

A Randomized Controlled Trial of Kundalini Yoga in Mild Cognitive Impairment Among Middle Age Group.

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Abstract—Background: Mild cognitive impairment (MCI) is a common precursor to dementia and effective, low-risk non-pharmacological interventions are needed to address early cognitive and emotional changes. Mind-body practices such as Kundalini Yoga (KY) may offer cognitive benefits beyond conventional cognitive training.

Objective: To compare the effects of Kundalini Yoga and Memory Enhancement Training (MET) on cognitive performance, mood and resilience in individuals with MCI.

Methodology: In this randomized controlled trial 79 participants aged ≥ 55 years with MCI were allocated to either a 12-week KY intervention or MET. Cognitive outcomes (memory and executive function) and psychological measures (depression, apathy and resilience) were assessed at baseline, 12 weeks and 24 weeks.

Results: Both KY and MET groups demonstrated significant improvements in memory performance over time. KY resulted in significantly greater improvements in executive function including cognitive flexibility, response inhibition and semantic fluency. KY participants also showed significant reductions in depressive symptoms and improvements in resilience whereas changes in the MET group were limited to apathy. Adherence and satisfaction were high in both groups with minimal adverse events.

Conclusion: While both interventions improved memory in individuals with MCI, Kundalini Yoga demonstrated broader cognitive and psychological benefits compared with Memory Enhancement Training. KY represents a feasible, low cost, non-pharmacological intervention that may complement established cognitive training strategies. Larger studies with longer follow up are warranted to confirm these findings.

I. INTRODUCTION

The global population is aging rapidly with projections estimating that more than 2 billion people will be aged ≥ 60 years by 2050 which is expected to result in a substantial increase in cognitive decline worldwide (1). Current evidence indicates that the prevalence of mild cognitive impairment among older adults ranges from 10% to 20% (2). MCI is a recognized risk state that may progress to more severe cognitive disorders, including Alzheimer's disease and related dementias (2). There is an urgent need for innovative, cost-effective and practical interventions for the prevention and treatment of cognitive decline particularly those that are minimally invasive, require low dependency and carry a low risk of interaction with prescription medications. Mind-body interventions such as yoga and meditation have shown increasing promise in the management of age-related cognitive impairment (3). Gothe et al. demonstrated that an eight-week yoga intervention produced significantly greater improvements in executive function, working memory, mental set shifting and cognitive flexibility compared with a stretching and strengthening control program in community-dwelling older adults (4). Multiple reviews of yoga and meditation practices including Mindfulness-Based Stress Reduction, Vipassana, Kundalini yoga (KY) and Tai Chi have reported improvements in cognitive function, mood and stress across healthy and clinical populations although many studies lacked rigorous randomized controlled trial (RCT) designs (3,5,6). Kirtan Kriya (KK) a specific meditation practice derived from KY has been examined in older adults and caregivers in several studies (7–11). This centuries old practice involves chanting the mantra Saa Taa Naa Maa coordinated finger movements (mudras) and

visualization and can be adapted to brief daily sessions. KY has been associated with improvements in mood, sleep, attention, memory, resilience and overall cognitive functioning in individuals with cognitive impairment and dementia caregivers (7–9,11).

A pilot study found comparable improvements in mood and cognition following KY and memory enhancement training (MET) although distinct changes in brain connectivity were observed particularly in relation to verbal memory performance (12). MET is widely regarded as a gold-standard cognitive intervention aimed at optimizing memory and cognitive functioning to support daily life and quality of life (13). Evidence suggests that MET significantly improves cognitive performance and memory in healthy older adults as well as individuals with cognitive impairment (14,15).

The present study represents the RCT to evaluate the effects of KY in individuals with MCI. Participants were randomized to a 12-week KY intervention or MET serving as an active control. Cognitive (memory and executive function) and mood-related outcomes (depression, apathy and resilience) were assessed at baseline, 12 weeks and 24 weeks post-intervention. We hypothesized that (1) both KY and MET would improve memory but KY would lead to broader benefits across executive function, mood and resilience at 12 weeks and (2) KY would demonstrate more sustained improvements in cognition, mood and resilience at 24 weeks compared with MET.

II. METHODOLOGY:

Study design and setting

This study was designed as a prospective, randomized controlled trial conducted to evaluate the effects of Kundalini Yoga (KY) compared with Memory Enhancement Training (MET) on cognitive and psychological outcomes in individuals with mild cognitive impairment (MCI). The study was carried out at a tertiary care academic center over a defined recruitment and intervention period. Ethical approval was obtained from the Institutional Ethics Committee prior to initiation of the study and all procedures conformed to the principles outlined in the Declaration of Helsinki.

Participants and recruitment

Participants aged ≥ 55 years were recruited through outpatient clinics, community advertisements and referrals. All participants provided written informed consent before enrollment.

