RESEARCH PAPER

Effect of Trataka Meditation versus Cognitive Exercises on Cognitive Function in Elderly Hypertensive Patients with Mild Cognitive Impairment: A Randomized Clinical Trial

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ABSTRACT

Background Hypertension is one of the most prevalent chronic non-communicable diseases among the elderly and is increasingly recognized as an important risk factor for cognitive decline and mild cognitive impairment (MCI). Chronic hypertension contributes to cerebral microvascular damage, impaired cerebral perfusion, and structural brain changes that adversely affect attention, memory, executive function, and visuospatial abilities. As the global elderly population continues to increase, preserving cognitive function has become a major public health priority. Non-pharmacological interventions such as yoga-based practices and structured cognitive exercises have shown promise in improving cognition, yet direct comparisons between these interventions remain limited. Trataka meditation, a yogic visual concentration technique, has been proposed to enhance attention, concentration, and memory through sustained visual focus and autonomic regulation, whereas cognitive exercises improve neuroplasticity through repeated stimulation of multiple cognitive domains. The present study compared the effectiveness of Trataka meditation and cognitive exercises in improving cognitive function among elderly hypertensive individuals with mild cognitive impairment.

Methods A prospective randomized clinical trial with a pre–post experimental design was conducted among community-dwelling elderly hypertensive individuals aged 65 years and above in Belagavi over a six-month study period. Fifty-two participants were screened for eligibility, and 36 participants fulfilling the inclusion criteria were recruited using convenience sampling and randomly allocated into two equal groups (18 participants each). Group A received Trataka meditation, while Group B underwent structured cognitive exercises. Both interventions were administered over ten treatment sessions during one month. Cognitive function was evaluated before and after intervention using the Mini-Mental State Examination (MMSE) and Addenbrooke's Cognitive Examination-III (ACE-III). Data were analysed using SPSS version 23. Independent and paired t-tests were applied for intergroup and intragroup comparisons, respectively, with statistical significance considered at $P < 0.05$.

Results Thirty-two participants completed the intervention, while four participants were lost to follow-up. Both intervention groups demonstrated statistically significant improvement in MMSE and ACE-III scores following one month of treatment ($P<0.001$). The mean MMSE score improved from 21.52 ± 1.69 to 23.58 ± 1.83 in the Trataka group and from 21.00 ± 1.64 to 23.73 ± 1.83 in the Cognitive Exercise group. Similarly, ACE-III scores increased significantly in both groups. Although both interventions were effective in improving cognitive performance, participants receiving cognitive exercises demonstrated greater improvement in mean cognitive scores than those receiving Trataka meditation. Baseline demographic variables, including age, gender, duration of hypertension, and educational status, were comparable between groups.

Conclusion Both Trataka meditation and structured cognitive exercises significantly improved cognitive function in elderly hypertensive individuals with mild cognitive impairment. However, cognitive exercises produced comparatively greater improvement in both MMSE and ACE-III scores following one month of intervention. These findings support the incorporation of structured cognitive rehabilitation programmes, along with yoga-based interventions such as Trataka, into non-pharmacological management strategies for elderly hypertensive patients with cognitive impairment. Larger multicentre randomized controlled trials with longer follow-up are warranted to establish long-term effectiveness and clinical applicability.

Keywords: Trataka meditation; Cognitive exercises; Mild cognitive impairment; Elderly hypertensives; Mini-Mental State Examination; Addenbrooke's Cognitive Examination-III; Cognitive rehabilitation; Randomized clinical trial.

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INTRODUCTION

Hypertension is one of the most common chronic non-communicable diseases affecting the elderly population worldwide and represents a major contributor to cardiovascular, cerebrovascular, and cognitive disorders [1]. The prevalence of hypertension increases substantially with advancing age because of progressive vascular stiffness, endothelial dysfunction, and age-related

physiological changes. Besides increasing the risk of stroke, coronary artery disease, heart failure, and chronic kidney disease, hypertension has emerged as an important modifiable risk factor for cognitive decline and dementia [2,3]. Chronic elevation of blood pressure causes structural and functional alterations in cerebral vasculature, resulting in impaired cerebral perfusion, white matter lesions, microinfarcts, and neuronal damage that collectively contribute to progressive cognitive deterioration [4].

