Original Article

Effect of trataka on cognitive functions in the elderly

Shubhada Talwadkar, Aarti Jagannathan, Nagarathna Raghuram
Division of Yoga and Life Sciences, Swami Vivekananda Yoga Anusandhana Samasthana, Bengaluru, Karnataka, India

Address for correspondence: Dr. Aarti Jagannathan,
Swami Vivekananda Yoga Anusandhana Samasthana 19, Gavipuuram,
Kempegowda Nagar - 560 019, Bengaluru, Karnataka, India.
E-mail: jaganaarti@gmail.com

ABSTRACT

Background: Trataka, a type of yoga practice is considered to improve cognitive functions. The aim of this study was to test the effect of trataka on cognitive functions of the elderly.

Materials and Methods: Elderly subjects were recruited based on inclusion and exclusion criteria ($n = 60$) and randomly divided using randomized block design into two groups: Trataka and wait list control group. Trataka (a visual cleansing technique) was given for a period of 1 month (26 days). The subjects in both groups were assessed on day 1 (pre- and postintervention in trataka group and after quiet sitting in control group) and on day 30 on Digit Span Test, Six Letter Cancellation Test (SLCT), and Trail Making Test-B (TMT-B).

Results: Friedman's test and Wilcoxon signed-rank test showed that at the 2nd follow-up there was significant improvement in digit span scores ($z = -3.35$, $P < 0.01$) in the trataka group. SLCT scores ($t = 5.08$, $P < 0.01$) and TMT-B scores ($t = -4.26$, $P < 0.01$) improved immediately after the practice of trataka (when baseline compared to first follow-up). At 1 month follow-up, trataka group showed significantly better performance in the SLCT test compared to baseline ($t = -3.93$, $P < 0.01$) and TMT-B scores ($t = 7.09$, $P < 0.01$). Repeated measure analysis of variance (RM ANOVA) results also reiterated that there was significant interaction effect at the end of 1 month of trataka intervention as compared to control group on TMT-B and SLCT scores.

Conclusions: The results of this study establish that Trataka can be used as a technique to enhance cognition in the elderly.

Key words: Cognitive functions; elderly; trataka.

INTRODUCTION

In normal aging, decreased ability to retrieve information can cause memory lapses that sometimes impair the ability to perform activities of daily living.[1] These changes are largely the result of decline in frontal lobe function, which is measured as executive functions (the ability to organize, plan, and focus on a topic).[2] Age-related decline in cognitive abilities varies considerably across individuals and across cognitive domains. Various cognitive domains show different degrees of susceptibilities to aging.[3] Changes in the brain due to aging occur earliest in the prefrontal cortex (PFC).[4] The PFC is associated with memory, attention, executive functions, as well as various other complex cognitive functions.[5-7] Varied treatment options have been propagated for cognitive impairment in the elderly such as oral medications,[8] cognitive interventions,[9] diet,[10] etc., Many experts have suggested that mentally challenging activities (e.g. crossword puzzles and brain teasers) may be helpful for patients with mild cognitive impairment.[11] Physical activity (PA), aimed at improving cardiorespiratory health, has been proposed to be a good, practical, and powerful candidate to overcome cerebral and behavioral declines.[12] Yoga practices also have shown various health benefits including the ability to improve cognition and thereby preventing cognitive impairments and dementia.[13]

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Many scientific studies have proven that yoga is effective to improve various cognitive functions such as remote memory, mental balance, attention and concentration, attention span, processing speed, attention alternation ability, delayed and immediate recall, executive functions, verbal retention, and recognition tests in the healthy young subjects.[14,15] Very few studies have looked at the effect of yoga in the elderly population. For example, relaxation

response training is seen to improve reaction time on simple attention/psychomotor tasks in older adults.[16] Another cross-sectional study comparing the cognitive performance of 20 meditators (long-term practitioners of Vihangam yoga meditation) and 20 non-meditators in the geriatric age group showed that Vihangam yogis performed better on all the tests of attention except for the digit backward test.[17]

The above review depicts that the number of published literature in the last decade on effectiveness of yoga on cognitive functions of the elderly is limited. Although there are no published scientific studies, authentic traditional texts of yoga describe the benefits of trataka on a whole range of physiological and cognitive functions.[18,19] It is observed to be most effective on the ajna chakra[20] (the vortice of vital energy in the forehead) and the brain.[21] Ajna chakra is described as the "eye of knowledge", and it is said that with the activation of this chakra, the intelligence, concentration, and memory improve and the mind becomes strong and steady.[22] It is proposed that the practice of Trataka may activate this chakra,[23] and thus may improve attention, memory, and concentration.[24,25] In the above context, the aim of this study was to test the effect of trataka on cognitive functions of the elderly. Effect of trataka was studied as against wait list control group; in improving short term memory, attention, concentration, and executive functions.

