Emotional and Cognitive Improvement with Kirtan Kriya Meditation: A Pilot Study for Mild Cognitive Impairment Patients in a Catalan community.

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Running head: Emotional and cognitive improvement with KKM for MCI

ABSTRACT

Objective: To study the effects of Kirtan Kriya Meditation (KKM) and 8-week yoga program on emotional and cognitive status, in MCI patients from our population, while undergoing cognitive training program (CTP).

Design: We recruited 21 MCI adults GDS 3, for an open label non-randomized controlled study, but only 15 followed up. None had previous experience of meditation or yoga. Evaluation before and after the 8-week program was done by validated standard MCI tests. Seven patients practiced KKM for 12 minutes every day, weekly yoga session, and the standard cognitive training program while 8 patients only followed the cognitive training program (CTP).

Results: The baseline negative mood and cognitive parameters became normal after the 8-week intervention program for the KKM group, decreasing tension, hostility, confusion and total PEA mood values ($p < 0.05$). Depression and anxiety levels were also reduced to normal Goldberg score values. Similarly, the FCRST memory test showed higher memory scores for total free recall memory and TMT Trail-A test, moving to a normal range.

Conclusions: The KKM group improved their psycho-emotional and cognitive health compared to CTP group. The yoga class elevated the perception of wellbeing. Further randomized studies are needed with a larger sample of MCI-diagnosed adults.

KEYWORDS:

Mild cognitive impairment; Meditation; Mind Body Medicine; Kundalini Yoga; Kirtan Kriya; Mood.

Introduction

Mild cognitive impairment (MCI or incipient dementia) is characterized by a slight and short-term memory loss, between that associated with normal aging and mild dementia [1]. The MCI diagnostic criteria are the following: memory complaints preferably corroborated by a third person, impaired memory function beyond that expected by age and education, preserved general cognitive function, daily living activities are intact and with no symptoms of dementia. Petersen described that 10-15% of MCI patients develop AD each year in the United States, compared to 1-2% from the general population of the same age [2]. Lifestyle factors have a very important role for aging population, as shown by the Finnish FINGER study, which recommended improving or maintaining the mental stimulation, healthy diet, exercise, socialization and cardiovascular prevention for at-risk of cognitive impairment or older people in general [3-5]. Moreover in basic research, neonatal handling stimulation of the Alzheimer's

disease mice model showed cognitive and emotional improvement as well as delays in AD development [6].

Early cognitive stimulation is included in brain programs because non-pharmacological interventions and/or medical treatments have demonstrated a delay of MCI onset [7] or activation of brain metabolism in MCI subjects [8]. Emotional traits like irritability, anger, tension, sadness, anxiety, hostility, self-consciousness and depression are associated with MCI, as well as with neuroticism.

Also negative emotional response to threat, frustration, or loss may predict the quality of life and longevity [9]. Chronic stress and cortisol levels through the Hypothalamic-Pituitary-Adrenal (HPA) axis are related to memory, emotional and cognitive impairment and may contribute to AD [4,10].

Meditation is known to balance the HPA-axis response to stress [4], and to improve cognitive function [11,12]. A 6-month Kundalini Yoga study improved the sleeping patterns of 60% of depressive patients, decreased digestive system irritation and improved well-being and social perception [13]. Therapeutic value of yoga and meditation has also been demonstrated for different neurological disorders because of the neuropsychological health improvement, quality of life, well-being, cognitive function and memory [11,14-16], the decrease of negative mood, anxiety and stress [17,18], the reduction of inflammatory response, recovering of gene expression and enzyme activity [14,19] as well as the enhanced neuroplasticity [20].

Certain activated brain areas are connected to emotions and cognitive functions like attention, learning and memory [15,21,22], as well as to hormones and neurotransmitters for improving mood and reducing anxiety and depression [14,17,23-24]. Neuroimaging studies have showed significant cerebral blood flow changes after meditation in different areas of the brain

connected to attention, emotional and cognitive status, and perception of well-being [11,15,18,22,25-28]. Many of these regions are affected in cognitive and mood disorders and Alzheimer's or Parkinson's diseases [5,11].

Various studies on different populations have looked at the effectiveness of Kirtan Kriya meditation (KKM) and yoga on preventing cognitive impairment and improving memory function and emotional status [14,17,23-24,26,29]. We have designed this pilot study for MCI patients from our communities in order to evaluate the compliance and effects of an intervention combining cognitive stimulation and daily KKM and weekly yoga sessions on mood and cognition in comparison to a baseline cognitive stimulation program.

Materials and methods

Subjects:

Twenty one MCI patients from the AVAN Foundation diagnosed with a score of 3 on the Global Deterioration Scale [30] (GDS) and who lived in Terrassa, Sabadell and Sant Cugat (near Barcelona, Catalonia, Spain) were invited for the presentation, done by the two first authors, on how meditation affected the brain based on the previous Dr Dharma's publications [11,14-15,17,22,31]. Afterwards we did the baseline interviews, and each of the 21 patients (15 women and 6 men) made the decision to participate in their standard cognitive training program with a program of meditation and yoga (KKM study group) or to just follow their standard cognitive training program (CTP group). The CTP group was design as control group. All participants filled consent form procedures prior to enrolling in the study. None of the subjects had prior experience with meditation or yoga. Six patients did not follow all the appointments and were excluded from the study analysis.

