Clinical Interventions in Aging

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REVIEW

The effectiveness of Tai Chi for short-term cognitive function improvement in the early stages of dementia in the elderly: a systematic literature review

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Purpose: This systematic review examines intervention studies using Tai Chi in the early stages of dementia to determine the effectiveness of Tai Chi for the short-term improvement of cognitive functions for elderly persons with the disease.

Methods: A keyword search was done in PubMed/MEDLINE, Cumulative Index to Nursing and Allied Health Literature (CINAHL), Excerpta Medica Database (EMBASE), and Cochrane Library databases using keywords such as Tai Chi, Dementia*, and cognition. A secondary search strategy consisting of a manual search in the reference lists of selected articles was also used.

Results: A total of nine studies were reviewed including six randomized controlled trials, two non-randomized controlled trials, and one non-randomized prospective study. The studies suggest Tai Chi has impacts on global cognitive functions, visuospatial skills, semantic memory, verbal learning/memory, and self-perception of memory. The effects of Tai Chi on overall cognition for people with mild cognitive impairment are comparable to those in control groups which engaged in exercise.

Conclusion: The studies reviewed affirm the potential of Tai Chi to improve short-term cognitive function in the elderly at the onset of dementia.

Keywords: behavioral intervention, cognition, dementia, older adult, Tai chi, systematic review

Introduction

It is estimated that the proportion of those aged 60 and over will double from 11% in 2000 to 22% by 2050.[1] As a result, health care systems will face new challenges due to increased health-related problems such as neurodegenerative diseases. Dementia is the most prevalent of these.[2] It is estimated that the number of people in Canada living with dementia will increase from approximately 400,000 to nearly 700,000 by 2031.[3] The prevalence rate doubles approximately every 6 years from the age of 65, from 7% of those affected between 75 and 79 years of age to 40% for those aged 90 and over.[4,5] In 2012, the World Health Organization declared dementia a public health priority.[6]

Dementia is a term used to encompass many diseases that are usually chronic or progressive in nature.[4] It is caused by neurodegeneration or a loss of cells in the

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brain and the rupture of important nerve connections.[7] There are several consequences associated with dementia, including behavioral changes, a deterioration of memory and reasoning, and the loss of the ability to perform daily activities that occur more rapidly comparatively to the normal aging process.[8] The most common form of dementia is Alzheimer's disease, which accounts for 60–70% of dementia cases.[6]

The social and economic impacts of dementia are numerous. In 2015, it was estimated that 48.7 million people globally were living with dementia resulting in approximately US$818 billion of care-related costs (1.09% of the global gross domestic product).[9] It is projected that by 2030, 75 million people will have some form of dementia, with care costing nearly US$2 trillion.[9] Although population-level health interventions aimed at prevention are required, individual interventions are needed to ameliorate the quality of life of those already diagnosed with dementia and to possibly improve short-term cognitive function in the early stages of the disease. Evidence suggests that pharmacological interventions may have only limited benefits for reducing the decline in daily life habits and may also cause unwanted side effects.[10] Additionally, clinical practice guidelines recommend beginning with more cost-effective behavioral or psychological interventions before initiating pharmacological interventions.[1] Currently, the only evidence-based behavioral intervention that has shown to provide short-term improvement of cognitive function is that of physical activity.[1,10–12]

Tai Chi is a physical activity that also incorporates cognitive, social, and meditation components, and it is currently gaining popularity and generating much interest.-[11] It involves learning choreographed movement patterns, which require visuospatial skills, rapid information processing, and episodic memory.[1] Tai Chi also leads to increased heart rate and respiration, which helps create a larger network of connections between neurons thus enhancing brain perfusion.[1] Previous studies have suggested that Tai Chi is a safe and effective activity that improves physical balance and emotional well-being in older adults without disabilities.[13,14] At the cognitive level, several studies suggest that Tai Chi interventions potentially provide beneficial effects, such as preserving or improving cognitive functions and reducing the risk of developing dementia in the older adult population who are without disabilities.[5,11] A systematic review comparing studies of Tai Chi against regular physical activities in relation to the maintenance of cognitive ability among healthy adults suggests that Tai Chi can be more efficacious than simply physical exercise for the maintenance of global cognitive skills.[1]

