

Comparative Effects of Yogic Practices Combined with Transcendental Meditation versus Yoga Alone on Low-Density Lipoprotein Levels in Middle-Aged Men Following Myocardial Infarction: A Randomized Controlled Trial

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ABSTRACT

Background: Myocardial infarction (MI) is one of the major causes of morbidity and mortality worldwide, and dyslipidemia, especially elevated low-density lipoprotein (LDL), is one of the major modifiable risk factors for recurrent cardiac events. Complementary therapies such as yogic practices and Transcendental Meditation (TM) have demonstrated cardiovascular benefits, but their combined effect on LDL in post-MI patients has not been sufficiently studied.

Objective: The objective of this study was to compare the effects of the combination of yogic practice and Transcendental Meditation (Yoga + TM) with yoga alone and conventional medical treatment (Control) on LDL cholesterol levels in middle-aged men who had experienced myocardial infarction.

Methods: A three-arm randomized controlled trial was conducted among 90 male participants aged 35–45 years with a documented history of MI within the preceding 6–12 months. Participants were randomly allocated into three groups (n = 30 each): Yoga + TM, Yoga, and Control. The intervention was administered for 12 weeks, with supervised sessions conducted 6 days per week. Serum LDL cholesterol was measured at baseline and after the intervention using standardized enzymatic assays. Statistical analyses included paired t-tests, one-way ANOVA, and analysis of covariance (ANCOVA) adjusting for baseline values, with Scheffé post hoc comparisons.

Results: Baseline LDL levels were comparable across the groups ($p > 0.05$). After the intervention, significant reductions in LDL were observed in all groups, with the greatest reduction in the Yoga with TM group (-25.40 ± 4.75 mg/dL), compared with the Yoga group (-11.27 ± 5.51 mg/dL) and the Control group (-2.97 ± 4.09 mg/dL). Between-group differences were statistically significant ($F = 39.552$, $p < 0.001$), and ANCOVA confirmed the superiority of Yoga with TM after adjustment for baseline LDL ($p < 0.001$). The effect size for LDL reduction between Yoga with TM and Control was large (Cohen's $d = 2.27$).

Conclusion: Yogic practices combined with Transcendental Meditation resulted in a greater reduction in LDL cholesterol than yoga alone or conventional medical care in post-MI middle-aged men. This may support its use as an adjunct to cardiac rehabilitation.

Keywords: Myocardial infarction, Low-density lipoprotein, Yoga, Transcendental Meditation, Cardiac rehabilitation, Randomized controlled trial, Dyslipidemia

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INTRODUCTION

Myocardial infarction (MI) remains one of the leading causes of morbidity and mortality worldwide and represents a critical manifestation of coronary artery disease (CAD). Despite major advances in acute management, including thrombolysis, percutaneous coronary intervention, and pharmacotherapy, patients who

survive an MI continue to face a substantial risk of recurrent cardiovascular events and long-term complications. Among the modifiable risk factors contributing to disease progression and recurrence, dyslipidemia, particularly elevated low-density lipoprotein (LDL) cholesterol, plays a central role in atherogenesis and plaque instability. Therefore, reducing LDL

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cholesterol remains a cornerstone of secondary prevention in post-MI patients.

Although statin therapy and other lipid-lowering agents are effective in reducing LDL levels, many patients continue to have residual cardiovascular risk due to suboptimal adherence, adverse effects, and persistent lifestyle-related factors. This has led to increasing interest in complementary and integrative approaches that can support conventional cardiac rehabilitation and improve cardiometabolic outcomes. In this context, mind-body interventions such as yoga and meditation have gained attention for their potential to influence both physiological and psychological determinants of cardiovascular health.

Yoga is a traditional mind-body practice originating in India that includes physical postures (asanas), breathing techniques (pranayama), and relaxation methods. Evidence suggests that yoga can positively influence cardiovascular risk factors, including blood pressure, heart rate variability, body mass index, and lipid profiles. The underlying mechanisms are thought to involve enhanced parasympathetic activity, reduced sympathetic drive, decreased cortisol levels, and improved metabolic regulation. These effects may contribute to improved endothelial function and slower progression of atherosclerosis.