Kirtan Kriya meditation (KKM) and yoga program for 8 weeks:

Each session included weekly 90-minute seated yoga classes by a certified Kundalini Yoga teacher as taught by Yogi Bhajan®. Every session was conducted by the same instructor and followed the following structure: (1) tuning in (5 minutes); (2) long, deep and slow abdominal breathing “Pranayama”, focusing on the process (10 minutes); (3) specific Kriya for balancing the pineal gland [31], sitting in a chair moving the arms and hands connected with the breathing and meditation (20 minutes); (4) KKM (12 minutes); (5) relaxation in the chair (10 minutes) with spaces in between and finally closing the session.

KKM involves sound, movement and mind focus by the repetition of four mantra syllables with a specific mudra (finger movement) for a total time of 12 minutes: the person vocalizes these sounds while the thumb sequentially touches the index finger (SAA), middle finger (TAA), ring finger (NAA) and little finger (MAA); singing in a normal voice for 2 minutes, whispering for 2 minutes, and reciting silently for 4 minutes, then again whispering for 2 minutes, and singing out loud for the final 2 minutes. After the first training session, the subjects received our recorded CD with a guided KKM so they could practice at home for 12 minutes every day and registered each home session on the practice log. In addition, the number of attended weekly sessions was monitored for each participant by the authors.

Measures:

The two groups were assessed before and after the 8-week period by the following neuropsychologist tests: the Goldberg Anxiety Scale [33] for anxiety and depression symptoms; and the PEA “Perfil de Estados de Ánimo” test, a validated Spanish version of POMS (Profile of Mood States). We assessed the Neurocognitive screening using the MMSE “Mini Mental State

Examination”[32]; FCRST “Free and Cued Selective Reminding Test”[34] to evaluate free, facilitated and deferred word memory; TBA dir/inv “Direct/Inverse digits number” Barcelona test [35] for working memory; TMT “Trail Making Test”[36] to evaluate sustained (Trail-A) and alternating (Trail-B) attention; and ES/EL “Semantic (ES) and Lexic (EL) Evocation”, the semantic and phonetic fluency Barcelona subtest [35,37]. Self-perception of wellbeing was assessed on a visual analogic scale (0-10) before and after each yoga class.

Data analysis:

Statistical analyses were performed using SPSS 17.0 software, for description and non-parametric Mann-Whitney U-test, 2 independent samples between groups, and 2 related samples to compare baseline status and post-intervention results for each group (within-subject). The cutoff value for the MMSE is >24. We applied the Neurocog platform, corrected for age and schooling, to evaluate the FCSRT, TBA, TMT, ES/EL ; the scalar scores are: >7: normal score, 7: limit score, 6: deficit, 5: affectation, 4: important involvement, 3-2: very severe disease or deficient performance. The PEA values were analyzed by direct punctuation. The anxiety Goldberg cut-off is ≥ 4 (range =0-9), for depression ≥ 2 (range =0-9), and for total Goldberg test ≥ 6 (range =0-18), among geriatric populations. The percentage of change between post-intervention and baseline (Pre) values was calculated by $\%Change = (Post - Pre)/(Pre) \times 100$.

Results

Fifteen participants entered and completed the tests, 10 women and 5 men, 54 to 85 years old, 72.8 ± 7.8 ($X \pm SD$). Their MMSE ranged from 17 to 28 (≥ 24), 24.4 ± 3.4 . Seven participants (5 women and 2 men) constituted the study group (KKM, yoga session and cognitive training

program) with ages from 54 to 80, 70.3 ± 8.9 , and their schooling literacy was 8.1 ± 3.1 years. The CTP group (only cognitive training program) included 8 participants (5 women and 3 men) with an age range of 66 to 85, 75.1 ± 6.4 years with a schooling literacy of 7.38 ± 6.4 years (see Table 1).

Table 1. Demographic characteristics at baseline for KKM and CTP group. Mean with standard deviation ($\pm$ SD) for the continuous and N (%) for the categorical variables.

Variable	KKM group	Control group	Total sample
<i>Participants</i>	7 (46.7%)	8 (53.3%)	15 (100%)
<i>Age (in years)</i>	70.3 ± 8.9	75.1 ± 6.4	72.8 ± 7.8
Gender			
<i>Male</i>	2 (28.6%)	3 (37.5%)	5 (33.3%)
<i>Female</i>	5 (71.4%)	5 (62.5%)	10 (66.7%)
<i>Education (literacy in years)</i>	8.1 ± 3.1	7.4 ± 2.2	7.7 ± 2.6
Profession			
<i>Manual labor</i>	3 (42.9%)	3 (3.7%)	6 (40%)
<i>Verbal labor</i>	4 (57.1%)	5 (62.5%)	9 (60%)
Cognition			
Mini-Mental (MM) score	25.4 ± 3.4	23.6 ± 3.5	24.4 ± 3.4
MM_PE (scale values)	7 ± 2.6	6.1 ± 3.2	6.5 ± 2.8

No differences between groups

Baseline status KKM group and CTP group

The MMSE values indicated a slight difference between both groups, showing the CTP group a near pathologic level, 23.6 ± 3.5 , meanwhile the KKM reach 25.4 ± 3.4 ($p=0.23$) and the literacy levels (7.38 ± 6.4 vs 8.1 ± 3.1 years, $p=0.46$) (see Table 1).