MATERIALS AND METHODS

Participants were recruited from old age homes in Goa and from individuals staying in and around Ponda and Margao areas in Goa. The approval from Institutional Ethics Committee of Swami Vivekananda Yoga Anusandhana Samasthana (SVYASA) was obtained.

A total of 136 subjects were screened usinginclusion and exclusion criteria. Those who were 60-80 years of age and had minimum of fifth grade education were included in the study. Further those subjects who had (a) Any neurological disorder, (b) any psychiatric disorder, and (c) had received yoga training in last 3 months were excluded from the study. The above exclusion criteria and abnormality in hearing and vision were examined by a trained and qualified clinician. Based on this screening procedure, 75 subjects were found suitable for the study. As 15 of them declined to give consent to participate, the remaining 60 subjects were considered for the study and written informed consent was taken from them.

The sample size calculation estimated that 27 participants in each group was required to detect a clinically significant difference equivalent to an effect size of 0.75 (Cohen's d) in total memory score between the groups. A sample of 27 had 80% power to detect this difference with an alpha of 0.05 for a between-groups analysis. To account for a dropout of about 10%, a sample of 30 patients in each group was decided. Hence, it was decided to recruit a total of 60 healthy elderly sample for the study using purposive sampling. The CONSORT diagram of the flow of participants and the sociodemographic data of the participants has been provided in Figure 1 and Table 1, respectively.

A randomized block design was used in the study where subjects were divided into four blocks (two old ages homes comprising of one block each and two blocks of individual elderly participants from Ponda area of Goa), a sample of approximately 15 subjects comprised of one block. The lottery method of manual randomization was conducted due to the small number of blocks ($n = 4$). Two blocks were randomized into trataka group (intervention group) and two blocks were randomized into wait list control group.

For the intervention group, assessments were conducted on day 1 before intervention, immediately after trataka intervention on day 1, and after 1 month of trataka intervention. In the wait list control group, data was taken on day 1 before the quite sitting and after 30 min of quite sitting and at the end of 1 month. The variables used in this study were: (a) Working memory (Digit Span Forward and Backward Test[26]), (b) attention and concentration (Six Letter Cancellation Test, SLCT[27]), and (c) executive functions (Trail Making Test B, TMT-B[28]). For SLCT and TMT-B, the standard procedure for translation was used; translated and back translated from Roman to Devnagiri to Roman. The tests were translated into Devnagiri for the ease of application of the tests to the local population in Goa. The Digit Span (DS) is a subtest in Wechsler Adult Intelligence Scale-third edition (WAIS-III)[29] and has been standardized for use in an Indian population. The SLCT which measures cognitive functions such as selective and focused attention, concentration, visual scanning as well as activation and inhibition of rapid responses has been employed to assess cognitive impairments in alcoholic

Table 1: Socio-demographic details of the subjects (n=55)

Variable	Mean (SD)/n (%)		t value/ chi-square	P value
	Trataka (n=31)	Control (n=24)		
Age (years)	67.7 (7.4)	71.2 (6.6)	−1.83	0.07
Educational status (years)	11.8 (3.6)	11.6 (3.8)	0.15	0.88
Gender				
Male	8 (25.8)	9 (37.5)	0.87	0.35
Female	23 (74.2)	15 (62.5)		