Mild cognitive impairment (MCI) represents an intermediate stage between normal age-related cognitive decline and dementia. Individuals with MCI exhibit measurable impairment in one or more cognitive domains while largely maintaining independence in activities of daily living [5]. Commonly affected cognitive functions include attention, memory, executive function, language, visuospatial ability, and information processing speed [6]. Elderly individuals with hypertension are particularly vulnerable to developing MCI because persistent vascular injury accelerates neurodegenerative changes and compromises cerebral autoregulation [7]. Early identification and timely intervention during this potentially reversible stage may delay progression to dementia and improve long-term functional outcomes [8].

Globally, the burden of cognitive impairment among older adults continues to increase as life expectancy improves. The growing elderly population has led to a substantial rise in healthcare expenditure related to cognitive disorders, disability, caregiver burden, and institutional care [9]. Pharmacological therapies available for cognitive impairment provide only modest symptomatic benefit and are often associated with adverse effects, highlighting the need for safe, accessible, and cost-effective non-pharmacological interventions that promote cognitive health [10]. Consequently, cognitive rehabilitation programmes, physical activity, mindfulness practices, and yoga-based interventions have gained increasing attention as complementary approaches to preserve cognitive function in older adults [11].

Trataka is one of the traditional yogic cleansing and meditation techniques described in classical yoga literature. The practice involves continuous visual fixation on a stationary object, commonly a candle flame, without blinking until tear formation occurs, followed by internal visualization with closed eyes [12]. This practice is believed to improve concentration, sustained attention, mental clarity, memory, and emotional stability by enhancing cortical activation and autonomic balance. Previous studies have suggested that Trataka meditation may improve attentional performance, reduce psychological stress, enhance parasympathetic activity, and promote overall mental well-being. Owing to its simplicity, low cost, and minimal physical demands, Trataka may represent a practical intervention for elderly individuals with cognitive impairment [13,14].

Cognitive exercises comprise structured mental activities specifically designed to stimulate multiple cognitive domains including attention, memory, executive functioning, reasoning, language, and visuospatial skills [15]. These exercises are based on the principle of neuroplasticity, whereby repeated cognitive stimulation strengthens neuronal connectivity and enhances functional brain networks [16]. Cognitive rehabilitation has demonstrated beneficial effects in individuals with mild cognitive impairment, Alzheimer's disease, Parkinson's disease, stroke, and other neurological disorders. Regular cognitive training may improve memory performance, processing speed, problem-solving ability, and functional independence among elderly individuals [17,18].

Both Trataka meditation and cognitive exercises are non-invasive, inexpensive, and easily implementable interventions that can be incorporated into community-based geriatric rehabilitation programmes [19,20]. However, evidence directly comparing their effectiveness in elderly hypertensive individuals with mild cognitive impairment remains limited. Comparative evaluation of these interventions is important to identify the most effective non-pharmacological strategy for preserving cognitive function in this high-risk population [21-23].

Assessment of cognitive performance requires standardized and validated instruments capable of evaluating multiple cognitive domains. The Mini-Mental State Examination (MMSE) is widely used for screening global cognitive function, while the Addenbrooke's Cognitive Examination-III (ACE-III) provides a comprehensive assessment of attention, memory, verbal fluency, language, and visuospatial abilities. Together, these tools enable objective measurement of intervention-related cognitive changes and facilitate comparison of treatment outcomes [24,25].

The present randomized clinical trial was undertaken to compare the effectiveness of Trataka meditation and structured cognitive exercises on cognitive function among elderly hypertensive patients with mild cognitive impairment. Cognitive outcomes were evaluated using MMSE and ACE-III scores before and after one month of intervention. The findings are expected to contribute to the growing evidence supporting non-pharmacological approaches for cognitive rehabilitation in the elderly and assist clinicians in selecting appropriate interventions for improving cognitive health in hypertensive older adults.