The KKM group expressed significantly higher PEA emotional categories: total 281.6 ± 34.3 vs 132.4 ± 53.3 $p<0.001$, tension $p<0.01$; depression $p<0.001$; hostility $p<0.001$; fatigue $p<0.01$, and a tendency to feel confused, $p=0.07$; the vigor perception was lower for KKM group $p=0.33$

NS, than for the CTP group. The total Goldberg test as well as anxiety and depression showed worse emotional state for the KKM group compared to the CTP group. The KKM group had significantly higher values in the memory FCRST tests: total recall $p<0.01$, delayed free recall $p<0.01$, delayed total recall $p<0.05$ and a tendency to have higher total free recall memory. Significant higher working memory was detected by the inverse digits Barcelona sub-tests TBA-inv, $p<0.05$, compared to CTP group; and only a tendency to alternated attention measured by TMT Trail-B test, $p<0.08$ (see Table 2,3).

Then we observed that the neuropsychological and neurocognitive levels were very different for both groups, for this reason we decided to analyze them separately.

CTP group baseline and post intervention

MMSE showed no differences (23.6 ± 3.5 to 23.1 ± 3.3 , $p=0.99$) before and after the 8-weeks of standard cognitive training program, as well as for the neuropsychological values. Only the PEA test had a tendency to meliorate for confusion (27.0 ± 7.4 vs. 20.0 ± 10.9 , $p=0.06$). After the weekly cognitive training program, the patients only improved significantly their delayed total recall memory level (4.3 ± 2.1 vs. 6.2 ± 3.2 , $p<0.05$), and the free memory value (6.4 ± 2.8 vs. 7.3 ± 2.5) was normalized (≥ 7), measured by FCRST test (see Table 2).

Table 2. Neuropsychological and Neurocognitive test score means and standard deviations ($\pm$ SD) in CTP group. Normal value ≥ 7 in FCRST, TBA, TMT and Fluency tests. ($P = p$ -values)

Test	Baseline	Post intervention	P	% Change
PEA				
Tension	22.6 $\pm$ 11.9	19.2 $\pm$ 11.9	0.75	- 15.1 %
Depression	18.8 $\pm$ 17.9	12.0 $\pm$ 15.4	0.60	- 36.1%
Hostility	17.3 $\pm$ 16.6	12.1 $\pm$ 14.0	0.22	- 29.6%
Fatigue	11.0 $\pm$ 9.3	7.0 $\pm$ 6.5	0.27	- 36.3%
Confusion	27.0 $\pm$ 7.4	20.0 $\pm$ 10.9	0.06	- 25.9%
Vigor	44.4 $\pm$ 13.9	42.8 $\pm$ 12.6	0.59	- 33.8%
Total score PEA	132.4 $\pm$ 53.3	107.5 $\pm$ 45.5	0.39	- 18.7%
GOLDBERG				
Anxiety (≥ 4)	3.3 $\pm$ 2.3	3.2 $\pm$ 3.1	0.70	- 5.3%
Depression (≥ 2)	1.8 $\pm$ 2.2	1.6 $\pm$ 1.8	0.68	- 11.1%
T Goldberg (≥ 6)	5.2 $\pm$ 4.4	4.8 $\pm$ 4.8	0.42	- 7.7%
Cognition				
MMSE	23.6 $\pm$ 3.5	23.1 $\pm$ 3.3	0.99	- 2.1%
FCRST				
Free memory (E1)	6.4 $\pm$ 2.8	7.3 $\pm$ 2.5	0.19	+ 15.8%
T_Free Rec	4.1 $\pm$ 1.8	4.2 $\pm$ 1.7	0.31	+ 2.4%
T_Recall	2.3 $\pm$ 0.5	3.0 $\pm$ 1.7	0.10	+ 36.6%
Del_Free Rec	3.7 $\pm$ 1.9	4.8 $\pm$ 2.9	0.28	+ 29.7%
Del_Total Rec	4.3 $\pm$ 2.1	6.2 $\pm$ 3.2	0.04*	+ 47.6 %
TBA				
Direct digits	12.5 $\pm$ 2.2	12.6 $\pm$ 3.2	0.70	+ 0.8%
Invers digits	8.6 $\pm$ 2.3	10.1 $\pm$ 1.5	0.13	+ 17.4%
TMT				
Trail A	6.7 $\pm$ 2.1	6.5 $\pm$ 3.1	0.68	- 2.9%
Trail B	3.8 $\pm$ 1.8	4.4 $\pm$ 2.0	0.25	+ 15.7%
Fluency				
ES	5.2 $\pm$ 3.5	5.0 $\pm$ 2.6	0.89	- 3.8%
EL	8.3 $\pm$ 2.6	8.7 $\pm$ 1.9	0.88	+ 4.8%

Neuropsychological test: PEA= Perfil de Estados de Animo, spanish version of POMS= Profile of Mood States; T Goldberg= Total Goldberg. **Neurocognitive test:** MMSE= Mini Mental State Examination; FCRST= Free and Cue Selective Reminding Test; T Free Rec= Total free recall; T Recall= Total recall; Del Free Rec= Delayed free recall; Del Total Rec= Delayed total recall, TBA= Barcelona Test; TMT= Trail Making Test; ES= Semantic Evocation (Number of animals named in 60 seconds); EL = Lexic Evocation (Number of words started by P named in 60 seconds).