SD = Standard deviation

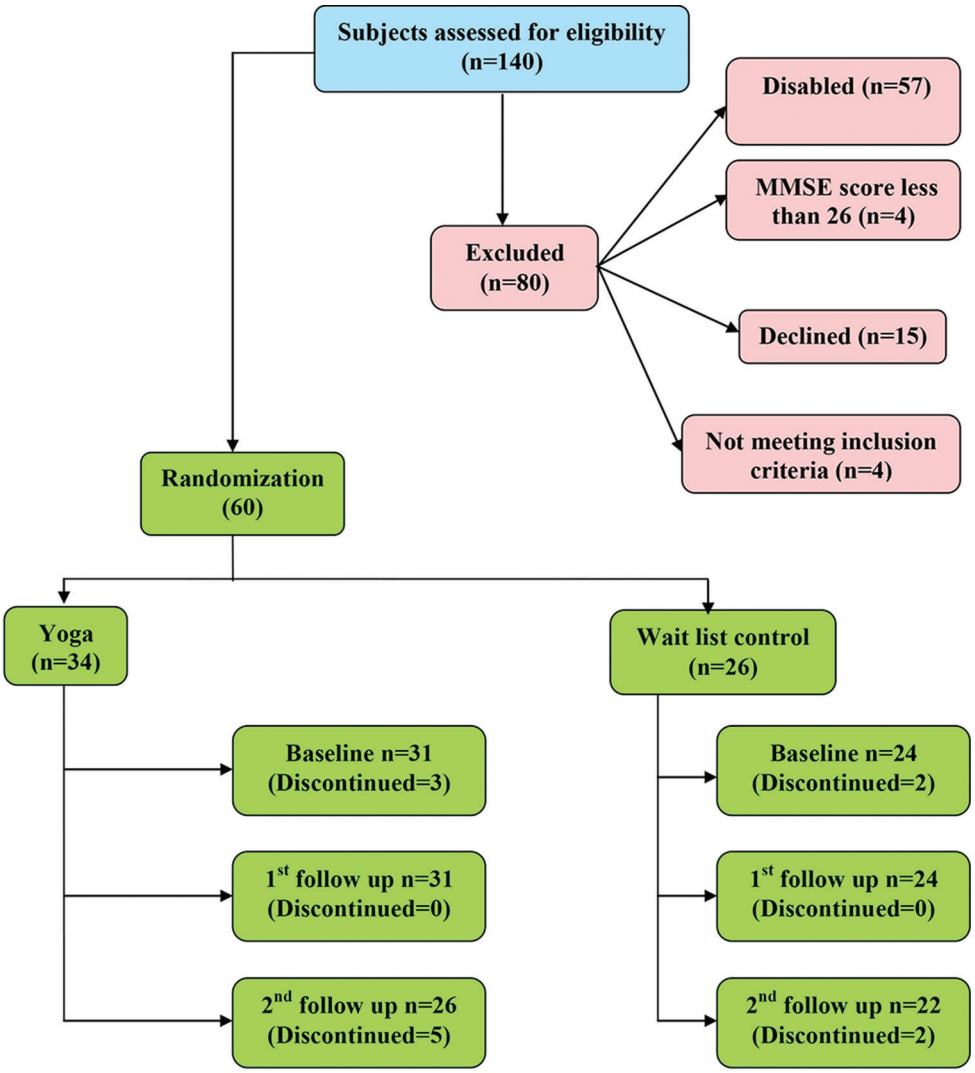

Figure 1: The CONSORT (consolidated standards of reporting trials, Altman *et al.*, 2001) diagram of flow of participants through each stage of the randomized trial

cirrhotic patients,[30] and to evaluate target detection deficits in patients who have undergone frontal lobectomy surgery.[31] This test has also been evaluated for its reliability and validity based on standard criteria and has standard norms for the Indian population. TMT-B is one of the most popular neuropsychological tests and is included in most test batteries, is a measure of visual scanning, complex attention, psychomotor speed mental flexibility, and executive functions. The TMT is sensitive to a variety of neurological impairments.[32,33] Adequate test-retest reliability has been found for both Part A and Part B of the TMT in the healthy control group ($r = 0.46$ and 0.44, respectively), as calculated using Pearson's correlation coefficients.[34]

The intervention of trataka included set of procedures including eye exercises and gazing at the candle flame with focused attention followed by defocussing. Breathing and chanting were also included in the practice that promotes internal awareness and focusing on the activity followed by defocusing. Each session was of 30 min duration [Table 2]. Classes were conducted on everyday basis, except for Sundays and attendance was also recorded. Data of only those participants who had completed a minimum of 75% and above class attendance was analyzed.

The data at baseline was assessed for normality using Shapiro-Wilk test. As the data was found to be normal for TMT-B (trataka, statistics = 0.931, $P = 0.05$; control, statistics = 0.929, $P = 0.09$) and SLCT (trataka = 0.957, $P = 0.24$; control statistics = 0.946, $P = 0.22$) parametric tests such as paired sample *t*-tests, independent sample *t*-test, and Repeated measure analysis of variance (RM ANOVA) were used to analyze the data. In case of the Digit Span Test, the data was not found to be normally distributed (trataka statistics = 0.845, $P = 0.00$; control statistics = 0.931, $P = 0.72$). There were no outliers in the data; however the data had distinct two peaks at the higher and lower range of scores. If we had divided the

digit span scores using the median values into two groups, we could have possibly got two independent normal distributions. However, as we did not have any rationale for dividing the group based on the median values, nonparametric tests such as Mann-Whitney, Wilcoxon signed rank test, and Friedman's test were used to analyze the Digit Span Test scores. Bonferroni adjustment was conducted as there were multiple comparisons to analyze the time effect.