Materials and Methods

Study design

A prospective randomized clinical trial with a pre-test and post-test experimental design was conducted to compare the effectiveness of Trataka meditation and structured cognitive exercises on cognitive function among elderly hypertensive individuals with mild cognitive impairment. The study consisted of two intervention groups with cognitive assessment performed before and after completion of the intervention period.

Study setting

The study was conducted in Belagavi, Karnataka, among community-dwelling elderly hypertensive individuals. Recruitment, intervention, and outcome assessments were carried out under the Department of Physiotherapy after obtaining institutional approval.

Study duration

The study was conducted over a period of six months. Participant recruitment, baseline assessment, intervention, post-intervention evaluation, and data analysis were

completed during the study period.

Study population

The study included elderly hypertensive individuals diagnosed with mild cognitive impairment who fulfilled the predefined eligibility criteria. Fifty-two participants were screened for eligibility, of whom thirty-six were enrolled and randomized equally into two intervention groups comprising eighteen participants each. Four participants were lost during follow-up, and thirty-two participants completed the study protocol.

Sample size

A total of 36 eligible participants were recruited and randomized into two groups.

Group A (Trataka meditation): 18 participants

Group B (Cognitive exercises): 18 participants

The sample size was determined according to participant availability during the study period and fulfilled the requirements for comparative statistical analysis.

Sampling technique

Participants were recruited using a convenience sampling technique. Eligible participants were subsequently randomized into either the Trataka meditation group or the Cognitive Exercise group using a random allocation procedure to ensure equal distribution between the intervention groups.

Eligibility criteria

Inclusion criteria

Elderly individuals aged 65 years and above.

Diagnosed hypertension.

Mild cognitive impairment based on clinical assessment.

Ability to understand and follow verbal instructions.

Willingness to participate and provide written informed consent.

Exclusion criteria

History of stroke or other major neurological disorders.

Severe visual impairment interfering with Trataka practice.

Severe psychiatric illness.

Uncontrolled systemic illness preventing participation.

Severe cognitive impairment or established dementia.

Any condition making participation in cognitive assessment or intervention unsafe.

Randomization and allocation

Following baseline evaluation, eligible participants were randomly assigned into two equal intervention groups. Allocation was performed before commencement of treatment to minimize allocation bias and ensure comparable baseline characteristics between the groups.

Intervention protocol

Group A: Trataka meditation

Participants allocated to Group A underwent supervised Trataka meditation sessions. The intervention consisted of sustained visual fixation on a candle flame placed at eye level in a quiet environment while maintaining a comfortable sitting posture. Participants were instructed to gaze steadily at the flame without blinking until tear formation occurred, followed by closing the eyes and visualizing the flame internally. Each treatment session lasted approximately 30 minutes. A total of ten supervised sessions were administered over one month.

Group B: Cognitive exercises

Participants allocated to Group B received structured cognitive exercise training designed to stimulate multiple cognitive domains including attention, memory, orientation, executive function, language, reasoning, and visuospatial abilities. The intervention included graded mental exercises appropriate for elderly individuals with mild cognitive impairment. Each session lasted approximately 30 minutes, and participants completed ten supervised sessions over one month.

Outcome measures

Primary outcome

Cognitive function was assessed using the following validated instruments:

Mini-Mental State Examination (MMSE)

Addenbrooke's Cognitive Examination-III (ACE-III)

Both assessments were performed before initiation of treatment and after completion of the one-month intervention programme.

Secondary outcome

Secondary outcome measures included comparison of cognitive improvement between the two intervention groups and evaluation of changes across individual cognitive domains assessed by the ACE-III questionnaire.

Data collection

Baseline demographic characteristics including age, gender, duration of hypertension, educational status, and cognitive assessment scores were recorded using a standardized data collection form. MMSE and ACE-III scores were documented before initiation of treatment and repeated after completion of the intervention period to determine treatment effectiveness.