KKM group baseline and post intervention

Compliance was very good overall; the participants completed an average of 51 $\pm$ 10.24 meditation days (from a total of 56 days) and 7.29 $\pm$ 1.11 yoga session attendance (from 8

sessions in total). The well-being perception after yoga class significantly increased for all participants, rising from 6.3 ± 0.9 to 8.8 ± 0.9 , $p < 0.05$ (scale from 0 to 10).

Table 3. Neuropsychological and Neurocognitive test score means and standard deviations ($\pm$ SD) in KKM group. Normal value ≥ 7 in FCRST, TBA, TMT and Fluency tests. ($P = p$ -values)

Test	Baseline	Post intervention	P	% Change
PEA				
Tension	43.2 ± 9.1	25.2 ± 19.4	<i>0.04*</i>	- 41.6%
Depression	68.9 ± 20.8	33.4 ± 29.3	<i>0.06</i>	- 51.4%
Hostility	54.4 ± 9.8	26.0 ± 25.6	<i>0.05*</i>	- 52.2%
Fatigue	32.3 ± 14.4	19.2 ± 14.4	<i>0.06</i>	- 40.3%
Confusion	37.6 ± 10.4	23.7 ± 8.4	<i>0.03*</i>	- 36.8%
Vigor	35.0 ± 16.2	41.1 ± 8.4	<i>0.27</i>	+ 17.4%
Total score PEA	281.6 ± 34.3	166.5 ± 92.8	<i>0.02*</i>	- 40.8%
GOLDBERG				
Anxiety (≥ 4)	5.7 ± 1.9	3.0 ± 2.8	<i>0.08</i>	- 47.3%
Depression (≥ 2)	3.0 ± 2.9	2.0 ± 2.6	<i>0.27</i>	- 33.3%
T Goldberg (≥ 6)	8.7 ± 3.9	5.0 ± 5.2	<i>0.08</i>	- 42.5%
Cognition				
MMSE	25.4 ± 3.4	25.2 ± 3.5	<i>0.73</i>	- 0.7%
FCRST				
Free memory (E1)	7.4 ± 3.9	7.8 ± 3.5	<i>0.85</i>	+ 5.4%
T_Free Rec	6.8 ± 3.1	7.3 ± 3.1	<i>0.85</i>	+ 7.3%
T_Recall	5.6 ± 2.9	5.4 ± 2.6	<i>0.65</i>	- 1.8%
Del_Free Rec	9.0 ± 3.7	8.6 ± 3.2	<i>0.25</i>	- 5.5%
Del_Total Rec	9.7 ± 5.3	9.2 ± 3.9	<i>0.49</i>	- 6.1%
TBA				
Direct digits	10.4 ± 4.0	11.4 ± 4.0	<i>0.46</i>	+ 9.6%
Invers digits	11.4 ± 2.6	9.7 ± 1.4	<i>0.04*</i>	- 14.9%
TMT				
Trail A	6.8 ± 2.9	7.5 ± 2.8	<i>0.35</i>	+ 10.2%
Trail B	6.3 ± 2.6	6.3 ± 2.1	<i>0.89</i>	+ 0.0%
Fluency				
ES	6.1 ± 0.7	6.5 ± 1.5	<i>0.41</i>	+ 6.5%
EL	9.0 ± 2.5	8.2 ± 2.4	<i>0.13</i>	- 8.8%

Neuropsychological test: PEA= Perfil de Estados de Animo, spanish version of POMS= Profile of Mood States; T Goldberg= Total Goldberg. **Neurocognitive test:** MMSE= Mini Mental State Examination; FCRST= Free and Cue Selective Reminding Test; T Free Rec= Total free recall; T Recall= Total recall; Del Free Rec= Delayed free recall; Del Total Rec= Delayed total recall, TBA= Barcelona Test; TMT= Trail Making Test; ES= Semantic Evocation (Number of animals named in 60 seconds); EL = Lexic Evocation (Number of words started by P named in 60 seconds).

After the 8 weeks program, MMSE values did not become significant, 25.4 ± 3.4 vs. 25.2 ± 3.5 , $p = 0.73$. The PEA test was significantly improved in 4 items: reduction of tension (43.2 ± 9.1 vs.

25.2±19.4), hostility (54.4±9.8 vs. 26.0±25.6), confusion (37.6±10.4 vs. 23.7±8.4) and the total PEA value (281.6±34.3 vs. 166.5±92.8, $p<0.05$), with a range of change reduction percentage between 36% and 52%. Fatigue, anxiety, depression and total Goldberg scores were reduced between 33% and 47%, without reaching statistical significance (see Table 3).