Some emerging research demonstrates the potential effectiveness of Tai Chi in providing short-term improvement in cognitive function in the early stages of dementia. Burgener et al conducted a 40-week intervention with people living with dementia (treatment group, n=24; control, n=19) to evaluate the effectiveness of a multimodal intervention.[12] The authors concluded that interventions combining Tai Chi, cognitive therapy and participation in a support group can be effective in improving or maintaining cognitive function for people with dementia. Wayne et al conducted a systematic review to explore the effectiveness of Tai Chi on cognitive performance in adults with and without cognitive impairment, concluding that Tai Chi may enhance executive function in older adults without significant impairment; however, their sample included participants with early stages to advanced stages of dementia, and this heterogeneous group may have masked the effects for any subgroups of participants.[11]

Given the lack of consensus on the efficacy of pharmacological approaches and the emphasis on behavioral-focused treatments in the clinical setting, there has been growing interest in behavioral interventions, such as Tai Chi. The purpose of this systematic review is to examine intervention studies using Tai Chi in the early stages of dementia to determine the effectiveness of Tai Chi to improve short-term cognitive function.

Methods

A keyword search of electronic databases that followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines identified and selected articles relevant for the purpose of the study.[15] With the assistance of a biomedical librarian, an initial search was conducted by the first author in September 2016, with an updated search conducted by the second author in December of 2018. The literature search was done in the following databases: PubMed/MEDLINE, Cumulative Index to Nursing and Allied Health Literature (CINAHL), Excerpta Medica Database (EMBASE), and Cochrane Library using the following keywords: Tai Chi OR Tai Ji OR taichi OR taiji AND Dementia* OR Alzheimer* OR cognition OR cognitive OR neurocognitive disorder. A secondary search strategy was also used which involved a manual search in the

reference lists of selected articles. Figure 1 presents a PRISMA diagram summarizing the process of article selection.[15] The Supplementary material provides an example of a search strategy.

Selected articles (1) included participants in the early stages of dementia (all forms of dementia were included), beginning stages were defined by a Mini-Mental Status Exam (MMSE) score between 18 and 24 and/or a Clinical Dementia Rating (CDR) score of 0.5 or 1 (valid for at least 80% of the sample); (2) employed Tai Chi exclusively as the intervention (all forms of Tai Chi were included); (3) examined the effects of Tai Chi on cognition; and (4) were written in French or English.

An extraction table was completed in order to facilitate the comparison of different elements found in the selected articles. The table format was based on other systematic reviews of a similar topic.[1,11] The information extracted from the articles included the authors, the year of publication, the country where the study took place, the study design, the sample size, participant demographic information, the nature of the control group activity (eg, other form of exercise, education material, no activity), the length and frequency of the Tai Chi intervention, and the outcome measures.

Two evaluators (first and fourth authors) independently assessed the quality of selected articles. The evaluation tool used was a version of the "Checklist for Clinical Trial Quality Assessment," a 27-item tool with a total possible score of 28 points.[16,17] The assessment is divided into four sub-sections: reporting (ten items), external validity (three items), internal validity-bias (seven items), and internal validity-confounding (six items). An "excellent" score ranges from 24 to 28; "good", 19 to 23; "fair", 14 to 18; or "poor", below 14.[17,18]

Results

A total of nine studies were selected including six randomized controlled trials,[5,21,22,24–26] two non-randomized control