RESULTS

Out of the 60 subjects, 55 subjects completed the first follow-up on day 1 (postintervention). However, only 48 subjects completed the second follow-up, which was conducted at the end of 1 month (trataka group $n = 26$, wait list control $n = 22$).

There were no group differences at baseline in all three outcome variables. Both the groups were comparable at baseline, on all outcome variables. On Mann-Whitney tests, there was no significant difference between trataka and wait list control group in Digit Span Test scores at the first follow-up. When compared to wait list control group at the second follow-up a possible trend towards significance could be observed in the trataka group. When compared within group (Friedman's test and Wilcoxon signed rank test), digit span scores improved at the first follow-up in trataka group, but the difference was not significant. At the second follow-up, there was significant improvement in digit span scores ($z = -3.35$, $P < 0.01$). While in control group, scores decreased at the first and the second follow-up, but there were no any significant changes [Figure 2].

Table 2: Details of trataka practice

Name of the practice	Duration
Starting prayer	1 min
Preparatory eye exercises	9 mins
Up and down or vertical movements-10 rounds	30 secs
Simple palming	1 min
Right and left or horizontal movements-10 rounds	30 secs
Simple palming	1 min
Diagonal movements-right up-left down-10 rounds	30 secs
Press and release palming	1 min
Diagonal movements-left up-right down-10 rounds	30 secs
Press and release palming	1 min
Rotational movements-clockwise-10 rounds	30 secs
Constant pressure palming	1 min
Rotational movements-anticlockwise-10 rounds	30 secs
Constant pressure palming	1 min
Jyoti trataka	
Effortless gazing or focusing	4 mins
'A'kara chanting	1 min
Intensive focusing	4 mins
'U'kara chanting	1 min
Break	1 min
De-focussing	4 mins
Bhramari	1 min
Silence	4 mins
Closing prayer	1 min

When compared between groups (independent sample *t*-test), there was no significant difference between the trataka and wait list control group at first and second follow-up in SLCT scores. However, with respect to time effect (paired sample *t*-test), selective as well as sustained attention and concentration (measured using SLCT scores) was seen to improve immediately after the practice of trataka (when baseline compared to first follow-up) ($t = 5.08$, $P < 0.01$). Wait list control group also performed better (may be because of retest effect), but the improvement was not significant. At 1 month follow-up, trataka group showed significantly better performance in the SLCT test compared to baseline ($t = -3.93$, $P < 0.01$). Whereas, scores of wait list control group came back to the baseline scores at the second follow-up.

On the independent sample *t*-test, at the first follow-up, there was no significant difference in TMT-B scores between trataka and wait list control group. However at the second follow-up, there was a trend towards significance. Trataka group performed significantly better at the first follow-up (paired sample *t*-test) ($t = -4.26$, $P < 0.01$) in TMT B test (indicative of executive functions). In contrast, in the wait list control group there was increase in time taken to complete the task (suggestive of poor performance) and the change was not significant. At the second follow-up, only trataka group showed significantly improved (statistics = 7.09, $P = 0.00$) performance when compared to the baseline scores.

The traditional analysis that is used to detect treatment outcomes in randomized longitudinal clinical trials was used; RM ANOVA. RM ANOVA results showed that the executive functions in both the groups improved over time (occasion effect). Though there was no significant group effect, trataka group showed significant improvement in TMT-B scores over a month period of the study as compared to the wait list control group ($f = 6.67$, $P < 0.01$; interaction effect) [Table 3].