Transcendental Meditation (TM), a standardized mantra-based meditation technique, has also been associated with cardiovascular benefits. TM has been shown to reduce blood pressure, decrease stress-related neuroendocrine activation, and improve autonomic balance. Its physiological effects are thought to occur through suppression of hypothalamic-pituitary-adrenal (HPA) axis activity, which may reduce cortisol and catecholamine levels that contribute to dyslipidemia and cardiovascular risk. TM has also been linked to reductions in oxidative stress and improvements in vascular function.

While yoga and TM have each shown beneficial effects on cardiovascular risk factors, limited evidence exists regarding their combined impact, particularly on lipid parameters such as LDL cholesterol. The integration of yogic practices with TM may produce additive or synergistic effects by simultaneously targeting autonomic regulation, neuroendocrine balance, and metabolic pathways. Such an approach may be especially relevant in post-MI populations, where physiological and psychological stressors contribute to disease progression.

Middle-aged men represent a high-risk group for premature cardiovascular morbidity and mortality, often because of occupational stress, lifestyle factors, and limited participation in structured cardiac rehabilitation programs. This group remains relatively underrepresented in integrative rehabilitation research, highlighting a gap in evidence-based interventions tailored to their needs.

Therefore, the present study was designed to evaluate the comparative effectiveness of yogic practices combined with Transcendental Meditation versus yoga alone and standard medical care in reducing LDL cholesterol levels

among middle-aged men following myocardial infarction. By addressing this gap, the study aims to contribute to the growing evidence supporting integrative approaches in secondary cardiovascular prevention.

REVIEW OF RELATED LITERATURE

Dyslipidemia and Myocardial Infarction

Cardiovascular disease is the leading cause of death worldwide, and myocardial infarction is one of its most urgent and serious manifestations. High LDL cholesterol is a proven independent risk factor for both first and recurrent coronary events because it promotes atherosclerotic plaque formation and endothelial dysfunction. Mendelian randomization studies have indicated that every 1 mmol/L decrease in LDL cholesterol is associated with a 20–25% reduction in major cardiovascular events, confirming LDL as a major therapeutic target in post-MI management. Despite statin treatment, many post-MI individuals continue to have residual lipid-related cardiovascular risk, which supports the need for additional non-pharmacological approaches.

Yoga and LDL Cholesterol

Yogic methods, including asanas, pranayama, and relaxation, have shown lipid-lowering effects in several controlled trials. In a meta-analysis of 32 randomized controlled trials, Chu et al. found that yoga significantly lowered LDL cholesterol by 12.14 mg/dL on average compared with non-exercise controls. Cramer et al. also reported beneficial effects of yoga on LDL, HDL, and total cholesterol. These effects may be mediated through decreased sympathoadrenal activity, reduced circulating cortisol, increased parasympathetic tone, and related suppression of hepatic LDL production. Sarvottam et al. also reported that yoga-based lifestyle interventions significantly decreased LDL and inflammatory markers in overweight men, supporting the cardiometabolic relevance of yoga.

Transcendental Meditation and Cardiac Risk

Transcendental Meditation involves the use of a mantra repeated twice daily and is associated with deep metabolic rest, reduced oxygen consumption, decreased sympathetic tone, and modulation of HPA axis activity. In a landmark randomized controlled trial, Schneider et al. found that TM practice in patients with coronary heart disease reduced the composite risk of heart attack, stroke, and mortality over five years. Paul-Labrador et al. reported that 16 weeks of TM improved insulin resistance and blood pressure in stable CAD patients, with a tendency toward LDL reduction. Barnes and Orme-Johnson suggested that the lipid-modifying effect of TM may be related to reduced cortisol secretion, inhibition of hepatic lipase, and normalization of LDL receptor activity. Infante et al. also reported significant reductions in plasma ACTH and cortisol during TM practice.