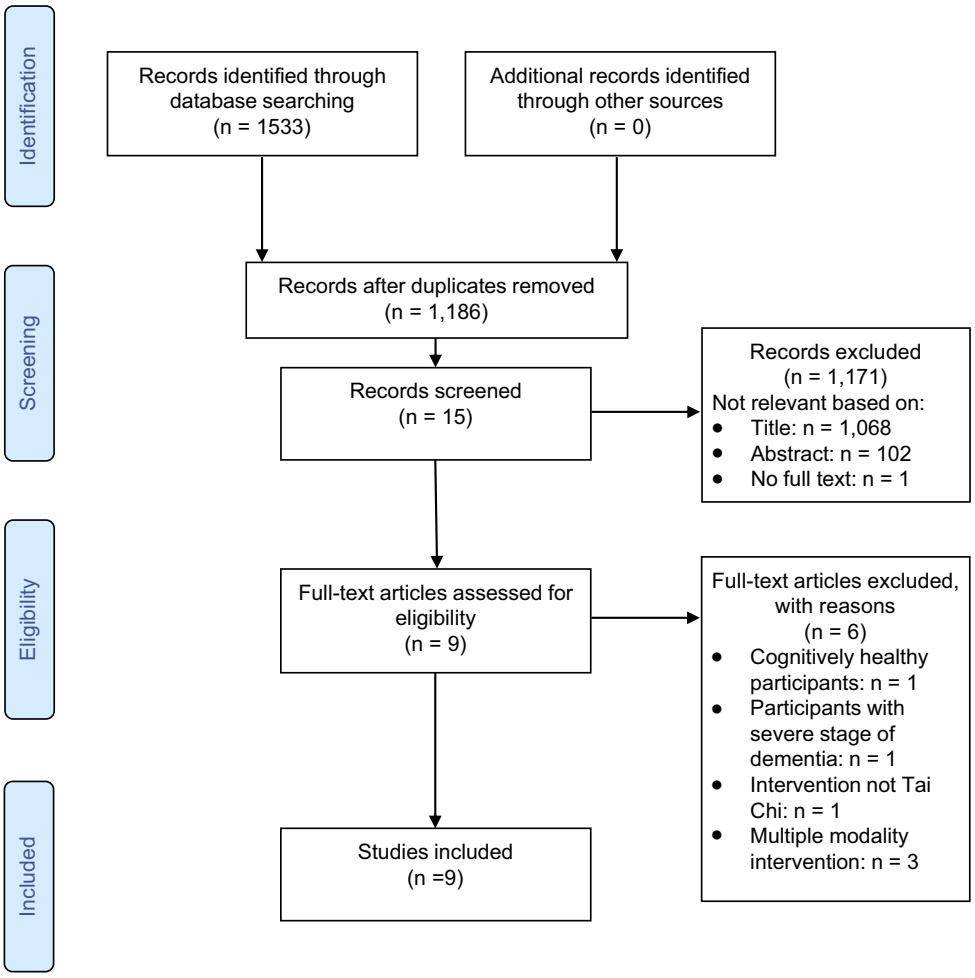

Figure 1 PRISMA diagram.

trials,[20,23] and one non-randomized prospective study.[19] The average age across all 9 studies was 78 years old. The sample size for each of the studies ranged from 11 to 238 participants. The studies were conducted in five countries: Brazil (n=1),[20] China (n=3),[5,21,26] the United States (n=3),[19,23,24] France (n=1),[22] and Thailand (n=1).[25] In seven of the studies, participants lived in the community,[5,19,20,23–26] while two studies focused on participants in an institutionalized environment.[21,22] The duration of Tai Chi interventions varied greatly from 8 weeks to 1 year, in terms of frequency of practice (1 to 4 times a week), and style. Seven of the studies used control groups with various types of interventions, such as education, adaptive physical activity, or crafts-based exercises.[5,20,21,23–26] Table 1 presents the characteristics of each of the selected studies.

Methodological quality scores ranged from 14 to 25, with an average of 20.2 out of a possible 28 points. According to the interpretation scale, two articles scored as being of "excellent" quality,[25,26] five articles qualified as "good,"[5,21–24] and two articles qualified as "fair."[19,20] None of the studies were identified as being of "poor" quality. The methodological quality of the selected studies is described in Table 2.

Effects of tai chi on cognitive functions

Similar to the reporting style for the studies reviewed, the results presented below are according to cognitive functions that were measured in the selected studies.

Global cognitive functions

Impacts on global cognitive function were estimated in seven of the studies.[5,19,21–24,26] All studies used the MMSE tool,[5,19,21–24,26] however, Lam, et al also used the Alzheimer's Disease Assessment Scale (ADAS-Cog) and the Clinical Dementia Rating (CDR).[5] The MMSE and the CDR are tools used to screen for cognitive disorders, while the ADAS-COG is often used to evaluate the effectiveness of interventions for Alzheimer's disease.