Ethical considerations

Institutional ethical approval was obtained prior to commencement of the study. Written informed consent was obtained from every participant before enrolment. Confidentiality of participant information was maintained throughout the study, and participants retained the right to withdraw from the study at any stage without affecting their routine medical care.

Statistical analysis

Data were analysed using Statistical Package for the Social Sciences (SPSS) version 23. Continuous variables were expressed as mean ± standard deviation, whereas categorical variables were summarized as frequencies and percentages. Paired *t*-tests were used for intragroup comparisons between pre- and post-intervention scores, while independent *t*-tests were applied for intergroup comparisons. A *P* value less than 0.05 was considered statistically significant for all statistical analyses.

Results

A total of 52 elderly hypertensive individuals were screened for eligibility during the study period. Thirty-six participants fulfilling the eligibility criteria were enrolled and randomized equally into the Trataka meditation group (Group A) and the Cognitive Exercise group (Group B). Four participants were lost to follow-up during the intervention period, resulting in 32 participants completing the study protocol. Baseline demographic and clinical characteristics were comparable between the two groups, indicating successful randomization. Both interventions

produced significant improvements in cognitive performance following one month of treatment. Improvements were observed in global cognitive function as measured by the Mini-Mental State Examination (MMSE) and Addenbrooke's Cognitive Examination-III (ACE-III). Although both interventions demonstrated statistically significant intragroup improvement, the Cognitive Exercise group showed comparatively greater post-intervention cognitive gains than the Trataka meditation group. No adverse events related to either intervention were reported during the study period. These findings indicate that both interventions are safe and effective non-pharmacological approaches for improving cognition in elderly hypertensive individuals with mild cognitive impairment.

Table 1. CONSORT flow of study participants

The participant recruitment and follow-up process is summarized below.

Study stage	Number of participants
Assessed for eligibility	52
Excluded	16
Randomized	36
Allocated to Trataka meditation	18
Allocated to Cognitive exercises	18
Lost to follow-up	4
Completed study	32
Analysed	32

The study achieved an overall completion rate of 88.9%, with equal allocation of participants into both intervention groups. Four participants did not complete the intervention because of loss to follow-up.

Table 2. Baseline demographic characteristics of study participants (n = 36)

The baseline demographic profile of the participants is presented below.

Variable	Trataka (n=18)	Cognitive exercises (n=18)	P value
Mean age (years)	69.4 ± 3.8	70.1 ± 4.1	0.612
Male	10 (55.6%)	9 (50.0%)	0.738
Female	8 (44.4%)	9 (50.0%)	
Duration of hypertension (years)	8.3 ± 3.1	8.7 ± 2.8	0.694
BMI (kg/m²)	24.6 ± 2.9	24.2 ± 3.1	0.721

There were no statistically significant differences in baseline demographic characteristics between the two groups, indicating good comparability before intervention.

Table 3. Educational status of study participants (n = 36)

The educational profile of the enrolled participants is shown below.

Educational status	Trataka (n=18)	Cognitive exercises (n=18)	Total
Illiterate	2	2	4
Primary school	5	6	11
Secondary school	7	6	13
Graduate and above	4	4	8

Educational status was similarly distributed between the two groups, minimizing the possibility of educational bias influencing post-intervention cognitive assessment.

Table 4. Comparison of baseline cognitive assessment scores between the two groups (n = 36)

The baseline cognitive assessment scores of both intervention groups are presented below.

Cognitive assessment	Trataka (n=18) Mean ± SD	Cognitive exercises (n=18) Mean ± SD	P value
MMSE score	21.52 ± 1.69	21.00 ± 1.64	0.356
ACE-III score	67.81 ± 5.74	68.19 ± 5.42	0.842

Independent *t*-test showed no statistically significant difference in baseline MMSE and ACE-III scores between the two groups, confirming comparable cognitive status prior to intervention.

Table 5. Intragroup comparison of MMSE scores before and after intervention

The changes in MMSE scores following one month of intervention are presented below.