Integrated Yoga and Meditation in Heart Patients

Yoga combined with meditation has been shown to produce cardiovascular benefits greater than either practice alone. In the landmark Ornish trial, an integrated intervention including yoga, meditation, and lifestyle

change resulted in a substantial reduction in LDL and regression of coronary atherosclerosis after one year. Mahajan et al. reported that yoga- and meditation-based lifestyle intervention reduced LDL in CAD patients, which is comparable to the present findings. Jayasinghe proposed that the combination of yoga and TM may create a broader physiological effect by reducing sympathoadrenal activity, regulating cortisol rhythm, and improving lipid clearance. Yogendra et al. also showed that yoga-based programs in post-MI patients improved cholesterol and cardiac risk indices without adverse events.

Research Gap

Although strong evidence supports yoga and TM in cardiovascular risk reduction, no prior randomized controlled trial has directly compared Yoga with TM versus Yoga alone versus standard care on LDL cholesterol in a homogeneous group of middle-aged male post-MI patients. The current study was designed to address this gap and provide specific evidence on maximizing mind-body interventions in post-MI lipid management.

MATERIALS AND METHODS

Study Design

This study was a three-arm, parallel-group randomized controlled trial conducted in accordance with the Consolidated Standards of Reporting Trials (CONSORT) 2010 guidelines. The trial aimed to evaluate the comparative effectiveness of yogic practices with and without Transcendental Meditation on LDL cholesterol levels among middle-aged men following myocardial infarction.

Participants

The study was conducted at a tertiary care institution. A total of 90 male participants aged 35–45 years with a documented history of myocardial infarction within the preceding 6–12 months were recruited.

Inclusion Criteria:

- Male participants aged 35–45 years with a confirmed diagnosis of myocardial infarction within the preceding 6–12 months.
- Clinically stable before hospital discharge with clearance for mild-to-moderate exercise.
- Receiving regular medical treatment for cardiac protection.
- Able to provide informed consent and adhere to the study protocol until completion.
- Living in the geographic catchment area of the study site.

Exclusion Criteria:

- Recurrent myocardial infarction, unstable angina, or uncontrolled heart failure.
- Severe orthopedic or neurological limitations preventing yoga practice.

- Uncontrolled hypertension or uncontrolled arrhythmias at baseline.
- Psychiatric conditions that could interfere with meditation practice.
- Uncooperative attitude toward intervention requirements or follow-up assessments.

Randomization and Sample Size

The sample size was calculated to detect a clinically meaningful difference in LDL cholesterol between groups. Assuming a large effect size (Cohen's $d = 0.8$), a two-tailed significance level of 0.05, and 80% power, the minimum required sample size was estimated at 21 participants per group. To improve statistical robustness and account for attrition, 30 participants were included in each group. Sample size estimation was guided by standard statistical methods for clinical trials.

Participants were randomly assigned to one of three groups (Yoga with TM, Yoga alone, and Control) using a computer-generated random allocation sequence. Allocation concealment was maintained through sequentially numbered, sealed, opaque envelopes that were opened only after enrollment. This approach reduces selection bias and maintains unpredictability of group assignment. Outcome assessors and laboratory personnel were blinded to group allocation to reduce detection bias.

Interventions

The intervention was conducted over 12 weeks, with six supervised sessions per week, each lasting approximately 60 minutes.

Yoga with TM Group:

This group received a structured yoga program that included asanas, pranayama, and relaxation under the guidance of a qualified yoga teacher. In addition, participants practiced TM for 20 minutes twice daily while seated comfortably with their eyes closed.

Yoga Group: This group received the same yoga program as the Yoga with TM group, without meditation.

Control Group:

This group continued regular medical care without organized yoga or meditation intervention.

Outcome Measure

The primary outcome was serum LDL cholesterol (mg/dL). Blood samples were collected at baseline and after completion of the 12-week intervention period.

LDL cholesterol was measured using a standardized enzymatic colorimetric assay, a widely accepted method for lipid profiling in clinical practice. All analyses were performed in a certified biochemistry laboratory following standardized protocols.

Statistical Analysis

Data analysis was performed using SPSS version 25.0. Descriptive statistics are presented as mean and standard deviation. Within-group changes were assessed using

paired samples t-tests. One-way analysis of variance (ANOVA) was used to compare differences between groups. Scheffé post hoc testing was used to identify specific group differences. The level of statistical significance was set at $p < 0.05$, and all tests were two-tailed.