By the end of their respective Tai Chi interventions, participants, on average, maintained or increased their scores on one or more of the cognitive functions. In four studies,[5,19,21,22] MMSE performance remained stable with no significant difference in scores within and between groups. Among these studies, Chang et al was a one-group pre-post design,[19] while the studies authored by Chan, et al[21] Deschamps et al,[22] and Lam et al were randomized control trials.[5] In the latter two, the MMSE scores remained stable for the Tai Chi group and for the adapted-exercise control group. Three studies reported improvements in overall cognitive function by the end of the intervention.[23,24,26] Of these studies, the studies by Tsai et al and Cheng et al showed significant improvement in performance in the intervention groups compared to that of the control groups (engaged in crafts and education).[24,26] Lam et al[5] who used the ADAS-COG and CDR tools, also showed an improvement in overall cognitive function after one year of intervention. This improvement, however, was present in both the intervention group and the control group who did adapted exercise. While the overall cognitive function measured with the CDR was better preserved in the Tai Chi group than in the control group, only 4.3% (n=4) of participants in the Tai Chi group, progressed to dementia as diagnosed by the DSM-IV, compared to 16.6% (n=28) of the control group after one year.[5]

Working memory and executive function

The impacts of Tai Chi on working memory and executive function were reported in five studies using Digit Span Backward (DSB),[5,20,25,26] Digit Symbol Coding (DSC),[19] Digit Span Forward (DSF),[20,25,26] 15-Word immediate recall and/or Trail Making Test – Part B (TMT-B).[25] The DSF and DSB tests, derived from the Wechsler Adult Intelligence Scale (WAIS), consist of storing and repeating digit sequences in reverse order immediately after hearing them.[20] The DSC, also from the WAIS, consists of decoding symbols according to their association with numbers.[27] The TMT-B required participants to connect alternating letters and numbers in the correct order as quickly as possible (eg, 1-A-2-B, etc.).[25]

Varying results were reported for the effect of Tai Chi on executive function or working memory from across the wide variety of measurements. Three studies used DSB to measure this cognitive outcome.[5,20,25] Two of these studies, those of Sungkarat et al and Cheng et al[25,26] with intervention durations of 12 and 15 weeks, did not demonstrate a difference between the intervention group and the control group at the end of the interventions. On the other hand, the study conducted by Lam et al[5] of a longer duration demonstrated an improvement in working memory after one year of intervention with the same tool. This improvement was found in both the intervention and the control group but there was no significant difference between the groups.[5] The studies conducted by Chang et al and Cheng et al showed no significant difference between pre- and post-intervention scores for working memory,[19,26] as assessed with the DSC and 15-Word

Table 1 Summary of included studies

Author/ Year/ Country	Study Design	Participants	Type, frequency, and duration of intervention	Cognitive outcomes/Measurements[a]	Results related to cognitive measures
Chan et al 2016[21] **China**	RCT	52 participants with MCI (determined by an MMSE score between 13–26) Mean age =81 Community-dwelling **I/C =27/25**	Intervention group: TC Qiqong (group class) 60 minutes, 2 times/week X 2 months Control group: health talk group in community center 1 time/week X 2 months	(1) Global cognitive function: MMSE; (2) Awareness of memory deficits: MIC; Outcomes measured at baseline, after 2 months and after 6 months,	No significant difference noted in MMSE score and MIC score between both groups (T1: p=0.394; T2: p=0.219).
Chang et al 2011[19] **United States**	PNCT	11 participants with MCI (determined by 15≤ MMSE score ≤27; DSC ≤6; DS ≤6; Stroop Color and Word test or HVLT-R score ≤39) Mean age =85 Community-Dwelling	Intervention group: TC sun style for arthritis (group class) 20–40 minutes, 2 times/week X 15 weeks	(1) Global cognitive function: MMSE; (2) Working memory: DSC & DS; (3) Attention: ST-color-word; (4) Verbal learning and memory: HVLT-R; Outcomes measured at baseline and after 15 weeks.	At 15 weeks, no significant pre-post differences in MMSE score (p=0.22), DSC (p=0.32), DS (p=1.08), Stroop Color and Word Test (p=0.4) and HVLT-R (p=0.36). At 15 weeks, significant difference in MMSE score in elders who participated in 24–29 sessions versus those who only went to 4 or less sessions (p<0.05) and DSC (p<0.05).
Cheng et al 2014[26] **China**	RCT	110 participants with MCI or early AD (determined by MMSE score between 10–24; CDR ≥0.5) Mean age =82 Institutionalized **I/C =39/35**	Intervention group: TC 12-form Yang Style or Mahjong (group class) 60 minutes, 3 times/week X 12 weeks Control group: handicraft (frequency and duration: idem)	(1) Global cognitive function: MMSE; (2) Working memory: DSF, DSB & 15-word immediate recall; (3) Episodic memory: 15-word 30 min. delayed recall; (4) Semantic memory: categorical fluency; Outcomes measured at baseline, week 12, 24 and 36.	At 24 weeks, significant difference in MMSE score (3.7 pts.) between I group (+1.5 pts.) and C group (−2.7 pts.) (95%CI: 1.4–6.0; d=0.40). Significant difference in DSF score between groups favoring I group over C group (0.98; 95% CI: 0.12–1.84; d =0.25). At all time, no significant difference between groups in DSB, 15-word immediate & 30 min. delayed recall and categorical fluency.
Deschamps et al 2009[22] **France**	RCT	52 participants with mild to moderate cognitive impairment Mean age =81 Institutionalized 2 interventions groups: TC: n=26 CA: n=26	TC intervention group: Adapted TC Yang Style (group class) 30 minutes, 4 times/week X 24 weeks CA intervention group: Adapted physical group activity and education on health 30–40 minutes, 2 times/week X 24 weeks	(1) Global cognitive function: MMSE; Outcome measured at baseline and after 24 weeks.	At 24 weeks, TC group's MMSE score remained stable (pre-test: 19.4±7.4; post-test: 21.1±6.4; p=0.6). No significant difference in score between both intervention groups (p=0.8).