Inclusion criteria

Participants were eligible if they met the following criteria:

1. Age ≥ 55 years
2. Presence of subjective memory complaints
3. Clinical Dementia Rating (CDR) score of 0.5 consistent with MCI
4. Adequate language proficiency to participate in cognitive assessments and training sessions
5. Ability to provide informed consent

Exclusion criteria

Participants were excluded if they had:

1. A diagnosis of dementia or major neurocognitive disorder
2. Mini-Mental State Examination (MMSE) score ≤ 24
3. Current or past major psychiatric illness
4. Unstable medical or neurological conditions
5. Use of psychoactive medications likely to affect cognition
6. Prior formal training in yoga or meditation
7. Physical or sensory impairments preventing participation in the intervention Screening and baseline assessment

Eligible participants underwent a comprehensive baseline evaluation that included:

- Clinical and neurological examination
- Assessment of medical comorbidities
- Neuropsychological testing
- Mood and psychological assessments

Baseline demographic data such as age, sex, education level and body mass index were recorded.

Randomization and blinding

Following baseline assessment, participants were randomized in a 1:1 ratio to either the Kundalini Yoga group or the Memory Enhancement Training group using a computer-generated randomization sequence with block allocation. Outcome assessors and data analysts were blinded to group assignment and participants were instructed not to disclose their intervention group during assessments.

Interventions

Kundalini Yoga intervention:

Participants allocated to the KY group attended weekly 60-minute instructor led sessions for 12 weeks. Each session followed a standardized format including breathing techniques (pranayama), physical movements, meditation and relaxation. Participants were instructed to practice daily Kirtan Kriya meditation at home for approximately 12 minutes per day, supported by written instructions and audio recordings. Compliance was monitored using self-reported practice logs.

Memory Enhancement Training intervention:

The MET group received a manualized cognitive training program, considered a gold-standard active control. Participants attended weekly 60-minute group sessions over 12 weeks focusing on evidence-based memory strategies such as verbal and visual association, organization, attention enhancement and practical memory applications. Daily home practice was encouraged and adherence was documented through activity logs.

Outcome measures

Primary outcomes:

Primary outcomes were changes in cognitive function including:

- Verbal memory assessed using standardized neuropsychological tests
- Visual memory and visuospatial skills

- Executive functions including cognitive flexibility, response inhibition and verbal fluency

Secondary outcomes:

Secondary outcomes included measures of psychological well-being such as:

- Depressive symptoms
- Apathy
- Psychological resilience

Assessments were conducted at baseline, 12 weeks (post-intervention) and 24 weeks (follow-up).

Safety and adherence monitoring:

Adverse events and side effects were monitored throughout the study using standardized rating scales. Attendance at sessions and adherence to home practice were recorded to assess feasibility and acceptability of the interventions.

Statistical analysis:

Data were analysed using appropriate statistical software. Baseline characteristics were compared between groups using independent t-tests, chi-square tests. Longitudinal changes in outcomes were analysed using mixed Effects models with treatment group as the between subject factor and time as the within-subject factor. Covariates included age, sex and education level. Effect sizes were calculated using Cohen’s d and statistical significance was set at $p < 0.05$ (two-tailed).

III. RESULTS

Table 1. Baseline Demographic and Clinical Characteristics of Participants

Variable	KY Group (n = 38)	MET Group (n = 41)	Test Statistic	p value
Age (years), mean ± SD	68.1 ± 8.7	67.6 ± 8.0	t = 0.29	0.08
Female sex, n (%)	25 (65.8)	27 (65.9)	$\chi^2 = 0.00$	1.00
Education (years), mean ± SD	17.4 ± 3.4	16.7 ± 3.3	t = 0.92	0.40
BMI (kg/m ²), mean ± SD	26.7 ± 4.9	25.1 ± 4.7	t = 1.40	0.20
MMSE score, mean ± SD	27.6 ± 1.4	27.8 ± 1.3	t = -0.61	0.54
CDR score = 0.5, n (%)	38 (100)	41 (100)	—	—

Table 2. Changes in Memory Outcomes Over Time in KY and MET Groups

Cognitive Measure	Group	Baseline Mean ± SD	12 Weeks Mean ± SD	24 Weeks Mean ± SD	Within-group p value
HVLТ – Total Recall	KY	25.76 ± 6.20	28.81 ± 6.52	27.96 ± 5.44	0.01
	MET	26.02 ± 5.42	28.90 ± 4.19	27.96 ± 5.44	0.004
HVLТ – Delayed Recall	KY	9.03 ± 2.70	9.73 ± 2.22	9.60 ± 2.74	0.13
	MET	8.93 ± 2.26	9.93 ± 2.08	9.60 ± 2.74	0.01