Ethical Considerations

The Institutional Ethics Committee approved the study protocol based on the Declaration of Helsinki (World Medical Association, 2013) by Meenakshi Medical college Hospital and Research Institute under Registration No: EC/NEW/INST/2021/2220. Informed consent was written in advance on all participants.

RESULTS

Baseline Characteristics

All 90 enrolled participants completed the study, with no dropouts. Baseline characteristics were comparable across the three groups (Yoga with TM, Yoga, and Control), indicating successful randomization. There were no statistically significant differences in baseline LDL cholesterol levels among the groups (Yoga + TM: 143.47 ± 11.21 mg/dL; Yoga: 146.33 ± 10.67 mg/dL; Control: 147.20 ± 11.38 mg/dL; $F = 0.931$, $p = 0.398$). Similarly, no significant differences were observed in anthropometric, physiological, or psychological variables at baseline ($p > 0.05$ for all comparisons), supporting homogeneity of the study population before intervention.

Effect of Intervention on LDL Cholesterol

The within-group and between-group effects of the three interventions on LDL cholesterol are presented in Table 1.

Table 1: Effectiveness of Intervention on Low-Density Lipoprotein (LDL) Among Middle-Aged Men Following Myocardial Infarction

Group	Mean Effect Score (mg/dL)	SD	Paired t-value	p-value
Yoga with TM	25.40	4.75	$t = 29.314$	$p < 0.001^{***}$
Yoga Group	11.27	5.51	$t = 11.191$	$p < 0.001^{***}$
Control Group	2.97	4.09	$t = 3.973$	$p < 0.001^{***}$
F-test (ANOVA)	F = 39.552			p < 0.001*

Table 2: Post Hoc Test (Scheffe's Test)

Comparison	p-value
Yoga with TM vs. Yoga	$p < 0.001^{***}$
Yoga with TM vs. Control	$p < 0.001^{***}$
Yoga vs. Control	$p < 0.011^{**}$

Note: $** p < 0.01$; $*** p < 0.001$. $N = 30$ per group.

Within-Group Changes in LDL Cholesterol

Following the 12-week intervention, all three groups showed statistically significant reductions in LDL cholesterol compared with baseline.

- The Yoga with TM group showed the greatest reduction, with a mean decrease of 25.40 ± 4.75 mg/dL ($t = 29.314$, $p < 0.001$).
- The Yoga group showed a moderate reduction of 11.27 ± 5.51 mg/dL ($t = 11.191$, $p < 0.001$).
- The Control group showed a smaller but statistically significant reduction of 2.97 ± 4.09 mg/dL ($t = 3.973$, $p < 0.001$).

These findings indicate that standard medical care contributed to LDL reduction, while structured mind-body interventions produced substantially greater improvements.

Between-Group Comparison of LDL Reduction

One-way ANOVA showed a statistically significant difference in LDL reduction among the three groups ($F = 39.552$, $p < 0.001$).

Post hoc analysis using Scheffé's test showed a significantly greater reduction in the Yoga with TM group than in the Yoga group and Control group, and a significant difference between the Yoga group and the

Control group. These results indicate a graded response, with the greatest effect observed in the combined Yoga with TM intervention, followed by yoga alone, and the smallest change in the control group.

ANCOVA

Analysis of covariance, adjusting for baseline LDL levels, confirmed the robustness of the findings. The difference in post-intervention LDL levels between groups remained statistically significant ($p < 0.001$), indicating that the observed effects were independent of baseline variation.

Magnitude of Effect

The magnitude of LDL reduction in the Yoga with TM group was clinically substantial. The absolute reduction of 25.40 mg/dL corresponds to an approximate 17.7% decrease from baseline, compared with 7.7% in the Yoga group and 2.0% in the Control group. The effect size for LDL reduction between the Yoga with TM and Control groups was very large (Cohen's $d = 2.27$), indicating a strong intervention effect.

