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ORIGINAL RESEARCH ARTICLE

Evaluating the Impact of Transcendental Meditation on Stress Reduction: A Comparative Controlled Clinical Study

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ABSTRACT

Introduction: Stress is a major contributor to psychological disorders and cardiovascular morbidity through disturbances in autonomic regulation and activation of the hypothalamic–pituitary–adrenal axis. Transcendental meditation (TM), a mantra-based meditation technique, has been proposed as an effective non-pharmacological intervention for stress reduction; however, controlled clinical evidence remains limited.

Objective: The objective of this study was to evaluate the effect of TM, practiced along with a fixed regimen of yogic practices, on stress reduction in healthy individuals.

Materials and Methods: A randomized controlled comparative clinical trial was conducted among 20 healthy participants aged 18–60 years at GS Ayurveda Medical College and Hospital. Participants were randomly allocated into two groups: Group A (intervention group, $n = 10$) and Group B (control group, $n = 10$). Group A practiced TM along with associated yogic practices for 4 weeks, 6 days/week, whereas Group B received no intervention. Outcome measures included Beck Anxiety Inventory scores, chakra alignment assessed using the Bio-Well scale, systolic and diastolic blood pressure, and pulse rate. Assessments were performed at baseline and after 1 month. Statistical analysis was conducted using paired and independent *t*-tests.

Results: Group A demonstrated a statistically significant reduction in anxiety scores (16% decrease, $P < 0.001$), systolic blood pressure (4% reduction, $P < 0.001$), diastolic blood pressure (7% reduction, $P = 0.007$), and pulse rate (6% reduction, $P = 0.012$). Chakra alignment also showed significant improvement (7% increase, $P < 0.001$). In contrast, Group B showed no statistically significant changes in any assessed parameter. Post-intervention comparison between groups revealed statistically significant differences favoring the intervention group.

Discussion and Conclusion: TM practiced with a fixed regimen of yogic practices for 4 weeks produced significant improvement in stress-related psychological and physiological parameters among healthy participants. The findings suggest that this combined intervention may serve as an effective non-pharmacological approach for stress reduction and autonomic balance.

1. INTRODUCTION

Stress is a complex physiological and psychological response to perceived challenges or threats, which, when persistent, can disrupt homeostasis and impair overall health.[1] The chronic activation of stress pathways not only affects mental health but also exerts detrimental effects on multiple bodily systems.[2] Prolonged exposure to elevated stress hormones such as cortisol can lead to immune suppression, increased inflammation, and metabolic dysregulation.[3] These biological alterations contribute to the development and progression of various non-communicable diseases, including type 2 diabetes, obesity, and neurodegenerative disorders, highlighting the systemic impact of sustained stress.[4]

Moreover, the dysregulation of the autonomic nervous system (ANS) and the hypothalamic–pituitary–adrenal (HPA) axis plays a central role in mediating these adverse effects. The ANS imbalance often

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manifests as heightened sympathetic activity coupled with reduced parasympathetic tone, which can increase heart rate and blood pressure, thereby elevating cardiovascular risk. Concurrently, HPA axis hyperactivity leads to persistent cortisol secretion, which disrupts normal feedback mechanisms and exacerbates psychological symptoms such as anxiety and depression.[5] Understanding these interconnected mechanisms is crucial for developing targeted interventions aimed at mitigating stress-related health consequences and improving resilience in affected populations.