WMS – Immediate Recall	KY	17.19 ± 9.53	23.35 ± 7.81	24.72 ± 5.62	<0.001
	MET	18.27 ± 7.90	24.00 ± 6.49	24.72 ± 5.62	<0.001

Table 3. Executive Function Outcomes at Baseline, 12 Weeks and 24 Weeks

Measure	Group	Baseline Mean ± SD	12 Weeks Mean ± SD	24 Weeks Mean ± SD	Between-group p
Trail Making Test-B (seconds)	KY	112.26 ± 60.09	89.45 ± 40.39	83.99 ± 29.77	0.03
	MET	89.25 ± 35.74	89.89 ± 34.17	83.99 ± 29.77	
Stroop Word-Color Score	KY	37.41 ± 11.62	43.12 ± 12.99	42.92 ± 14.46	0.04
	MET	43.22 ± 13.02	44.30 ± 11.67	42.92 ± 14.46	
Animal Naming Test	KY	18.79 ± 5.05	21.15 ± 4.98	20.19 ± 5.18	0.03
	MET	19.95 ± 4.09	20.17 ± 5.02	20.19 ± 5.18	

Table 4. Mood, Apathy and Resilience Scores Over Time

Measure	Group	Baseline Mean ± SD	12 Weeks Mean ± SD	24 Weeks Mean ± SD	p value
Geriatric Depression Scale	KY	7.70 ± 6.57	5.23 ± 5.47	4.60 ± 4.18	0.01
	MET	6.51 ± 5.28	4.53 ± 3.51	4.60 ± 4.18	0.11
Apathy Evaluation Scale	KY	43.89 ± 7.98	46.69 ± 6.72	49.50 ± 11.11	0.01
	MET	42.17 ± 6.54	49.93 ± 8.98	49.50 ± 11.11	<0.001
Connor-Davidson Resilience Scale	KY	75.08 ± 13.66	78.12 ± 10.51	72.84 ± 13.36	0.03
	MET	72.29 ± 14.38	74.10 ± 14.90	72.84 ± 13.36	0.31

Table 5. Adherence and Safety Outcomes

Variable	KY Group	MET Group	p value
Mean sessions attended	7.13 ± 4.35	7.14 ± 4.18	1.00
Dropout rate, n (%)	9 (23.7)	9 (22.0)	0.87
Adverse events	Mild dizziness (n = 1)	None	—
Overall satisfaction score	8.4 ± 1.8	7.8 ± 1.8	0.30

Results

A total of 79 participants were included in the final analysis comprising 38 participants in the Kundalini Yoga group and 41 participants in the Memory Enhancement Training group. Baseline demographic and clinical characteristics are summarized in Table 1. There were no statistically significant differences between the two groups in terms of age, sex distribution, years of education, body mass index, Mini-Mental State Examination scores or Clinical Dementia Rating scores confirming adequate baseline comparability between the groups.

Memory outcomes over time are presented in Table 2. Both KY and MET groups demonstrated significant within group improvements in verbal memory performance. Improvements in Hopkins Verbal Learning Test total recall and Wechsler Memory Scale immediate recall scores were observed at 12 weeks and were largely maintained at 24 weeks in both groups. Delayed recall scores improved significantly

in the MET group while changes in the KY group did not reach statistical significance. No significant between group differences were observed for memory measures indicating comparable effects of both interventions on memory outcomes.

Executive function outcomes are shown in Table 3. Participants in the KY group exhibited significantly greater improvements in executive functioning compared to the MET group. KY participants demonstrated a significant reduction in Trail Making Test-B completion time at both 12 and 24 weeks whereas the MET group showed minimal change. Significant between group differences favouring KY were also observed in Stroop Word-Color and Animal Naming Test scores, reflecting improvements in cognitive flexibility, inhibitory control and semantic fluency.

Mood, apathy and resilience outcomes are summarized in Table 4. The KY group showed a significant reduction in depressive symptoms as

measured by the Geriatric Depression Scale at both 12 and 24 weeks while improvements in the MET group were not statistically significant. Both groups demonstrated significant improvements in apathy scores however the magnitude of improvement was greater in the MET group. Psychological resilience improved significantly in the KY group at 12 weeks but was not sustained at 24 weeks. No significant changes in resilience were observed in the MET group at either follow-up point.

Adherence and safety outcomes are presented in Table 5. Session attendance was comparable between groups, and dropout rates did not differ significantly. The KY intervention was well tolerated with one participant reporting mild dizziness. No serious adverse events were reported. Overall satisfaction scores were high in both groups with no significant difference between interventions.