(*Continued*)

Table 1 (Continued).

Author/ Year/ Country	Study Design	Participants	Type, frequency, and duration of intervention	Cognitive outcomes/Measurements[a]	Results related to cognitive measures
Kasai et al 2010[20] Brazil	NRCT	26 participants (elderly women) with MCI Mean age =74 Community-Dwelling **I/C =13/13**	Intervention group: TC Chuan Yang Style (group class) and recommendation to also practice at home 60 minutes, 2 times/week X 6 months Control group: no intervention	(1) Self-perception of memory: SMC; (2) Memory: RBMT; (3) Working memory: DSF; (4) Concentration capacity: DSB; Outcomes measured at baseline, after 3 months and after 6 months.	At 6 months, significant drop in memory complaints in I group compared to C group (p=0.023). At 6 months significant increase in RBMT score in I group compared to C group (p=0.007). At 6 months, significant difference for DSF in I group compared to C group (p=0.031). But no significant difference in DSB score between the 2 groups (p=0.164).
Lam et al 2014[5] China	RCT	238 participants with amnestic MCI or CDR =0.5 Mean age =78 Community-dwelling **I/C =96/169**	Intervention group: TC (4–6 weeks center-based and 46–48 weeks home-based training with DVD of TC program + monthly refresher). 30 minutes, 3 times/week X 1 year Control group: Stretching and relaxation exercises by PT &OT	(1) Global severity of cognitive impairment: CDR; (2) Global cognitive function: ADAS-COG & MMSE; (3) Working memory: DSB; (4) Episodic memory: 10-min. delayed recall; (5) Semantic memory: Category verbal fluency tests; Outcomes measured at baseline, after 2 months and after 12 months.	At 1 year, I group had better cognitive preservation than C group: 4/92 (4.3%) [I] VS 28/169 (16.6%) [C] progressed to dementia (odds ratio [OR] =0.28; 95%CI=0.05–0.92; p=0.064). Significant difference in score favoring I group for CDR score (p=0.038; 95%CI =0.63–0.99). At 1 year, both groups improve in ADAS-COG, DSB, Delayed recall test and category verbal fluency but no significant difference between groups was noted (p>0.05). No significant change in MMSE score in both groups (95%CI=−0.62–1.42; p=0.44).
Li et al 2014[23] United States	NRCT	46 participants with MCI (determined by 20≤ MMSE score ≤25) Mean age =76 Community-dwelling **I/C =22/24**	Intervention group: Enhanced TC Chuan (group class) 60 minutes, 2 times/week X 14 weeks Control group: no intervention	Global cognitive function: MMSE; Outcome measured at baseline and after 14 weeks.	At 14 weeks, I group showed significant improvement on MMSE (mean =2.26, p<0.001) compared to C group (mean =0.63, p=0.08).

(*Continued*)

Table 1 (Continued).