Meditation-based interventions, particularly transcendental meditation (TM), have gained considerable attention as effective non-pharmacological strategies for managing stress and enhancing psychological well-being.[6] TM involves the silent repetition of a mantra for about 15–20 min twice daily, which facilitates a unique state of restful alertness characterized by deep relaxation without drowsiness.[7] This practice has been shown to reduce the physiological and psychological symptoms of stress by modulating ANS activity, decreasing sympathetic arousal, and promoting parasympathetic dominance. Such neurophysiological changes contribute to improvements in cardiovascular health, including reductions in blood pressure and heart rate variability, especially in individuals experiencing elevated baseline stress.[8]

Empirical evidence from randomized controlled trials and meta-analyses supports the efficacy of TM in alleviating anxiety, perceived stress, and psychological distress across diverse populations.[9,10] Beyond psychological benefits, TM has demonstrated positive effects on neuroendocrine function, including reductions in cortisol levels and improvements in hormonal regulation associated with stress response.[11-13] These outcomes suggest that TM not only provides symptomatic relief but may also enhance resilience against stress-related pathophysiology. The ease of practice and minimal cognitive effort required make TM a feasible and sustainable intervention for long-term stress management, positioning it as a valuable complementary approach within integrative health frameworks.

Despite growing evidence, variability in outcomes and methodological limitations across studies necessitate further controlled trials. Therefore, the present study was conducted to evaluate the effect of TM on perceived anxiety and selected hemodynamic parameters in a controlled clinical setting.

2. MATERIALS AND METHODS

2.1. Study Design and Setting

A randomized comparative controlled clinical trial with a pre–post intervention design was conducted at GS Ayurveda Medical College and Hospital among healthy students and faculty members. The study was designed to evaluate the effect of TM on stress reduction and associated physiological parameters.

2.2. Participants

A total of 20 healthy participants aged 18–60 years were enrolled and randomly allocated into two equal groups: Group A (trial group, $n = 10$) and Group B (control group, $n = 10$).

2.3. Inclusion Criteria

Participants who fulfilled the following criteria were included in the study:

1. Healthy adults aged between 18 and 60 years
2. Individuals with no prior experience of yoga or meditation practices
3. Ability to participate in physical activity and chanting practices.

2.4. Exclusion Criteria

Participants were excluded if they had:

1. Chronic illnesses or medical conditions that contraindicate physical activity
2. Hearing impairment interfering with chanting practices
3. Musculoskeletal disorders such as rheumatoid arthritis or osteoarthritis.

2.5. Randomization and Group Allocation

Participants were randomly assigned to two groups using equal allocation:

- Group A (Trial Group): Received TM along with a fixed regimen of yogic practices
- Group B (Control Group): Received no intervention during the study period.

2.6. Intervention Protocol

The intervention was administered for 4 weeks, 6 days/week, with each daily session lasting approximately 30 min.

The protocol included the following components:

- Brisk walking for 10 min at moderate intensity
- Surya Namaskar: Two sets performed at a comfortable pace with synchronized breathing.

Meditation Practices:

- Kapalabhati – 2 min
- Anulom Vilom – 2 min
- Bhramari – 1 min
- Loud Om chanting for 5 min, emphasizing diaphragmatic breathing and correct pronunciation
- Silent Om chanting for 5 min.

2.7. Relaxation Phase

Participants rested in the same space for 5 min after completion of the session.

2.8. Outcome Measures

Assessments were performed at baseline (BT) and after completion of the intervention at 1 month (AT).

The following outcome measures were recorded:

1. Beck Anxiety Inventory score
2. Chakra alignment measured using the Bio-Well scale (percentage)
3. Systolic blood pressure
4. Diastolic blood pressure
5. Pulse rate.

2.9. Statistical Analysis

Data were analyzed using a paired *t*-test for within-group comparisons and an independent *t*-test for between-group comparisons. $P < 0.05$ was considered statistically significant.

3. RESULTS

3.1. Demographics

A total of 20 participants were enrolled in the study, with 10 participants each in the trial and control groups. In Group A (trial group), participants included six females and four males. The age of participants ranged from 22 to 54 years, with a mean age of 27.3 ± 9.8 years. Female participants constituted 60% of the group, whereas males constituted 40%. In Group B (control group), participants included four females and six males. The age ranged from 22 to 25 years, with a mean age of 23.5 ± 1.1 years. Female participants constituted 40% of the group, whereas males constituted 60%. Overall, among all 20 participants, 10 were females (50%), and 10 were males (50%). The overall mean age of participants was 25.4 ± 7.1 years.