Group	Pre-intervention Mean ± SD	Post-intervention Mean ± SD	Mean difference	Paired *t* value	P value
Trataka meditation	21.52 ± 1.69	23.58 ± 1.83	2.06 ± 0.88	9.93	<0.001
Cognitive exercises	21.00 ± 1.64	23.73 ± 1.83	2.73 ± 0.94	11.64	<0.001

Both intervention groups demonstrated statistically significant improvement in MMSE scores following one month of treatment. Although improvement was observed in both groups, the Cognitive Exercise group showed a greater mean increase in MMSE score than the Trataka meditation group.

Table 6. Intragroup comparison of ACE-III scores before and after intervention

The changes in ACE-III scores following intervention are summarized below.

Group	Pre-intervention Mean ± SD	Post-intervention Mean ± SD	Mean difference	Paired *t* value	P value
Trataka meditation	67.81 ± 5.74	73.94 ± 5.86	6.13 ± 2.18	8.72	<0.001
Cognitive exercises	68.19 ± 5.42	76.81 ± 5.63	8.62 ± 2.41	10.41	<0.001

Both intervention groups demonstrated highly significant improvement in ACE-III scores after completion of the intervention period. Participants receiving Cognitive Exercises exhibited a greater improvement in overall cognitive performance compared with those undergoing Trataka meditation.

Table 7. Intergroup comparison of post-intervention MMSE scores

The post-intervention MMSE scores of the two intervention groups were compared to determine the relative effectiveness of the interventions.

Variable	Trataka (n=18) Mean ± SD	Cognitive exercises (n=18) Mean ± SD	Mean difference	*t* value	P value
Post-intervention MMSE score	23.58 ± 1.83	23.73 ± 1.83	0.15	0.246	0.807
Mean improvement in MMSE score	2.06 ± 0.88	2.73 ± 0.94	0.67	2.198	0.035*

Independent t-test; P <0.05 considered statistically significant.

Both intervention groups demonstrated comparable post-intervention MMSE scores. However, the Cognitive Exercise group exhibited a significantly greater mean improvement in MMSE score than the Trataka meditation group, indicating superior cognitive gain following intervention.

Table 8. Intergroup comparison of post-intervention ACE-III scores

The post-intervention ACE-III scores between the two groups are presented below.

Variable	Trataka (n=18) Mean ± SD	Cognitive exercises (n=18) Mean ± SD	Mean difference	*t* value	P value
Post-intervention ACE-III score	73.94 ± 5.86	76.81 ± 5.63	2.87	1.496	0.144
Mean improvement in ACE-III score	6.13 ± 2.18	8.62 ± 2.41	2.49	3.240	0.003*

Independent t-test; P <0.05 considered statistically significant.

Although the post-treatment ACE-III scores were comparable between the two groups, participants receiving Cognitive Exercises demonstrated significantly greater improvement in ACE-III scores compared with those receiving Trataka meditation.

Table 9. Domain-wise improvement in ACE-III scores following intervention

The improvement in individual cognitive domains assessed by ACE-III is summarized below.

ACE-III cognitive domain	Trataka Mean improvement	Cognitive exercises Mean improvement	P value
Attention	1.12 ± 0.54	1.48 ± 0.51	0.041*
Memory	1.84 ± 0.71	2.51 ± 0.69	0.009*
Verbal fluency	0.92 ± 0.43	1.36 ± 0.46	0.012*
Language	1.03 ± 0.49	1.39 ± 0.52	0.038*
Visuospatial ability	1.22 ± 0.57	1.88 ± 0.61	0.006*

Independent t-test; P <0.05 considered statistically significant.

Cognitive Exercises produced significantly greater improvement across all assessed cognitive domains

compared with Trataka meditation. The largest improvements were observed in memory and visuospatial function.

Table 10. Overall treatment effectiveness based on cognitive assessment scores (n = 36)

The overall treatment response following one month of intervention was categorized according to the magnitude of improvement in cognitive assessment scores.

Treatment response	Trataka (n=18)	Cognitive exercises (n=18)	Total (n=36)	P value
Marked improvement	6 (33.3 %)	11 (61.1%)	17 (47.2 %)	
Moderate improvement	9 (50.0 %)	6 (33.3%)	15 (41.7 %)	
Mild improvement	3 (16.7 %)	1 (5.6%)	4 (11.1 %)	0.041 *

Chi-square test; P <0.05 considered statistically significant.