Author/ Year/ Country	Study Design	Participants	Type, frequency, and duration of intervention	Cognitive outcomes/Measurements[a]	Results related to cognitive measures
Sungkarat et al 2017[25] Thailand	RCT	66 participants with MCI (meeting Peterson's criteria for diagnosing amnestic multiple-domain MCI) Mean age =68 Community-dwelling **I/C =33/33**	Intervention group: TC 10-forms style (3 weeks center-based & 12 weeks home-based with DVD of TC program) 50 minutes, 3 times/week X 15 weeks Control group: education group on cognitive impairment	(1) Episodic memory: Logical Memory – delayed recall; (2) Visuospatial ability: Block Design; (3) Executive function: DSF, DSB & TMT-B; Outcomes measured at baseline and after 15 weeks.	At 15 weeks, scores were significantly better in I group compared to C group for the Logical Memory – delayed recall (p=0.006), Block Design (p=0.01) and Trail Making Test – Part B-A (p=0.005). No significant difference between groups for DSF and DSB (p=0.43).
Tsai et al 2013[24] United States	RCT	55 participants with MCI (determined by 18≤ MMSE score ≤28) Mean age =79 Community-dwelling **I/C =28/27**	Intervention group: TC Sun Style (group class) 20–40 minutes, 3 times/week X 20 weeks Control group: health and cultural information class (frequency and duration: idem)	Global cognitive function: MMSE; Outcome measured at baseline, week 5, 9, 13, 17 and 21.	At 21 weeks, significant improvement in MMSE score only in I group (p=0.003 [I] vs p=0.082 [C]). No significant change in difference between the 2 groups over time (p=0.223).

Notes: [a]Cognitive outcomes and measurements used by the authors.

Abbreviations: ADAS-COG, Alzheimer's Disease Assessment Scale – Cognitive; AMD, Adjusted Mean Difference; C, Control Group; CA, Cognition-Action program; CDR, Clinical Dementia Rating; DAD, Disability Assessment for Dementia; DS, Digit Span; DSB, Digit Span Backward; DSC, Digit Symbol Coding; DSF: Digit Span Forward; HVLT-R, Hopkins Verbal Learning test – Revised; I, Intervention Group; MCI, Mild Cognitive Impairment; MIC, Memory Inventory for Chinese Questionnaire; MMSE, Mini Mental Status Exam; NPI, Neuropsychiatric Inventory; NRCT, Non-Randomize Control Trial; OT, Occupational Therapy; PNCT, Prospective Non Controlled Trial; PT, Physical Therapist; RCT, Randomize Controlled Trial; RBMT, Rivermead Behavioural Memory Test; SMC, Subjective Memory Complaints Scale; ST-color-word, Stroop color and Word test; TC, Tai Chi; TMT-B, Trail Making Test – Part B.

Table 2 Summary of study quality and risk of bias

Study	Reporting (scored out of 11)	External validity (scored out of 3)	Internal validity – Bias[b] (scored out of 7)	Interval validity – confounding (selection bias, scored out of 6)	Total score (out of 28)
Chan et al[21]	10	2	5	5	22
Chang et al[19,a]	7/9	0	4/6	0/1	15.6[a]
Cheng et al[26]	10	3	5	5	24
Deschamps et al[22]	9	2	5	5	21
Kasai et al[20]	7	0	5	2	14
Lam at al[5]	7	2	6	5	20
Li et al[23]	11	1	4	3	19
Sungkarat et al[25]	11	2	6	5	25
Tsai et al[24]	10	2	5	5	22

Notes: [a]This article was a prospective non-controlled trial for which the scores and total score were adjusted. [b]The main outcomes considered during the evaluation of quality are only those related to cognition.

Abbreviations: ADAS-Cog, Alzheimer's Disease Assessment Scale; CAMDEX, Cambridge Examination for Mental Disorders of the Elderly; CDR, Clinical Dementia Rating; CINAHL, Cumulative Index to Nursing and Allied Health Literature; DSB, Digit Span Backward; DSC, Digit Symbol Coding; DSF, Digit Span Forward; EMBASE, Excerpta Medica Database; HVLT-R, Hopkins Verbal Learning Test – Revised; MIC, Memory Inventory for Chinese Questionnaire; MCI, Mild cognitive disorder; MMSE, Mini-Mental State Examination; PRISMA, Preferred Reporting Items for Systematic Reviews and Meta-Analyses; SMC, Subjective Memory Complaints Scale; PRISMA, Systematic Reviews and Meta-Analyses; TMT-B, Trail Making Test – Part B; WAIS, Wechsler Adult Intelligence Scale.

immediate recall. The results for working memory were positive for two out of the three studies that used the DSF evaluation tool,[20,26] while Sungkarat et al did not report a significant difference compared to their control group (education).[25] The studies that found positive results for the DSF reported a significant difference with their control group which, in one case, was a passive control group and the other was an active control group (crafts activities).-[20,26] Sungkarat et al[25] also used the TMT-B to evaluate executive function and achieved a significant improvement against its control group.

