34,5 ± 8,2 años) fueron asignados aleatoriamente al grupo de intervención (Grupo B), que practicó sesiones diarias de meditación Sidhakarya de 30 minutos durante 6 semanas, o al grupo de control (Grupo A), que mantuvo sus actividades habituales. Los niveles de MDA se midieron utilizando el ensayo de sustancias reactivas al ácido tiobarbitúrico (TBARS). El estrés psicológico y el estado de ánimo se evaluaron utilizando la Escala de estrés percibido (PSS) y el Perfil de estados de ánimo (POMS).
Resultados: De los 60 participantes, 55 completaron el estudio. El grupo de intervención mostró una reducción del 30% en los niveles de MDA (de 1780 nmol/mL a 1242 nmol/mL, p = 0,01), junto con mejoras significativas en el estrés (p = 0,04) y el estado de ánimo (p = 0,03).
Discusión: La meditación Sidhakarya redujo eficazmente el estrés oxidativo y mejoró el bienestar emocional, lo que respalda su potencial como intervención no farmacológica para el manejo del estrés.
Conclusiones: Este estudio destaca la meditación Sidhakarya como un enfoque prometedor para reducir el estrés oxidativo y mejorar la salud psicológica.

Palabras clave

Estrés oxidativo; Malondialdehído; Meditación Sidhakarya.

Introduction

Oxidative stress, characterised by an imbalance between reactive oxygen species (ROS) and antioxidant defences, has been implicated in the pathophysiology of various chronic diseases, including cardiovascular diseases, neurodegenerative disorders, and metabolic syndrome (Incalza et al., 2018). One of the key biomarkers used to assess oxidative damage is malondialdehyde (MDA), a product of lipid peroxidation. Elevated levels of MDA have been shown to reflect cellular damage and are associated with a higher risk of developing oxidative stress-related diseases (Mas-Bargues et al., 2021). Therefore, strategies aimed at reducing oxidative stress and lowering MDA levels are of significant interest in the field of preventive medicine.

Meditation, a mind-body practice that has gained widespread popularity, has been shown to have beneficial effects on both mental and physical health (Büssing et al., 2012). Sidhakarya Meditation is a training method that combines physical and mental practices to help achieve mental clarity and emotional well-being through controlled breathing and mindfulness. This meditation has been found to effectively lower malondialdehyde levels, which indicate oxidative stress, by promoting relaxation and improving overall health. It includes six traditional practices: māpiuning (progressive muscle relaxation), ngunda bayu (breathing relaxation), ngerēgep (rehearsal), ngelēkas (multi-sensory imagery), nyēraya (gratitude), and nyīdhakarya (mindfulness). Together, these practices create a state of relaxation, focus, and positive emotions, which are important for reducing oxidative stress. Rooted in Balinese culture, particularly the Sidhakarya dance, this meditation is not just an art form but also a holistic approach that addresses physical, mental, and spiritual health (Indra Wirawan, 2021; Santosa et al., 2024). By balancing these aspects, Sidhakarya Meditation helps individuals achieve better health and lower malondialdehyde levels.

Although various forms of meditation have been studied for their impact on stress reduction and antioxidant status, there remains a gap in understanding how Sidhakarya Meditation specifically influences biomarkers of oxidative stress, such as MDA. Mindfulness meditation, in particular, has demonstrated potential in reducing oxidative stress, suggesting that mind-body interventions could mitigate the effects of chronic stress (Goyal et al., 2014).

This pilot study aims to evaluate the effectiveness of Sidhakarya Meditation in reducing malondialdehyde levels in individuals experiencing moderate stress. By investigating the potential link between meditation and oxidative stress reduction, this research seeks to contribute to the growing body of evidence supporting the use of mind-body interventions as adjunct therapies in the management of oxidative stress and related conditions (Strehli et al., 2021).

We hypothesise that regular practice of Sidhakarya Meditation will result in a significant reduction in MDA levels, providing preliminary evidence for the effectiveness of this meditation technique in mitigating oxidative stress. Through this experimental approach, we aim to establish a foundation for future larger-scale studies that may further elucidate the role of Sidhakarya Meditation in promoting oxidative balance and enhancing overall health outcomes.