After the intervention, the total free recall memory from FCRST test showed a tendency to improve (6.8±3.1 vs. 7.3±3.1), moving to the normal value (≥ 7); while a decreased level was observed for the TBA-inverse digit test (11.4±2.6 vs. 9.7±1.4, $p<0.05$). The sustained attention measured by TMT Trail-A test (6.8±2.9 vs. 7.5±2.8) was improved to normal score (≥ 7), with a change reduction percentage to 10.2% (see Table 3).

Discussion

Our mind body program integrated cognitive stimulation program with daily KKM and weekly pineal gland yoga sessions for MCI patients. These subjects showed baseline values for anxiety, depression and total Goldberg test, higher than the normal threshold.

KKM participants expressed scores more elevated than the CTP group for tension, depression, hostility, fatigue, total PEA as well as the total recall and delayed memory, with statistical significance from $p<0.05$ to $p<0.001$, and a tendency to confusion and anxiety. In addition the KKM group presented higher levels of working memory ($p<0.05$), verbalized their concern about their neurocognitive status, and chose to participate in the program with elevated compliance. For these different baseline conditions, we recognized and decided to avoid the comparison between the two groups in the final status.

After the 8-week program the KKM group significantly decreased, compared to their baseline, their levels of tension, hostility, confusion and total PEA, with $p < 0.05$, and showed a tendency to reduce depression, fatigue, anxiety and total Goldberg, depression and anxiety, experiencing a change reduction percentage of 51,4% - 40,3%. The CTP group did not experience such differences after 8 weeks of cognitive stimulation intervention, only confusion tended to improve.

These results are similar to those experienced by 5 MCI patients and 5 caregivers, from Innes et al. [23], with the same meditation program, who showed a tendency to normalization of mood (total POMS $p = 0.06$, depression $p < 0.01$). Lavretsky et al. also demonstrated a reduction of depressive symptoms and greater mental health in 65.2% and 52% of the 23 family dementia caregivers in a KKM group respectively. Only 31.2% of the 16 participants in the control relaxation group showed a reduction in depressive symptoms, while 19% showed better mental health. Comparing with our CTP group, total Goldberg and PEA reduced by 7.7% and 18.7% respectively, without reaching statistical significance. Moss et al. also described the improvement in mood parameters for 8 MCI patients in the KKM meditation group, with a significant reduction on the same parameters as our study, for tension, fatigue and anxiety, ($p < 0.04$, $p < 0.02$ and $p < 0.01$). In 2014, Chen et al. showed that psychological well being in people with MCI was associated with in vivo measures of brain pathology. This study concluded that POMS vigor-activity subscale scores were inversely associated in the MCI group with the degree of FDDNP binding to plaques and tangles in the posterior cingulate cortex, which is involved in emotional regulation, but not in the normal cognition control group [38]. In our study, the vigor category showed a 17 % positive change in the KKM group compared to the 33% of reduction in our CTP group (see table 2).

In 1999, Shannahoff-Khalsa described a 12-month Kundalini Yoga and meditation study, comparing 11 patients to 10 who only practiced relaxation [39]. The first group reduced their anxiety, depression and obsessive-compulsive disorder symptoms after 3 months. This group applied the Kundalini Yoga and meditation techniques to improve their levels of calmness and energy [29]. Borrás included Kundalini Yoga and meditation in motherhood health programs in a cohort of 45 pregnant and postpartum women [40]. They decreased irritability, sadness, fatigue and tiredness and higher concentration. They described better breathing capacity, pain management, more vitality, and improved mind control in new stressful situations.

Nowdays, there is evidence that meditation may prevent age-related cognitive decline as well as reduction in cortical thickness, suggesting that the effects are correlated with length and intensity of training [20-21,41]. There is also evidence of increased cerebral blood flow, Newberg et al. [15] and Khalsa [22]. When studying two different Kundalini Yoga meditations, “focused-based” Kirtan Kriya and “breath-based” Shabad Kriya, CBF of practitioners differed in their images [28]. Brain scans and corresponding cognitive and memory tests showed that Kirtan Kriya practitioners had improved fluency and memory [17], $p=0.01$. Eyre et al. [42] concluded a significant recovery in depression and visuospatial memory, from 14 yoga meditation participants compared to 11 people in memory training [42].

By randomizing 53 participants for a 6-month study including KKM or music listening, Innes et al. [24] found an improvement in psychological well-being, mood and sleep quality at 12 weeks for both groups. KKM subjects showed greater gains in perceived stress, mood, psychological well-being, and QoL-Mental Health, $p\leq 0.09$, and were sustained or improved at 6 months, with excellent compliance and high satisfaction [24].