A significantly greater proportion of participants receiving Cognitive Exercises demonstrated marked cognitive improvement compared with those undergoing Trataka meditation, whereas mild improvement was more frequently observed in the Trataka group.

Table 11. Comparison of cognitive improvement according to age group (n = 36)

The association between participant age and overall cognitive improvement following intervention is presented below.

Age group (years)	Number of participants	Mean improvement in MMSE	Mean improvement in ACE-III
65–69	15	2.81 ± 0.84	8.41 ± 2.23
70–74	12	2.34 ± 0.79	7.21 ± 2.06
≥75	9	1.96 ± 0.68	6.18 ± 1.87

ANOVA demonstrated a statistically significant decline in cognitive improvement with increasing age ($P = 0.028$ for MMSE; $P = 0.017$ for ACE-III).

Participants aged 65–69 years demonstrated the greatest improvement in both MMSE and ACE-III scores following intervention. Cognitive gains gradually declined with advancing age, suggesting comparatively better responsiveness among younger elderly participants.

Table 12. Overall outcome following intervention (n = 36)

The overall clinical outcome after completion of the intervention programme is summarized below.

Outcome	Frequency (n)	Percentage (%)
Significant cognitive improvement	28	77.8
Mild cognitive improvement	8	22.2
Cognitive deterioration	0	0.0
Intervention-related adverse events	0	0.0
Treatment compliance >90%	33	91.7

No participant demonstrated deterioration in cognitive function during the study period. High treatment compliance was observed in both intervention groups, and no intervention-related adverse events were reported, indicating that both Trataka meditation and Cognitive Exercises were safe and well tolerated.

Tables Summary

Table 1: Thirty-six participants were randomized equally into the two intervention groups, with an overall study completion rate of 88.9%. **Table 2:** Baseline demographic characteristics, including age, gender, BMI, and duration of hypertension, were comparable between the Trataka and Cognitive Exercise groups. **Table 3:** Educational status was similarly distributed between the two groups, minimizing the influence of educational differences on cognitive outcomes. **Table 4:** Baseline MMSE and ACE-III scores did not differ significantly between groups, confirming comparable cognitive function prior to intervention. **Table 5:** Both Trataka meditation and Cognitive Exercises produced statistically significant improvements in MMSE scores after one month, with greater improvement observed in the Cognitive Exercise group. **Table 6:** Significant improvement in ACE-III scores was observed in both groups; however, Cognitive Exercises resulted in a larger increase in overall cognitive performance. **Table 7:** Although post-intervention MMSE scores were comparable, the Cognitive Exercise group demonstrated significantly greater improvement from baseline. **Table 8:** Participants receiving Cognitive Exercises showed significantly greater improvement in ACE-III score change compared with those undergoing Trataka meditation. **Table 9:** Cognitive Exercises produced superior improvement across all ACE-III cognitive domains, particularly in memory and visuospatial function. **Table 10:** Marked cognitive improvement was significantly more frequent among participants receiving Cognitive Exercises, indicating greater overall treatment effectiveness. **Table 11:** Younger elderly participants demonstrated greater cognitive improvement than older participants, suggesting that age may influence responsiveness to non-pharmacological cognitive interventions. **Table 12:** Both interventions were safe, well tolerated, and associated with high treatment compliance. Most participants experienced significant cognitive improvement, with no deterioration or intervention-related adverse events observed during the study period.

Discussion

The present randomized clinical trial compared the

effectiveness of Trataka meditation and structured cognitive exercises on cognitive function among elderly hypertensive individuals with mild cognitive impairment [1]. Both interventions resulted in significant improvement in cognitive performance following one month of treatment. However, participants receiving structured cognitive exercises demonstrated greater improvement in MMSE and ACE-III scores compared with those practicing Trataka meditation [2]. The findings suggest that both interventions are effective non-pharmacological strategies for cognitive rehabilitation, with cognitive exercises providing comparatively superior short-term cognitive benefits [3].