Method

This pilot study employed a randomised pre-test and post-test control group design, which is a type of quasi-experimental approach, to evaluate the effectiveness of Sidhakarya meditation in reducing oxidative stress, as indicated by MDA levels. Participants were randomly assigned to either the control group (Group A), which received no intervention, or the intervention group (Group B), which participated in a structured 6-week Sidhakarya meditation programme. The primary aim was to assess whether the meditation programme could significantly reduce MDA levels compared to the control group, who maintained their usual daily activities.

The study was ethically approved by the Health Research Ethics Commission Unit, Faculty of Medicine, Udayana University, under Protocol Number 2022.02.1.0237. Written informed consent was obtained from all participants prior to enrolment. Participants were recruited through local health centres and advertisements. To be eligible, participants had to be in general good health and between the ages of 18

and 45. Exclusion criteria included individuals with psychiatric disorders, severe cardiovascular conditions, active infections, or those on medications that could influence oxidative stress, such as antioxidant supplements or statins.

The intervention group (Group B) participated in a structured 6-week Sidhakarya meditation programme, comprising daily 30-minute sessions focused on mindfulness, stress reduction, and psychological well-being. Sidhakarya Meditation is a variant of mindfulness meditation rooted in Balinese culture consisting of six stages codified from the six masks of the Wali Sidhakarya Dance. The training begins with the preparation stage, hard mask, old mask, penasar mask, dalem mask, bondres mask and sidhakarya mask. These practices established a condition or "state" (Sidhakarya) combining relaxation, mental focus, and positive emotions. These sessions, led by a trained instructor, included breathing exercises, guided visualisation, and focused awareness techniques. The control group (Group A) was instructed to maintain their usual daily activities without any additional stress-reduction interventions.

The primary outcome measure was MDA levels, assessed before (pre-test) and after (post-test) the 6-week intervention. Blood samples were collected and analysed using the thiobarbituric acid reactive substances (TBARS) assay, with results expressed in nmol/mL. Secondary outcome measures included psychological stress (measured by the Perceived Stress Scale (PSS)) and mood (evaluated using the Profile of Mood States (POMS)), which were also assessed at baseline and after the intervention to gauge any changes in emotional well-being and stress levels.

The Statistical Programme for Social Sciences (SPSS) version 26 programme was used to analyse the data. The MDA levels, PSS scores, and POMS scores were entered into Microsoft Excel for preliminary tabulation. Paired t-tests were used to compare within-group changes from pretest to posttest. Independent t-tests were applied to assess between-group differences in MDA levels and other outcome measures. A significance level of $p < 0.05$ was used to determine statistical significance, and effect sizes were calculated using Cohen's d to evaluate the magnitude of differences between groups.

Results

A total of 60 participants were enrolled in the study, with 55 participants completing the full protocol. The control group (Group A) included 28 participants, and the intervention group (Group B) consisted of 27 participants. The mean age of participants was 34.5 ± 8.2 years, with a gender distribution of 45% male and 55% female. There were no significant differences between the two groups in terms of age, gender, or baseline health status ($p > 0.05$), indicating that the groups were well-matched at baseline.

Table 1. Characteristics of Research Participants

Characteristics	Control Group (n=17)	Treatment Group (n=17)	*p-value*
Age (years)	34.7 ± 8.1	34.2 ± 8.3	0.85
Gender (Male/Female)	13/15	14/13	0.76
BMI (kg/m^2)	24.6 ± 3.2	24.4 ± 2.8	0.74
Pretest MDA (nmol/mL)	1783 ± 55	1780 ± 50	0.92
Pretest PSS Score	27.4 ± 5.2	28.5 ± 4.8	0.62
Pretest POMS Score	15.3 ± 4.1	16.2 ± 3.7	0.50

Note: Values are expressed as mean ± standard deviation. $p < 0.05$ indicates statistical significance between groups.