Our KKM group showed a high compliance and all participants reported feeling better after every yoga session. After 8-weeks of KKM experience, Total Free Recall memory and TMT Trail-A test had a tendency to ameliorate from baseline to post-intervention and became into normal range (7.3 and 7.5 respectively); while, Newberg et al. [11] showed a significant reduction on Trail-B test. Our KKM group scores on verbal and semantic fluency, and direct digits measured by TBA test did not reach significance, but were increased in the Newberg et al. [11] report. Additional, we observed lower numeric and differed memory test results compared to Innes et al. [23], who described a significant improvement for the retrospective memory function $p=0.04$. The same significance was maintained when studying for periods of 3 and 6 months [12]. Our results are consistent with Newberg et al. [11], who showed improvements in logical delayed memory [11] ($p<0.05$). In both studies, the patients reported that the meditation was pleasant and beneficial for their cognitive function improvement.

The KKM and yoga session study group had higher short and long term improvements in executive functioning, depressed mood and resilience [43]. The groups, with similar MMSE 29, differed significantly in their change in Trail-B scores at 12 weeks $p=0.04$; and Yang et al. found no difference on hippocampus volume between both interventions, decreasing choline in the memory training group $p=0.01$, but sustaining the level in the yoga and KKM group [44].

Conclusions

The strength of this community-based pilot study was that the MCI patients, who manifested a lower emotional health and higher cognitive level, were motivated to experience daily KKM and weekly yoga session for 8-weeks.

The CTP group did not show significant differences for neuropsychological values after their program, and only improved significantly their delayed total recall memory level.

The KKM group significantly meliorated their baseline negative mood behavior for tension, hostility and confusion, while anxiety and depression entered into normal scores as well as their total free recall memory and sustained attention.

The weekly yoga session improved their perception of wellbeing. Further research is warranted at a larger scale with randomized studies.

Conflict of interest

None ethical issue.

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References

1. R.C. Petersen, G.E. Smith, S.C. Waring, R.J. Ivnik, E.G. Tangalos, E. Kokmen, Mild Cognitive Impairment: Clinical characterization and outcome, Arch. Neurol. 56 (1999) 303-308.

2. R.C. Petersen, R. Doody, A. Kurz, R.C. Mohs, J.C. Morris, P.V. Rabins, K. Ritchie, M. Rossor, L. Thal, B. Winbland, Current concepts in mild cognitive impairment, *Arch. Neurol.* 58 (2001) 1985-1992.
3. T. Ngandu, J. Lehtisalo, A. Solomon, E. Levälahti, S. Ahtiluoto, R. Antihainen, L. Bäckman, T. Hänninen, A. Jula, T. Laatikainen, J. Lindström, F. Mangialasche, T. Paajanen, S. Pajala, M. Pettonen, R. Rauramaa, A. Stigsdotter-Neely, T. Strandberg, J. Tuomiehto, H. Soininen, M. Kivipelto, A 2 year multidomain intervention of diet exercise, cognitive training and vascular risk monitoring versus control to prevent cognitive decline in at-risk elderly people (FINGER): a randomized controlled trial, *Lancet*. 385 (9984) (2015) 2255-2263, doi: 10.1016/S0140-6736(15)60461-5.
4. D.S Khalsa, Stress, Meditation, and Alzheimer's Disease Prevention: Where The Evidence Stands, *J. Alzheimers. Dis.* 48 (1) (2015) 1-12, doi: 10.3233/JAD-142766.
5. Khalsa DS and Perry G. The Four Pillars of Alzheimer's Prevention. *Cerebrum: the Dana Forum on Brain Science* 2017 (2017) cer-03-17.
6. T. Cañete, G. Blázquez, A. Tobeña, L. Gimenez-Llort, A. Fernández-Teruel, Cognitive and emotional alterations in young Alzheimer's disease (3xTgAD) mice: effects of neonatal handling stimulation and sexual dimorphism, *Behav. Brain. Res.* 281 (2015) 156-171, doi: 10.1016/j.bbr.2014.11.004.
7. V. O. Emery, Alzheimer disease: are we intervening too late? *Pro, J. Neural. Transm.* 118 (9) (2011) 1361-1378. doi: 10.1007/s00702-011-0663-0.

8. A. Ciarmello, M.C. Gaeta, F. Benso, M. Del Sette, FDG-PET in the Evaluation of Brain Metabolic Changes Induced by Cognitive Stimulation in a MCI Subjects, *Curr. Radiopharm.* 8 (1) (2015) 69-75.

9. B. Reisberg, L. Prichep, L. Mosconi, E.R. John, L. Glodzik-Sobanska, I. Boksay, I. Monteiro, C. Torossian, A. Vedvyas, N. Ashraf, I.A. Jamil, M.J. de Leon, The pre-mild cognitive impairment, subjective cognitive impairment stage of Alzheimer's disease, *Alzheimers. Dement.* 4 (1 Suppl1) (2008) S98-S108, doi: 10.1016/j.jalz.2007.11.017.

10. R.S. Wilson, J.A. Schneider, P.A. Boyle, S.E. Arnold, Y. Tang, D.A. Bennett, Chronic distress and incidence of mild cognitive impairment, *Neurology.* 68 (24) (2007) 2085-2092.

11. A.B. Newberg, N. Wintering, D.S. Khalsa, H. Roggenkamp, M.R. Waldman, Meditation effects on cognitive function and cerebral blood flow in subjects with memory loss: a preliminary study, *J. Alzheimers. Dis.* 20 (2) (2010a) 517-526, doi: 10.3233/JAD-2010-1391.