Baseline demographic characteristics including age, gender, body mass index, duration of hypertension, and educational status were comparable between the two intervention groups, indicating successful randomization and minimizing the influence of potential confounding variables [4]. Similar baseline comparability has been reported in previous randomized trials evaluating non-pharmacological interventions for cognitive impairment among elderly individuals. Comparable baseline characteristics strengthen the internal validity of the study and permit reliable comparison of treatment outcomes [5].

Both intervention groups demonstrated statistically significant improvement in MMSE scores following one month of intervention. Participants undergoing Trataka meditation exhibited meaningful improvement in global cognitive performance, suggesting that regular yogic concentration practices may positively influence attention, orientation, and memory [6]. The improvement observed with Trataka may be explained by sustained visual attention, enhanced concentration, autonomic nervous system regulation, and reduction in psychological stress, all of which contribute to improved cognitive processing [7]. Previous studies have similarly reported beneficial effects of yogic meditation techniques on cognitive performance, attentional control, and executive functioning among elderly populations [8].

Participants receiving structured cognitive exercises demonstrated a significantly greater improvement in MMSE scores compared with those practicing Trataka meditation [9]. Cognitive rehabilitation exercises are specifically designed to repeatedly stimulate multiple cognitive domains including memory, attention, executive functioning, language, reasoning, and visuospatial abilities [10]. Repeated activation of these neural pathways promotes neuroplasticity, improves synaptic efficiency, and enhances functional brain connectivity, thereby producing measurable improvement in cognitive performance [11]. The present findings support the growing evidence that structured cognitive training represents an effective intervention for delaying cognitive decline among elderly individuals with mild cognitive impairment [12].

Assessment using the ACE-III further confirmed significant improvement in overall cognitive function following both interventions. ACE-III provides a comprehensive evaluation of attention, memory, verbal fluency, language, and visuospatial abilities and is considered more sensitive than MMSE for detecting subtle cognitive changes [13,14]. Although both groups demonstrated significant improvement, participants undergoing Cognitive Exercises showed a greater increase in ACE-III scores than those receiving Trataka meditation. This finding suggests that structured cognitive rehabilitation may provide broader enhancement across multiple cognitive domains than meditation alone [15,16].

Domain-wise analysis of ACE-III demonstrated that Cognitive Exercises produced significantly greater improvement in attention, memory, verbal fluency, language, and visuospatial ability. Memory and visuospatial function showed the largest treatment gains [17]. These findings are biologically plausible because structured cognitive exercises repeatedly engage multiple cortical networks responsible for learning, recall, problem solving, and visual processing. In contrast, Trataka primarily emphasizes sustained attention and concentration, which may explain its relatively modest improvement across broader cognitive domains [18-20].

The present study also demonstrated that younger elderly participants achieved greater cognitive improvement than participants of more advanced age. This observation may reflect greater residual neuroplasticity and preserved neuronal reserve among relatively younger elderly individuals [21]. Progressive neuronal degeneration, cerebrovascular changes, and cumulative effects of chronic hypertension in older participants may reduce responsiveness to cognitive rehabilitation interventions. Nevertheless, clinically meaningful improvement was observed across all age groups, supporting the usefulness of non-pharmacological cognitive interventions throughout older adulthood [22,23].

Treatment compliance was excellent in both intervention groups, with more than 90% participant adherence. No intervention-related adverse events or cognitive deterioration were observed during the study period [24]. These findings indicate that both Trataka meditation and structured Cognitive Exercises are safe, inexpensive, non-invasive, and easily implementable interventions suitable for community-based geriatric rehabilitation programmes. Their simplicity and minimal resource requirements make them particularly attractive for primary healthcare settings and resource-limited communities [25].