DISCUSSION

This randomized controlled trial demonstrates that structured yogic practices significantly reduce low-density lipoprotein (LDL) cholesterol in middle-aged men following myocardial infarction, with a markedly greater effect when yoga is combined with Transcendental Meditation (TM). The magnitude of reduction in the

combined intervention group was substantially higher than that achieved with yoga alone and standard medical care, indicating a meaningful additive effect of meditation. From a clinical standpoint, such reductions are relevant in secondary prevention, because even modest decreases in LDL cholesterol are associated with lower risk of major cardiovascular events.

The lipid-lowering effect observed in the yoga-only group is consistent with prior systematic reviews and meta-analyses showing that yoga-based interventions improve lipid profiles, including reductions in LDL cholesterol, total cholesterol, and triglycerides. These benefits are often attributed to improved autonomic balance, increased parasympathetic activity, reduced sympathetic tone, enhanced metabolic regulation, and reduced inflammatory burden. In addition, yoga may improve endothelial function and insulin sensitivity, both of which are closely linked to lipid metabolism and cardiovascular risk.

The greater reduction in LDL cholesterol observed in the Yoga with TM group suggests a possible synergistic interaction between somatic and neuroendocrine mechanisms. TM has been associated with reductions in blood pressure, stress hormone levels, and cardiovascular morbidity. Its effects are thought to occur through attenuation of HPA axis activity, leading to decreased circulating cortisol and catecholamines. Because elevated cortisol can promote hepatic lipid synthesis and contribute to dyslipidemia, the combined reduction of sympathetic overactivity through yoga and neuroendocrine modulation through TM may enhance LDL clearance and reduce lipid production.

Psychological stress also plays an important role in cardiovascular disease through pathways involving neuroendocrine activation, systemic inflammation, and endothelial dysfunction. The superior effect of the combined intervention may therefore reflect not only physiological changes but also broader stress reduction. Previous studies have shown that meditation-based interventions reduce perceived stress and anxiety, which are independently associated with adverse cardiovascular outcomes. The relationship between psychological well-being and metabolic regulation provides a plausible explanation for the enhanced lipid-lowering effect observed in the combined intervention.

These findings also align with earlier integrative lifestyle interventions that combined dietary modification, physical activity, and stress management. Programs incorporating yoga and meditation have demonstrated regression of coronary atherosclerosis and substantial improvements in lipid profiles. Although the present study did not include dietary intervention, the magnitude of LDL reduction achieved through non-pharmacological means alone suggests the potential value of structured mind-body approaches in cardiac rehabilitation.

From a public health perspective, these results are relevant because participation in conventional cardiac rehabilitation remains limited in many settings. Yoga and meditation are cost-effective, culturally acceptable, and scalable

interventions that may be integrated into healthcare systems as adjuncts to standard therapy. However, the findings should be interpreted cautiously and not as a replacement for evidence-based pharmacological treatment.

Several limitations should be noted. The study duration was limited to 12 weeks, and long-term sustainability of lipid reduction was not assessed. Dietary intake and other lifestyle factors were not controlled, which may have influenced the observed outcomes. The study population was restricted to middle-aged men, limiting generalizability to women and other age groups. In addition, participant blinding was not possible because of the nature of the intervention, which may introduce performance bias. Despite these limitations, the randomized design, standardized intervention, and consistent findings across analyses strengthen the internal validity of the study.

Future research should include multicenter trials with larger and more diverse populations, longer follow-up periods, and better control of dietary and lifestyle factors. Studies investigating mechanistic pathways using biomarkers of inflammation, oxidative stress, and autonomic function would help explain the biological basis of the observed effects. Comparative effectiveness studies evaluating integrated yoga and meditation against standard cardiac rehabilitation programs may also provide important clinical insights.

CONCLUSION

This randomized controlled trial provides evidence that Transcendental Meditation combined with yogic practices produces a greater reduction in LDL cholesterol than yoga alone or standard care in middle-aged men who survived myocardial infarction. The combined intervention appears to be a safe, affordable, and useful adjunct to conventional cardiac rehabilitation. Further studies are needed to examine long-term effects, dose-response relationships, and mechanisms of action.

CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

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