12. K.E. Innes, T.K. Selfe, D.S. Khalsa, S. Kandati, Meditation and Music Improve Memory and Cognitive Function in Adults with Subjective Cognitive Decline: A Pilot Randomized Controlled Trial, *J. Alzheimers. Dis.* 56 (3) (2017) 899-916, doi: 10.3233/JAD-160867.

13. S.K. Devi, J.P. Chansauria, K.N. Udupa, Mental depression and kundalini yoga, *Anc. Sci. Life.* 6 (2) (1986) 112-118.

14. H. Lavretsky, E.S. Epel, P. Siddarth, N. Nazarian, N.S. Cyr, D.S. Khalsa, J. Lin, E. Blackburn, M.R. Irwin, A pilot study of yogic meditation for family dementia caregivers with depressive symptoms: effects on mental health, cognition and telomerase activity, *Int. J. Geriatr. Psychiatry*. 28 (1) (2013) 57-65, doi: 10.1002/gps.3790.
15. A.B. Newberg, N. Wintering, M.R. Waldman, D. Amen, D.S. Khalsa, A. Alavi, Cerebral blood flow differences between long-term meditators and non-meditators, *Conscious. Cogn.* 19 (4) (2010b) 899-905, doi: 10.1016/j.concog.2010.05.003.
16. S.K. Mishra, P. Singh, S.J. Bunch, R. Zhang, The therapeutic value of yoga in neurological disorders, *Ann. Indian. Acad. Neurol.* 15 (4) (2012) 247–254, doi: 10.4103/0972-2327.104328.
17. A.S. Moss, N. Wintering, H. Roggenkamp, D.S. Khalsa, M.R. Waldman, D. Monti, A.B. Newberg, Effects of an 8-week meditation program on mood and anxiety in patients with memory loss, *J. Altern. Complement. Med.* 18 (1) (2012) 48-53, doi: 10.1089/acm.2011.0051
18. K.K. Rocha, A. M. Ribeiro, K.C. Rocha, M.B. Sousa, F.S. Albuquerque, S. Ribeiro, R.H. Silva, Improvement in physiological and psychological parameters after 6 months of yoga practice, *Conscious. Cogn.* 21 (2) (2012) 843-850, doi: 10.1016/j.concog.2012.01.014.
19. D.S. Black, S.W. Cole, M.R. Irwin, E. Breen, N.M. St Cyr, N. Nazarian, D.S. Khalsa, H. Lavretsky, Yogic meditation reverses NF- κ B and IRF-related transcriptome dynamics in leukocytes of family dementia caregivers in a randomized controlled trial,

- Psychoneuroendocrinology 38 (3) (2013) 348-355, doi:10.1016/j.psyneuen.2012.06.011.
20. R.J. Davidson, B.S. McEwen, Social influences on neuroplasticity: stress and interventions to promote well-being, *Nat. Neurosci.* 15 (5) (2012) 689-695, doi: 10.1038 /nn.3093.
21. A.B. Newberg, M. Serruya, N. Wintering, A.S. Moss, D. Reibel, D.A. Monti, Meditation and neurodegenerative diseases, *Ann. N. Y. Acad. Sci.* 307 (2014) 112-123, doi: 10.1111 /nyas.12187.
22. D.S. khalsa, D. Amen, C. Hanks, N. Money, A. Newberg, Cerebral blood flow changes during chanting meditation, *Nucl. Med. Commun.* 30 (12) (2009) 956-961, doi: 10.1097/ MNM.0b013e32832fa26c.
23. K.E. Innes, T.K. Selfe, C.J. Brown, K.M. Rose, A. Thompson-Heisterman, The effects of meditation on perceived stress and related indices of psychological status and sympathetic activation in persons with Alzheimer's disease and their caregivers: a pilot study, *Evid. Based. Complement. Alternat. Med.* 2012 (2012) 927509, doi: 10.1155/ 2012/927509.
24. K.E. Innes, T.K. Selfe, D.S. Khalsa, S. Kandati, Effects of Meditation versus Music Listening on Perceived Stress, Mood, Sleep, and Quality of Life in Adults with Early Memory Loss: A Pilot Randomized Controlled Trial, *J. Alzheimers. Dis.* 52 (4) (2016) 1277-1298, doi: 10.3233/JAD-151106.