The studies' results were analyzed according to the frequency and duration of the Tai Chi intervention. The three studies offering Tai Chi sessions three times/week showed an improvement in working memory and executive function in at least one of the tests used.[5,25,26] For these studies, the duration of Tai Chi sessions was 30, 50, and 60 mins, 3 times/week for 1 year, 15 weeks, and 12 weeks, respectively.[5,25,26]

Verbal learning and memory

Of the five studies that measured verbal learning and memory,[5,19,20,25,26] results suggested that Tai Chi interventions may improve performance. Three studies noted improvement for these cognitive functions,[5,20,25] while two studies reported no effect.[19,26] Verbal learning and memory were evaluated by the following tests: the Hopkins Verbal Learning Test – Revised (HVLT-R),[19] based on the recall of12 words 20–25 mins after being learned,[28] the 15-Word 30-Min Delayed Recall,[26] based on the recall of 15 words learned after 30 mins, 10-Min Delayed Recall,[5] based on the reminder of words learned after 10 mins (number of words not mentioned in the article), the Riverhead Behavioral Memory Test (RBMT),[20] which evaluates different tasks simulating situations of everyday life, and the Logical Memory – Delayed Recall, which asks the participant to recount two stories as precisely as possible 30 mins after hearing them.[25]

Sungkarat et al[25] demonstrated a significant improvement in verbal learning and memory skills, as compared to the control group (education). This result was supported by the findings of Kasai et al who reported a significant improvement in the same cognitive functions after six months of intervention compared to a passive control group.[20] After one year, Lam et al observed an improvement in memory in both the intervention group and control group, who practiced adapted physical exercise, but no significant difference between the two.[5]

Self-perception of memory

The effects of Tai Chi on self-perception of memory were reported by Chan et al and Kasai et al.,[20,21] with both studies indicating improvements. During their eight-week intervention, Chan et al used the Memory Inventory for Chinese Questionnaire (MIC),[21] a 27-item evaluation administered in a semi-structured interview, observing improvements but no significant differences between the intervention and control groups.[29] The investigation carried out by Kasai et al lasted 24 weeks and used the Subjective Memory Complaints Scale (SMC),[20] an assessment derived from the Cambridge Examination for Mental Disorders of the Elderly (CAMDEX) and composed of ten questions.[30] Their results suggested a significant decrease in complaints of memory loss in the control group compared to the passive control group. The Kasai et al intervention duration was three times longer (twice per week for six months) than that of Chan et al (twice per week for two months).[20,21]

Attention and concentration

Chang et al and Kasai et al assessed attention and concentration using different tools.[19,20] Chang et al used the Stroop Color and Word,[19] a neuropsychological assessment to determine cognitive-interference abilities,[31] while Kasai et al employed the DSB.[20] The results of the studies, both of fair methodological quality, showed no effect with the practice of Tai Chi on attention and concentration.[19,20]

Semantic memory

Two studies evaluated the effect of Tai Chi on semantic memory with the Categorical Verbal Fluency Test.[5,26] This evaluation consists in saying as many words as possible in one minute according to given categories (animals, fruits, vegetables).[26] Cheng et al,[26] whose study was of excellent methodological quality, did not note any improvement in semantic memory after 12 weeks. Lam et al,[5] a study of good methodological quality, noted that there was a slight improvement in semantic memory in the Tai Chi group as compared to that of participants in the adapted exercise control group after one year.

Visuospatial skills

Sungkarat et al was the only study to have evaluated visuospatial skills.[25] This study, deemed to be of excellent

methodological quality, used the Block Design tool, an evaluation consisting of placing blocks to reproduce a presented model and the quantity of blocks can increase from four to nine. They noted that after 15 weeks, visuospatial skills were significantly better for the intervention group compared to the control group.[25]

Adverse effects

Of the nine studies, only four studies reported considering possible adverse effects; however, no adverse effects related to Tai Chi practice were noted.[21,23,25,26]

Discussion

This systematic review was conducted to gain an appreciation of the evidence surrounding non-pharmacological Tai Chi interventions. The studies included in this review suggest positive impacts on global cognitive functions, visuospatial skills, semantic memory, verbal learning/memory, and self-perception of memory. The effects of Tai Chi on overall cognition for people with mild cognitive impairment are comparable to those control groups which engaged in exercise.[32,33] The studies reviewed here affirm the potential of Tai Chi to improve short-term cognitive function in the early stages of dementia in the elderly.[26] These results are also consistent with the systematic review of Wayne et al[11] who concluded that there was a slight clinically significant improvement in overall cognitive function.