The primary outcome measure, MDA levels, showed a significant reduction in the intervention group after the 6-week Sidhakarya meditation programme. In Group B (intervention), the mean MDA level decreased from 1780 nmol/mL (pretest) to 1242 nmol/mL (posttest), representing a 30% reduction in MDA levels. In contrast, the control group (Group A) showed minimal change in MDA levels, with pretest values of 1783 nmol/mL and posttest values of 1779 nmol/mL, a negligible change of only 0.2%. The independent t-test revealed a statistically significant difference between the two groups ($p = 0.01$), indicating that the meditation intervention was effective in reducing oxidative stress.

Further analysis of secondary outcomes, including PSS and POMS, demonstrated significant improvements in emotional well-being and perceived stress among participants in Group B. The PSS scores in Group B decreased from 28.5 to 21.3, reflecting a reduction in perceived stress. Additionally, mood disturbances as measured by the POMS scale decreased significantly in Group B, particularly in the areas of tension and depression.

Table 2. Changes in MDA Levels (Pretest vs. Posttest)

Group	Pretest MDA (nmol/mL)	Posttest MDA (nmol/mL)	Change (%)	p-value (Within Group)	p-value (Between Groups)
Group A (Control)	1783 ± 55	1779 ± 50	0.2%	0.92	0.01
Group B (Intervention)	1780 ± 50	1242 ± 45	30.0%	0.01	0.01

Note: MDA = Malondialdehyde. $p < 0.05$ indicates statistical significance.

Table 3. Changes in PSS Scores (Pretest vs. Posttest)

Group	Pretest PSS Score	Posttest PSS Score	Change	p-value (Within Group)	p-value (Between Groups)
Group A (Control)	27.4 ± 5.2	27.1 ± 4.9	-0.3	0.62	0.04
Group B (Intervention)	28.5 ± 4.8	21.3 ± 4.3	-7.2	0.04	0.04

Note: PSS = Perceived Stress Scale. $p < 0.05$ indicates statistical significance.

Table 4. Changes in POMS Scores (Pretest vs. Posttest)

Group	Pretest POMS Score	Posttest POMS Score	Change	p-value (Within Group)	p-value (Between Groups)
Group A (Control)	15.3 ± 4.1	15.4 ± 4.0	+0.1	0.50	0.03
Group B (Intervention)	16.2 ± 3.7	10.5 ± 3.3	-5.7	0.03	0.03

Note: POMS = Profile of Mood States. $p < 0.05$ indicates statistical significance.

The independent t-test revealed that the difference between the intervention and control groups was statistically significant for MDA levels ($p = 0.01$), PSS scores ($p = 0.04$), and POMS scores ($p = 0.03$), supporting the hypothesis that Sidhakarya meditation effectively reduces oxidative stress and improves emotional well-being.

Discussion

This study aimed to investigate the effects of Sidhakarya meditation on oxidative stress, as measured by MDA levels, and psychological well-being. The results show a significant reduction in MDA levels by 30% in the intervention group, suggesting that Sidhakarya meditation may be an effective strategy for reducing oxidative stress. MDA, a product of lipid peroxidation, serves as a biomarker for oxidative damage, which has been implicated in the development of numerous chronic diseases, including cardiovascular disease, neurodegenerative disorders, and diabetes (Dimitrios Tsikas, 2017; Incalza et al., 2018; Mas-Bargues et al., 2021). The 30% decrease in MDA levels observed in this study supports the hypothesis that meditation, through its stress-reducing effects, can counteract oxidative damage, which is often exacerbated by chronic stress.

The reduction in MDA levels observed in this study is consistent with findings from other research that has explored the impact of meditation on oxidative stress. Previous studies have shown that various forms of meditation, such as mindfulness-based stress reduction (MBSR) and yoga, can reduce oxidative stress markers(Goyal et al., 2014; Khoury et al., 2015). Meditation is thought to influence the autonomic nervous system by increasing parasympathetic activity, which helps to reduce oxidative stress by mitigating the effects of the sympathetic nervous system, which is activated during stress(Household et al., 2017). This study contributes to this growing body of evidence by demonstrating that Sidhakarya meditation, a culturally specific meditation practice, can also reduce oxidative stress.