3.2. Effect on Anxiety Score

Baseline comparison of Beck Anxiety Inventory scores revealed no statistically significant difference between Group A and Group B ($P = 0.519$), indicating comparability at baseline. Following the 4-week intervention, Group A demonstrated a statistically significant reduction in anxiety score, with a mean decrease of 0.57 points corresponding to a 16% reduction ($P < 0.001$). In contrast, Group B did not show any statistically significant improvement. Post-intervention comparison between the two groups showed a highly significant difference ($P < 0.001$), suggesting a beneficial effect of TM on anxiety reduction (Table 1).

3.3. Effect on Chakra Alignment

Chakra alignment assessed using Bio-Well percentage demonstrated significant improvement in Group A after intervention, with a mean increase of 6.00 units corresponding to 7% improvement ($P < 0.001$). Conversely, Group B showed a significant decline, with a mean decrease of 5.00 units (6% reduction; $P < 0.001$). Both baseline and post-intervention comparisons between groups were statistically significant, favoring the intervention group (Table 1).

3.4. Effect on Systolic Blood Pressure

A statistically significant reduction in systolic blood pressure was observed in Group A following intervention, with a mean decrease of 5.60 mmHg corresponding to 4% reduction ($P < 0.001$). Group B showed a reduction in systolic blood pressure; however, the change was not statistically significant. Between-group post-intervention comparison did not reveal a statistically significant difference (Table 1).

3.5. Effect on Diastolic Blood Pressure

Group A showed a significant reduction in diastolic blood pressure after intervention, with a mean decrease of 5.20 mmHg corresponding to 7% reduction ($P = 0.007$). No statistically significant change was observed in Group B. Post-intervention comparison between groups demonstrated a statistically significant difference ($P = 0.030$), indicating better improvement in the intervention group (Table 1).

3.6. Effect on Pulse Rate

Pulse rate significantly decreased in Group A following intervention, with a mean reduction of 4.60 beats/min corresponding to 6% reduction ($P = 0.012$). Group B did not exhibit a statistically significant change. Although the reduction was greater in Group A, post-intervention comparison between groups did not reach statistical significance (Table 1).

4. DISCUSSION

The present randomized comparative controlled clinical trial demonstrated that TM combined with a fixed yogic regimen significantly improved psychological and physiological stress-related parameters among healthy adults. After 4 weeks of intervention, the trial group showed a significant reduction in anxiety score, systolic blood pressure, diastolic blood pressure, pulse rate, and improvement in chakra alignment. In contrast, the control group showed no comparable improvement.

A significant reduction in Beck Anxiety Inventory score in the intervention group indicates that meditation-based practice effectively reduces psychological distress and emotional arousal. Stress activates the HPA axis and sympathetic nervous system, leading to increased cortisol secretion and autonomic imbalance. Meditation has been shown to improve psychological distress by reducing sympathetic activation and promoting parasympathetic predominance. A randomized controlled trial among young adults reported that TM significantly reduced psychological distress, including anxiety, depression, and anger, while improving coping ability, supporting the present findings.[14]

The reduction in systolic and diastolic blood pressure observed in Group A suggests a favorable autonomic cardiovascular adaptation following intervention. In the present study, systolic blood pressure decreased by 5.60 mmHg and diastolic blood pressure by 5.20 mmHg after 4 weeks. These findings are consistent with meta-analytic evidence showing that TM is associated with clinically meaningful reductions in blood pressure, with pooled reductions of approximately 5.0 mmHg systolic and 2.8 mmHg diastolic pressure.[15] Such reductions are physiologically important because even modest blood pressure reduction contributes to lowering long-term cardiovascular risk.