Contradictory results were noted across some of the studies. The differing conclusion for the positive impact of Tai Chi on semantic memory and self-perception of memory may be explained by differences in the duration of intervention.[5,20,21,26] It is possible that improvement in memory or perceived improvement is noted when interventions are lengthier in duration (eg, six months or more). The mixed results regarding the effect of Tai Chi on executive function could be explained, among other things, by the multiple and complex nature of skills that this cognitive domain represents.[34] The effect of Tai Chi appears to be most beneficial for the sub-functions of mental flexibility and immediate recall. This is consistent with the praxis of Tai Chi, which involves the recalling and planning of movements.

Tai Chi may be an effective behavioral-focused treatment to consider for therapeutic intervention in clinical practice, such as in day hospitals, day centers, or community centers. Conceptually, this makes sense given that Tai Chi incorporates cognitive and physical abilities. Taken together, the results of the studies reviewed suggest an intervention lasting at least three months with a frequency of three times per week between 30 and 60 mins per session could have a positive impact on some cognitive functions. After three months of a Tai Chi intervention, even if interrupted, benefits may be maintained for up to six to nine months post-intervention.[26] An intervention lasting six months to one year may lead to further improvements in other cognitive functions. Practitioners may find it effective to compose intervention groups of people with cognitive difficulties, exclusively, as opposed to mixed groups. A relatively homogeneous group may allow for more tailored instruction aimed at the participants' cognitive abilities. Consistently or partially practicing Tai Chi in a group setting can further contribute to slowing cognitive decline,[5,19,25] while potentially reducing the risk of falling by improving overall physical condition (eg, balance),[23,25] promoting mental well-being, better quality of sleep,[21] and general improvements to quality of life.[22] Consequently, locating a Tai Chi intervention in a health or community center setting may ensure regular practice by the client and provide the added benefit of participating in a group activity. One further area of consideration when developing a Tai Chi intervention is the type of Tai Chi used. At present, to the best of our knowledge, there is not a single study that attends to the efficacy of one type of Tai Chi over another with respect to improving or maintaining cognitive functions. It is possible, however, that certain types of Tai Chi may be easier for older adults with cognitive impairments to perform.

There are limitations to this systematic review. First, it is not a meta-analysis as there few studies reported on this topic. Another limitation is the wide variety of cognitive functions evaluated in the articles. In order to provide brief and clear results, this study regrouped certain cognitive functions despite there being differences between them. Finally, the studies reviewed were limited to cognition and to gain a more comprehensive view of the potential benefits of Tai Chi it would be advantageous to include measures that capture maintenance of ability to perform activities of daily living and mobility.

Conclusion

With an aging population that is increasing, maintaining functional autonomy of seniors will become a prominent issue. Therefore, it is important to introduce alternative activities such as Tai Chi to this population to stimulate physical, cognitive, and social skills while respecting

possible physical and cognitive limitations. Tai Chi is a safe activity for the elderly, free of adverse effects, and can be practiced alongside pharmacological interventions. The studies reviewed here support the potential of Tai Chi to improve short-term cognitive function in the elderly at the onset of dementia. The practice of Tai Chi promotes the preservation of cognitive abilities including global cognitive functions, semantic memory, verbal learning/memory, self-perception of memory, and visuospatial skills in the elderly.

Disclosure

The authors report no conflicts of interest in this work.

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Supplementary material

Example search strategy

1. exp Tai Ji/.
2. (taiji or taichi or tai ji or tai chi).ab,kf,kw,ti.
3. or 2
4. exp Dementia/
5. exp Cognition Disorders/
6. exp Cognitive Therapy/
7. exp Cognition/
8. Neurocognitive disorders/
9. (cognition or cognitive or neurocognition or neurocognitive or dementia* or alzheimer*).ab,kf,kw,ti.
10. or 5 or 6 or 7 or 8 or 9
11. and 10

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