The clinical implications of the present study are noteworthy. Early identification of mild cognitive impairment among elderly hypertensive individuals provides an opportunity to initiate structured cognitive rehabilitation before progression to dementia. Incorporating Cognitive Exercises and yoga-based meditation techniques into routine geriatric care may enhance cognitive function, preserve independence in daily activities, improve quality of life, and potentially delay functional decline. Healthcare professionals including physiotherapists, occupational therapists, psychologists, geriatricians, and primary care physicians may integrate these interventions into multidisciplinary rehabilitation programmes.

Despite the encouraging findings, several limitations should be considered while interpreting the results. The relatively small sample size and short intervention duration may limit generalizability and preclude assessment of long-term cognitive outcomes. The study was conducted at a single

centre, and long-term follow-up was not performed to determine whether cognitive improvements were sustained over time. Future multicentric randomized controlled trials involving larger populations, longer intervention periods, neuroimaging assessments, and extended follow-up are warranted to establish the long-term effectiveness of Trataka meditation and Cognitive Exercises in preventing progression of mild cognitive impairment among elderly hypertensive individuals.

Strengths of the study

The study employed a randomized clinical trial design, minimizing selection bias and allowing an objective comparison between Trataka meditation and structured cognitive exercises.

Validated cognitive assessment tools, namely the Mini-Mental State Examination (MMSE) and Addenbrooke's Cognitive Examination-III (ACE-III), were used to comprehensively evaluate changes in cognitive function.

Baseline demographic and clinical characteristics were comparable between the intervention groups, enhancing the internal validity of the study.

Both interventions were standardized and administered under supervision, ensuring uniformity of treatment delivery.

The study assessed multiple cognitive domains, including attention, memory, language, verbal fluency, and visuospatial ability, providing a comprehensive evaluation of treatment effectiveness.

The interventions were non-pharmacological, inexpensive, safe, and easily applicable in community and primary healthcare settings.

High participant compliance and the absence of intervention-related adverse events support the feasibility and acceptability of both treatment approaches among elderly hypertensive individuals.

The study contributes important evidence regarding the comparative effectiveness of yoga-based meditation and cognitive rehabilitation for mild cognitive impairment in elderly hypertensive patients.

Limitations of the study

The study included a relatively small sample size, which may limit the statistical power and generalizability of the findings.

The intervention period was limited to one month, preventing evaluation of long-term cognitive benefits.

The study was conducted at a single centre, and therefore the findings may not be representative of the broader elderly population.

Four participants were lost to follow-up, which may have introduced minor attrition bias.

Long-term follow-up assessments were not performed to determine whether cognitive improvements were sustained after completion of the intervention.

Neuroimaging, biochemical markers, and detailed neuropsychological assessments were not included to objectively evaluate underlying neurological changes.

Daily physical activity, dietary habits, medication adherence, psychosocial factors, and other potential confounding variables were not assessed.

The study evaluated only elderly hypertensive individuals with mild cognitive impairment; therefore, the findings cannot be generalized to individuals with moderate or severe cognitive impairment.

Conclusion

Both Trataka meditation and structured Cognitive Exercises significantly improved cognitive function among elderly hypertensive individuals with mild cognitive impairment. Significant improvements were observed in MMSE and ACE-III scores following one month of intervention, indicating that both modalities are effective non-pharmacological approaches for cognitive rehabilitation.

Participants receiving Cognitive Exercises demonstrated significantly greater improvement in overall cognitive performance and individual cognitive domains compared with those practicing Trataka meditation. The findings suggest that structured cognitive rehabilitation may provide superior short-term benefits in enhancing memory, attention, language, verbal fluency, executive function, and visuospatial abilities while maintaining excellent safety and treatment compliance.

The study highlights the potential role of integrating Cognitive Exercises and Trataka meditation into routine geriatric rehabilitation programmes for elderly hypertensive individuals at risk of cognitive decline. Early screening for mild cognitive impairment, combined with timely implementation of structured non-pharmacological interventions, may help preserve cognitive function, improve quality of life, and delay progression to dementia.

Future multicentric randomized controlled trials with larger sample sizes, longer intervention periods, and extended follow-up are recommended to establish the long-term efficacy and clinical applicability of these interventions in diverse elderly populations.

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