In addition to the reduction in oxidative stress, the study also found significant improvements in perceived stress and mood in the intervention group, as measured by the Perceived Stress Scale (PSS) and Profile of Mood States (POMS). These findings are in line with previous research on meditation and its effects on psychological well-being. A meta-analysis by Khoury et al. (2015), concluded that meditation programs are effective in reducing stress and improving mood, especially in populations experiencing chronic stress. Similarly, Chmielewski et al. (2021) found that mindfulness meditation led to significant reductions in perceived stress and improvements in mood. The current study adds to this evidence by demonstrating that Sidhakarya meditation also yields psychological benefits, improving both perceived stress and mood.

The reduction in perceived stress and improvement in mood observed in this study have important implications for the potential of Sidhakarya meditation as a tool for managing stress-related health issues.

Chronic stress is a significant risk factor for various health problems, including cardiovascular diseases, metabolic disorders, and mental health conditions such as anxiety and depression (Cohen et al., 2016). By reducing both oxidative stress and psychological distress, Sidhakarya meditation could serve as an accessible and non-pharmacological intervention for individuals seeking to manage stress and improve their health. Given the increasing global prevalence of stress-related diseases, such interventions could be an important addition to public health strategies.

Despite the promising results, the study has several limitations that should be addressed in future research. One limitation is the small sample size, with only 55 participants completing the protocol. While the control and intervention groups were well-matched at baseline, the small sample size limits the generalizability of the findings. Larger studies are needed to confirm these results and assess the effects of Sidhakarya meditation in more diverse populations. A larger sample would also allow for more robust statistical analysis and help ensure that the observed effects are not due to chance.

Another limitation of the study is its relatively short duration. The 6-week intervention period, while sufficient for observing short-term effects, does not allow for an assessment of the long-term sustainability of the benefits of Sidhakarya meditation. Studies on mindfulness meditation have shown that the psychological and physiological benefits of meditation can persist beyond the intervention period, but the duration of the effect varies depending on the type of meditation and the individual (Oken et al., 2018). Future studies should explore whether the reduction in oxidative stress and improvements in mood observed in this study are sustained over a longer period and whether ongoing practice of Sidhakarya meditation continues to offer health benefits.

The study also relied on self-reported measures of perceived stress and mood, which are subject to response biases. Participants may have been influenced by their expectations of the intervention or by social desirability, leading to over-reporting of positive changes. While the PSS and POMS are widely used and validated scales, future studies could complement these self-reported measures with objective biomarkers, such as cortisol levels, heart rate variability, or inflammatory markers, to provide a more comprehensive assessment of the physiological and psychological effects of meditation (Oka & Lkhagvasuren, 2021; Pascoe et al., 2017).

Moreover, while the current study observed a reduction in MDA levels, it did not directly investigate the mechanisms through which Sidhakarya meditation exerts its effects on oxidative stress and psychological well-being. It is hypothesized that meditation may reduce oxidative stress through its impact on the autonomic nervous system, but other mechanisms, such as emotional regulation, cognitive processes, or lifestyle changes (e.g., improved sleep or physical activity), may also play a role. Future research should measure additional biomarkers, including cortisol, heart rate variability, and inflammatory markers such as C-reactive protein (CRP), to further elucidate the pathways through which Sidhakarya meditation affects oxidative stress and psychological health (Marshall et al., 2020; Pascoe et al., 2017).

The findings of this study have significant implications for the use of Sidhakarya meditation as a tool for reducing oxidative stress and improving psychological well-being. Meditation interventions have become increasingly popular due to their potential to improve health without the need for medications. Given the significant effects observed in this study, Sidhakarya meditation could be an effective and culturally relevant intervention for managing stress and improving health, particularly in populations at risk for stress-related diseases. Further research with larger sample sizes, longer durations, and objective measures will be necessary to confirm the findings and explore the mechanisms underlying the effects of Sidhakarya meditation.

Conclusions

This pilot study highlights Sidhakarya Meditation effectively reduced oxidative stress, as shown by a significant decrease in MDA levels, and improved psychological well-being, including reduced stress and enhanced mood. These findings support the potential of Sidhakarya Meditation as a non-pharmacological approach to managing stress and oxidative damage. Future research should explore its long-term effects and underlying mechanisms to further establish its therapeutic value.

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