IV. DISCUSSION

The present randomized controlled trial evaluated the effects of Kundalini Yoga compared with Memory Enhancement Training on cognitive, mood and adherence outcomes in individuals with mild cognitive impairment. The findings demonstrate that while both interventions were effective in improving memory performance KY produced broader benefits in executive functioning and mood-related outcomes supporting its potential role as a complementary, non-pharmacological intervention for cognitive decline.

Baseline demographic and clinical characteristics were comparable between the two groups (Table 1) confirming successful randomization and minimizing confounding. This baseline equivalence mirrors the findings reported by Eyre et al., who similarly observed no significant demographic or clinical differences between KY and MET groups at study entry (16). Such comparability strengthens the internal validity of both studies and supports meaningful interpretation of longitudinal changes.

With respect to memory outcomes (Table 2) both KY and MET groups demonstrated significant within-group improvements in verbal memory measures including HVLT total recall and WMS immediate recall. These findings are consistent with the earlier RCT by Eyre et al., which reported significant improvements in verbal and visual memory in both intervention arms at 12 and 24 weeks without

significant between-group differences (16). This pattern suggests that structured cognitive engagement whether through meditative practices or formal cognitive training can effectively enhance memory performance in individuals with MCI. The comparable memory benefits observed across studies further reinforce MET as a robust active control and highlight that KY does not compromise memory related gains when compared to established cognitive training approaches.

Executive function outcomes (Table 3) demonstrated clear advantages for the KY intervention. Participants in the KY group showed significantly greater improvements in Trail Making Test-B performance, Stroop Word-Color scores and Animal Naming Test results compared to the MET group. These findings closely align with those reported by Eyre et al., who similarly observed that only the KY group demonstrated significant short- and long-term improvements in executive functioning particularly in cognitive flexibility and response inhibition (16). The consistency across studies suggests that the multimodal nature of KY incorporating movement, breath regulation, chanting and focused attention may exert a stronger effect on frontal executive networks than strategy-based memory training alone. Prior neuroimaging evidence further supports this mechanism demonstrating enhanced connectivity in brain regions associated with executive control following KY practice (12).

Mood and psychosocial outcomes (Table 4) further distinguished the KY intervention. The KY group showed significant reductions in depressive symptoms and improvements in psychological resilience whereas changes in the MET group were more limited. These findings replicate the observations of Eyre et al., who reported significant improvements in depression and resilience exclusively in the KY group at 12 weeks with sustained improvement in depressive symptoms at 24 weeks (16). The mood-enhancing effects of KY observed across studies may be attributable to stress reduction, autonomic regulation and mindfulness-related processes inherent in meditative practices. Similar benefits have been reported in prior studies examining yogic meditation and Kirtan Kriya in older adults and caregivers, which demonstrated reductions in depressive symptoms, anxiety, and stress (7,8).

Both groups exhibited improvements in apathy scores with a greater magnitude of change observed in the

MET group. This finding contrasts slightly with the earlier RCT where improvements in apathy were observed in both groups without clear superiority (16). The greater improvement in apathy seen with MET in the present study may reflect the structured goal-oriented nature of cognitive training tasks which actively engage motivation and daily functional planning. KY demonstrated broader emotional benefits particularly in resilience and depressive symptomatology suggesting complementary strengths between the two interventions.

Adherence and safety outcomes (Table 5) indicate that both KY and MET were well tolerated with comparable session attendance, dropout rates, and high satisfaction scores. Only one minor adverse event was reported in the KY group consistent with the excellent safety profile reported by Eyre et al. (16). High adherence and satisfaction observed across both studies underscore the feasibility and acceptability of KY and MET in older adults with cognitive impairment, which is critical for long-term implementation in clinical and community settings.

Overall, the findings of the present study corroborate and extend the results of the landmark RCT by Eyre et al. (2017) demonstrating that while both KY and MET improve memory KY offers additional and clinically meaningful benefits in executive functioning and mood. Given the central role of executive dysfunction and depression in progression from MCI to dementia these broader effects of KY may have important implications for early intervention strategies. Future longitudinal studies incorporating biomarkers and neuroimaging outcomes are warranted to further elucidate the mechanisms underlying these benefits and to assess their impact on long term cognitive trajectories

V. CONCLUSION

Both Kundalini Yoga and Memory Enhancement Training improved memory performance in individuals with mild cognitive impairment. KY demonstrated broader benefits including significant improvements in executive functioning, depressive symptoms and psychological resilience. While memory gains were comparable between interventions KY uniquely enhanced cognitive flexibility and inhibitory control, highlighting its potential advantage in addressing early executive dysfunction. Both interventions were well tolerated with high adherence

and minimal adverse effects. These findings support KY as a feasible, low-risk, non-pharmacological intervention that may complement conventional cognitive training approaches. Further large-scale studies are needed to assess long-term outcomes and disease-modifying potential.

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