The observed reduction in pulse rate further indicates improved autonomic balance and reduced sympathetic drive. Meditation and slow breathing practices influence vagal tone, baroreflex sensitivity, and cardiovascular homeostasis. Earlier controlled studies have demonstrated that TM improves cardiovascular function both at rest and during acute stress exposure, particularly in adolescents and young adults at risk for hypertension.[16] In the present study, additional breathing techniques such as Anulom Vilom and Bhramari may have enhanced parasympathetic activation and respiratory synchronization, thereby potentiating autonomic regulation.

Improvement in chakra alignment assessed using Bio-Well percentage may reflect improved psychophysiological coherence following intervention. Although chakra assessment is not considered a conventional biomedical endpoint, the observed improvement may indicate enhanced relaxation and energetic balance within complementary medicine frameworks. In contrast, the decline observed in the control group may reflect persistence of daily stress exposure in the absence of structured relaxation practice.

The intervention used in the present study was not limited to TM alone but also included brisk walking, Surya Namaskar, breathing exercises, Om chanting, and relaxation. Therefore, the observed effects likely represent the combined influence of physical activity, respiratory regulation, auditory resonance, and meditative attention rather than meditation alone. Integrated yoga-based interventions have been shown to produce broader neurophysiological benefits by simultaneously influencing respiration, cardiovascular regulation, and cortical relaxation.[17]

The present findings are also supported by recent evidence demonstrating that meditation-based interventions produce sustained reduction in blood pressure and improve cardiovascular risk profiles in adults with elevated blood pressure.[18] However, certain systematic reviews have

highlighted methodological heterogeneity among meditation studies and emphasized the need for well-designed randomized trials with adequate sample size and objective biomarkers.[19]

The present study has certain limitations. The sample size was small, the intervention duration was limited to 4 weeks, and objective biomarkers such as serum cortisol, heart rate variability, or autonomic function testing were not included. One participant in the intervention group was older than the majority of participants, contributing to wider age dispersion. Future studies with larger sample sizes, longer follow-up, and objective neuroendocrine measures are recommended to strengthen the evidence base.

Overall, the findings suggest that a TM-based integrated yogic intervention may serve as an effective non-pharmacological strategy for stress reduction and autonomic regulation in healthy adults.

5. CONCLUSION

TM combined with a structured yogic regimen practiced regularly over 4 weeks resulted in significant reductions in anxiety, systolic and diastolic blood pressure, and pulse rate, alongside improved chakra alignment in healthy adults. This integrated intervention demonstrates potential as a non-invasive, cost-effective approach for stress reduction and autonomic regulation, contributing to cardiovascular health promotion.

6. ACKNOWLEDGMENTS

Nil.

7. AUTHORS' CONTRIBUTIONS

All authors give equal contribution in making of this manuscript.

8. FUNDING

Nil.

9. ETHICAL STATEMENT

Ethical approval was not required for this study as it was a review article with data obtained through a literature search.

10. CONFLICT OF INTERESTS

The authors declare no conflicts of interest regarding the publication of this paper.

11. DATA AVAILABILITY STATEMENT

The data analyzed in this review were obtained from publicly available sources, including peer-reviewed articles, observational studies, and surveys accessible through databases.

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Table 1: Comparison of pre- and post-intervention mean values in both groups (*n*=10 each)

Parameter	Group	Before (Mean)	After (Mean)	Mean difference	*P*-value
Beck Anxiety Inventory score	A	3.64	3.07	−0.57	<0.001
	B	3.79	4.07	+0.28	NS
Chakra alignment (%)	A	85.70	91.70	+6.00	<0.001
	B	89.10	84.10	−5.00	<0.001
Systolic blood pressure (mmHg)	A	130.40	124.80	−5.60	<0.001
	B	129.40	127.20	−2.20	NS
Diastolic blood pressure (mmHg)	A	78.00	72.80	−5.20	0.007
	B	78.40	76.60	−1.80	NS
Pulse rate (beats/min)	A	76.40	71.80	−4.60	0.012
	B	75.20	73.60	−1.60	NS

NS: Non-significant