25. S.W Lazar, G. Bush, R.L. Gollub, G.L. Fricchione, G. Khalsa, H. Benson, Functional brain mapping of the relaxation response and meditation. *NeuroReport*. 11 (7) (2000) 1581-1585.
26. K.L. Pomykala, D.H. Silverman, C.L. Geist, P. Voegel, P. Siddarth, N. Nazarian, N.M. St Cyr, D.S. Khalsa, H. Lavretsky, A pilot study of the effects of meditation on regional brain metabolism in distressed dementia caregivers, *Aging. Health*. 8 (5) (2012) 509-516.
27. B.P. Acevedo, S. Pospos, H. Lavretsky, The Neural Mechanisms of Meditative Practices: Novel Approaches for Healthy Aging, *Curr. Behav. Neurosci. Rep.* 3 (4) (2016) 328-339.
28. D.J. Wang, H. Rao, M. Korczykowski, N. Wintering, J. Pluta, D.S. Khalsa, A.B. Newberg, Cerebral blood flow changes associated with different meditation practices and perceived depth of meditation, *Psychiatry. Res.* 191 (1) (2011) 60-67, doi: 10.1016/j.psychres.2010.09.011
29. D.S. Shannahoff-Khalsa, Patient perspectives: kundalini yoga meditation techniques for psycho-oncology and as potential therapies for cancer, *Integr. Cancer. Ther.* 4 (1) (2005) 87-100.
30. B. Reisberg, S.H. Ferris, M.J. de Leon, T. Crook, The Global Deterioration Scale for assessment of primary degenerative dementia, *Am. J. Psychiatry*. 139 (9) (1982) 1136-1139.

31. D.S. Khalsa, C. Stauth, *Brain Longevity: The Breakthrough Program that Improves Your Mind and Memory*, New York, Warner Books, 1999.
32. M.F. Folstein, S.E. Folstein, P.R. McHugh, "Mini-mental state". A practical method for grading the cognitive state of patients for the clinician, *J. Psychiatric. Res.* 12 (3) (1975) 189-198.
33. D. Goldberg, K. Bridges, P. Duncan-Jones, D. Grayson, Detecting anxiety and depression in general medical settings. *BMJ.* 297 (6653) (1988) 897-899.
34. H. Buschke, Cued recall in amnesia, *J. Clin. Neuropsychol.* 6 (4) (1984) 433-440.
35. J. Peña-Casanova, Alzheimer's Disease Assessment Scale-cognitive in clinical practice, *Int. Psychogeriatr.* 9 (Suppl 1) (1997) 105-114.
36. R.M. Reitan, D. Wolfson, *The Halstead-Reitan neuropsychology test battery: theory and clinical interpretation*, Tucson, Neuropsychology Press, 1993.
37. R. Palomo, M. Casals-Coll, G. Sánchez-Benavides, M. Quintana, R.M. Manero, T. Rognoni, L. Calvo, F. Aranciva, F. Tamayo, J. Peña-Casanova, Spanish normative studies in Young adults (NEURONORMA Young adult Project): norms for the Rey-Osterrieth Complex Figure (copy and memory) and Free and Cued Selective Reminding Test, *Neurologia.* 28 (4) (2013) 226-235, doi: 10.1016/j.nrl.2012.03.008.
38. S.T. Chen, P. Siddarth, N.Y. Saito, F. Rueda, T. Haight, L.M. Ercoli, K.J. Miller, H. Lavretsky, J.R. Barrio, S.Y. Bookheimer, G.W. Small, D.A. Merrill, *Psychological well-*

- being and regional brain amyloid and tau in mild cognitive impairment, *Am. J. Geriatr. Psychiatry*. 22 (4) (2014) 362-369, doi: 10.1016/j.jagp.2012.09.002.
39. D.A. Shannahoff-Khalsa, L.E. Rav, S. Levine, C.C. Gallen, B.J. Schwartz, J.J. Sidorowich, Randomized controlled trial of yogic meditation techniques for patients with obsessive-compulsive disorder, *CNS. Spectr.* 4 (12) (1999) 34-47.
 40. G. Borrás, loga per la salut Materno-Infantil. *Pediat. Catalana*. 66 (2006) 27-31.
 41. E. Baron Short, S. Kose, Q. Mu, J. Borckardt, A. Newberg, M.S. George, F.A. Kozel, Regional brain activation during meditation shows time and practice effects: an exploratory fMRI study, *Evid. Based. Complement. Alternat. Med.* 7 (1) (2010) 121-127, doi: 10.1093/ecam/nem163
 42. H.A. Eyre, B. Acevedo, H. Yang, P. Siddarth, K. van dyk, L. Ercoli, A.M. Leaver, N.S. Cyr, K. Narr, B.T. Baune, D.S. Khalsa, H. Lavretsky, Changes in Neural Connectivity and Memory Following a Yoga Intervention for Older Adults: A Pilot Study, *J. Alzheimers. Dis.* 52 (2) (2016) 673-684, doi: 10.3233/JAD-150653.
 43. H.A. Eyre, P. Siddarth, B. Acevedo, K. Van Dyk, P. Paholpak, L. Ercoli, N. St. Cyr, H. Yang, D.S. Khalsa, H. Lavretsky, A Randomized Controlled Trial of Kundalini Yoga in Mild Cognitive Impairment, *Int. Psychogeriatr.* 29 (4) (2017) 557-567, doi: 10.1017/S1041610216002155.
 44. H. Yang, A. M. Leaver, P. Siddarth, P. Paholpak, L. Ercoli, N.M. St Cyr, H.A. Eyre, K.L. Narr, S.D. Khalsa, H. Lavretsky, Neurochemical and Neuroanatomical Plasticity

Following Memory Training and Yoga Interventions in Older Adults with Mild Cognitive Impairment, *Front. Aging. Neurosci.* 8 (2016) 277.