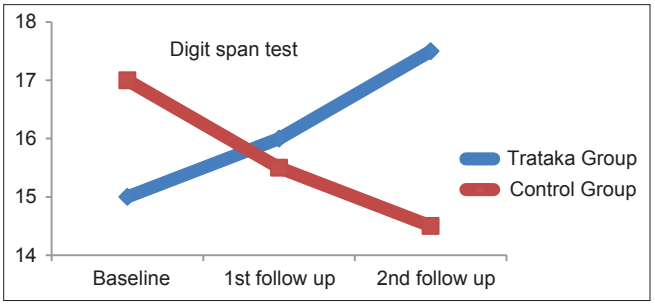

Figure 2: Changes in median digit span scores across timeline in trataka and wait list control group (Friedman's test)

Table 3: RMANOVA for TMT-B and SLCT scores

Variable	Mean (SD)			F	*P* value
	Baseline	1st follow up	2nd follow up		
TMT B					
Trataka	170.58 (92.43)	151.45 (88.0)	111.27 (71.63)	6.67	0.003
Control	187.96 (79.77)	191.70 (91.98)	151.76 (80.67)		
SLCT					
Trataka	23.88 (10.07)	31.48 (14.68)	31.04 (13.31)	3.11	0.05
Control	24.96 (12.71)	29.33 (14.61)	26.23 (13.53)		

TMT-B = Trail making test-B; SLCT = Six letter cancellation test; SD = Standard deviation

With respect to SLCT scores, there was a trend towards better improvement ($f = 3.11$, $P = 0.05$) in trataka group as compared to the wait list control group over the 1 month period of the study (interaction effect) [Table 3].

For the convenience of conducting intervention, half of the subjects in the trataka group were provided the intervention in the morning and the remaining half were provided the intervention in the evening. Baseline analysis showed that there were significant differences in TMT-B and SLCT scores between the morning group and the evening group, with scores higher in the evening group than morning group. Hence, post hoc test was conducted to check if there was any significant interaction effect (group X time) after controlling for baseline scores using analysis of covariance (ANCOVA). Results show that there was no significant difference between groups (people who practiced in the morning as compared to people who practiced in the evening) over the study period after controlling for baseline differences.

DISCUSSION

In this study on elderly subjects, trataka intervention improved cognitive functions (short-term memory and working memory, selective and focused attention, concentration, visual scanning as well as activation and inhibition of rapid responses and executive functions) when compared to wait list control group at the end of 1 month. Trataka practice involves various steps like preparatory eye exercises, focusing, defocusing, chanting, and silence during relaxation. Each component or all of them together could have been responsible for the improvement in the cognitive functions. Preparatory eye exercises improve the stamina of the eye muscles and avoid eye strain. The degree of optical illusion is observed to reduce post a set of yoga practices that includes trataka (involving both focusing and defocusing of the gaze and attention).[35] *Dharana* or focusing improves concentrative attention ("*desha-bandhashchittasya dharanam*"; Patanjali's Yoga Sutras, Chapter III, Verse 1).[36] Focused attention (FA) is the attention which is restricted to a specific focus[37] such as the breath or the candle flame (trataka). Receptive attention is a kind of attention which is "objectless" and the goal is simply to keep attention fully "readied" in the present moment of experience without orienting, directing, or limiting it in any way. Research studies have shown that intense FA meditation effects cortical engagement, as reflected by a concomitant reduction in event related desynchronization (ERD) to target tones in the beta (13-30 Hz) frequency band. Reductions in beta ERD after practice of external tasks is due to the decreased cognitive efforts.[38] There is enhanced processing of task-related auditory inputs during FA meditation. FA meditation training is thought to improve one's ability to remain vigilant and monitor distractors without losing focus. It is proposed that these mental training-related effects might be produced by a reduction in cortical noise and/or by an enhancement of the rhythmic mode of attention.

The second stage of trataka, the phase of defocussing is akin to the stage of *dhyana* effortless attention ("*tatra pratyayaikatanata dhyanam*"; Patanjali's Yoga Sutras, Chapter III, Verse 2).[39] When *dharana* becomes effortless, it takes the form of *dhyana*, which is defined as the uninterrupted spontaneous flow of the mind toward the chosen object. Vigilance and attention are not required during *dhyana*, which is the actual phase of meditation.[40] Though there are different forms of meditation all of them lead to calm yet alert mind.[41] At a more advanced level of training in FA meditation which could be considered a state of *dhyana*, the regulative attention skills are invoked less frequently, and the ability to sustain focus thus becomes progressively "effortless".[38] *Dhyana* is associated with reduced sympathetic activity and increased vagal tone.[42] The defocussed phase of trataka could be similar to the benefits of dhyana phase of meditation. Multiple studies show that meditation may affect multiple pathways that could play a role in brain aging and mental fitness.[13] For example, meditation may reduce stress-induced cortisol secretion and this could have neuroprotective effects potentially via elevating levels of brain derived neurotrophic factor (BDNF). Meditation processes are linked to gamma-aminobutyric acid (GABA) ergic cortical inhibition, a mechanism implicated in improved cognitive performance and enhanced emotional regulation.[43] Further, meditation may potentially strengthen neuronal circuits and enhance cognitive reserve capacity. Brain regions associated with attention, interception, and sensory processing are thicker in meditation practitioners including the PFC and right anterior insula.[44] Advanced meditators have higher melatonin levels (that blocks the build-up of beta-amyloid plaque, a hallmark feature of Alzheimer's disease)[45] than nonmeditators.[46]

The results suggest that long-term practice of trataka and not just 1 day practice is required to improve short-term

memory. Similar study done on elderly subjects showed that, at the 3 month follow-up, yoga group improved in semantic memory, short-term primary memory, and short-term working memory.[47] So, the result of our study is consistent with the results of earlier study. The only difference is that our study period was only of 1 month; still we could show significant improvement in the trataka group. Thus, we can make a statement from our results that first time yoga participants, if provided with 1 month trataka intervention, can improve their executive, memory, and cognitive functioning. This claim however needs to be tested in larger samples.

In a study done on the healthy aging adults, it was seen that performance on a simple attention task improved after 5-week relaxation response training program; whereas, no improvement was seen in complex tasks of attention.[16] In another study, net scores on the six-letter cancellation task were significantly higher after a session of *Dharana*.[48] These results are in consistence with our results, as we also observed increased SLCT scores immediately after Trataka practice. Since Trataka is a type of *dharana* practice that involves focused attention on a specified object, this further strengthens that the results are valid and obtained correctly.

There could be various other possible reasons for finding differences over the 1 month period. The group was at a stage when cognitive decline was a reality. All the aging individuals (after the age of 60 years) develop some degree of decline in cognitive capacity as time progresses. Studies show that 16.8% of aged people have some form of cognitive decline without the symptoms of dementia.[49] If the study was done on healthy young subjects, then we might not have got the significant difference, because of 'ceiling effect'.

Another reason for the significant result could be that majority of the participants of the study had never been exposed to trataka or any yoga intervention earlier. A few of the participants, who had earlier learnt yoga, had either discontinued or had not practiced it for the past 3 months. In such a case, we believe that the effect of trataka was pronounced as there was no previous or past effect of any similar intervention.

The fact that we got significant results to show that trataka practice for 1 month is effective in improving cognitive functions shows that the scales used in this study were sensitive enough to tap the cognitive improvement in the elderly after the trataka intervention. Three tests used in this study were Digit Span Test, TMT-B, and SLCT. Though not developed specifically to test the effect of trataka, these widely used tests have shown that they can tap significant changes post yoga intervention.

Studies have time and again discussed the importance of the prolonged practice of yoga.[50-52] We assessed the cognitive functions immediately after one session of trataka and after 1 month of continuous daily practice. The results pronounced that there was no significant difference between groups at the end of one session (first follow-up); however, significant group and time differences including interaction effects were observed at the end of 1 month of intervention. Hence, we believe that our study results validate earlier quoted studies which advocate prolonged duration (number of days) of practice of yoga/trataka for desirable effects.

The design of the study, that is, randomized block design (RBD) was the main strength of the study. RBD eliminates any bias in treatment assignment, specifically selection bias and confounding. It maximizes statistical power, especially in subgroup analyses. Another strength of the study was that the intervention was provided to the sample that needed the intervention, aging individuals (after the age of 60), as they often develop some degree of decline in cognitive capacity.

In spite of its strong methodology, the results of the study need to be understood in the context that the sampling was done only in two old age homes in Goa. Further the sample size was small. The total sample size was 60 based on earlier sample size calculations and post attrition, the sample size for analysis was reduced to 48. The results of the current study showed that there was a trend towards significance in the trataka group in the between group analysis (group effect) for some outcome variables. In this context, a larger sample size could have depicted significant differences between groups. Also, only three outcome variables were used in the study. Age-related cognitive decline can be seen in different cognitive domains (e.g. speed of processing, spatial ability, reasoning, etc.) and varies individually. Further studies can be conducted to test the effect of trataka on different neurological test batteries.

CONCLUSION

The results of this study establish that trataka can be used as a technique to enhance cognition in the elderly. The trataka intervention is easy to learn, implement, and adhere. Further trataka, after the initial few sessions, can be practiced independently by the participant to achieve desired results. For researchers, this study could provide a substantial base for conducting future trials to test the efficacy of trataka in controlled experiments.

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