The effect of Chinese traditional exercise on cognitive function improvement in the elderly – meta analysis

Authors' Contribution:
- **A** Study Design
- **B** Data Collection
- **C** Statistical Analysis
- **D** Manuscript Preparation
- **E** Funds Collection

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Abstract

Background and Study Aim: Chinese Traditional Exercise (CTE) can significantly improve the cognitive function of the elderly, but there is no further evidence in different areas of cognitive function and exercise programs. Therefore, the purpose of this review was to further discuss the current Randomized Controlled Trials (RCTs) of CTE on the improvement of cognitive function in the elderly aged 60 years and older.

Material and Methods: The databases were searched including Web of Science, PubMed, Cochrane Library, Scopus, CNYNET, VIP and Wanfang. The Cochrane systematic evaluation method was followed, and 25 RCTs met the final inclusion criteria.

Results: Of the 25 RCTs eventually included, 2 were of high quality and the rest were of medium quality; Quantitative analysis showed that CTE intervention could significantly improve the cognitive function of the elderly, including executive function, processing speed, long-term storage and retrieval, global cognition, cognitive-motor, short-term and working memory and physiological signals. Intervention methods include Taijiquan, Baduanjin, Wuqinxi, Qigong and so on, among which the 24-form taijichuan has the best effect on the improvement of cognitive function in the elderly. CTE intervention more than 3 times per week, each time 60min, intervention for 12 weeks or more can achieve the best effect of improving cognitive function of the elderly.

Conclusions: CTE can significantly improve the cognitive function of the elderly aged 60 and above, but the improvement effect of specific CTE on specific areas of cognitive function needs to be verified by further RCTs experiments.

Keywords: aging • cardiovascular function • cognitive impairment • plasticity

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Physical activity – *noun* exercise and general movement that a person carries out as part of their day [49].

Cognitive – *adjective* relating to the process of acquiring knowledge by the use of reasoning, intuition or perception [49].

Exercise – *noun* **1.** physical or mental activity, especially the active use of the muscles as a way of keeping fit, correcting a deformity or strengthening a part **2.** a particular movement or action designed to use and strengthen the muscles ■ *verb* **1.** to undertake physical exercise in order to keep fit and healthy **2.** to subject the body, or part of it, to repetitive physical exertion or energetic movement in order to strengthen it or improve [49].

Exercise intensity – *noun* the degree to which a workout is difficult for the exerciser [49].

Exercise intensity – in order to improve physical fitness, exercise must be hard enough to require more effort than usual. The method of estimating appropriate training intensity levels varies with each fitness component. Cardiovascular fitness, for example, requires elevating the heart-rate above normal [50].

INTRODUCTION

The aging of the world population is increasing, and cognitive impairment is a common phenomenon in the aging process. The prevalence of dementia in people over 60 years of age has reached 5% to 7% [1], and it is estimated that 60 million people will be affected by dementia by 2030 [2]. The decline of cognitive function affects the daily activity ability and quality of life of the elderly and increases the burden of the family [3]. Therefore, it is necessary to find effective interventions to prevent and improve the cognitive ability of the elderly.

Although cognitive ability decreases with the aging of the elderly, their nervous system has plasticity [4] and cognitive function can be improved by participating in sports [5]. Therefore, more and more scholars have carried out studies on the relationship between physical exercise and cognitive function, especially low-intensity and slow physical activities suitable for elderly groups [6], such as *taijichuan*, *Baduanjin* and other Chinese Traditional Exercise (CTE). Studies have shown that the density of gray matter in the inferior and medial temporal regions of the elderly who participated in *taijichuan* exercise for a long time was higher than that of the walking exercise group [7]. Because CTE is a kind of multi-component exercise that requires cognitive participation and coordination with the changing body, it can significantly improve the cognitive function [8, 9], quality of life [8, 9], cardiovascular function [11] and physical activity level [12] of the elderly with different health levels. Besides, *taijichuan* can also improve the psychological state and breathing function of basketball players [13]. This kind of CTE has become an important exercise method in some western countries [14].

Therefore, the purpose of this study was to further compare the effect of different CTE on the improvement of cognitive function in different areas of the elderly by combining different randomized controlled trials (RCTs) of CTE. In addition, it also includes the study of exercise dose, and further development of detailed intervention. So it is hypothesized that CTE has a significant advantage in improving cognitive function in the elderly compared to the control group, and may have a better effect in some cognitive subdomains.

MATERIAL AND METHODS

Search method

Web of Science (WOS), PubMed, Cochrane Library, Scopus, VIP, Wanfang and CNKI databases were searched for CTE studies on the elderly, and retrieved in titles and abstracts. The retrieval date was from the self-built database to September 2021. Boolean operator "OR" is used to merge the same search terms in title AND abstract, AND "AND" is used to merge different search terms. For example (" older adults "OR elderly) [title/abstract] AND ("Tai Chi Chuan" OR qigong OR Wuqinxi OR Yijinjing OR "Chinese Traditional exercise") AND (cognition OR "cognitive functions" OR brain) [title/abstract] AND (controlled OR trial OR randomized OR randomised).

References from other sources, such as references from other sources, will also be included in this retrospective analysis if their content is consistent.

Inclusion and exclusion criteria

Included literatures: Subjects aged ≥60 years were Randomized Controlled Trials (RCTs), in which *Tai Chi Chuan*, *Baduanjin* and other CTE intervention methods were used in the experimental group, while other physical intervention methods were used in the control group. Outcome indexes included any data that could evaluate cognitive function. Excluded literatures: reviews, conferences, cross-sectional comparisons, and subjects <60 years old; the control group adopted a special intervention designed to improve cognitive function; the outcome indexes did not include any data that could evaluate cognitive functions and the literatures for which data could not be quantitatively synthesized.

Study selection

The literatures will be screened strictly according to the inclusion and exclusion criteria after the search. The two researches will conduct screening separately, and then make a combined comparison. If there are differences, they will discuss and solve them. If they couldn't solve them, that will discuss and evaluate with the third research.

Quality assessment and risk of bias

The two researches separately used the manual of article quality evaluation criteria recommended by Cochrane Manual 5.1.0 to evaluate the quality of each included literatures [15], and evaluated each sub-item as "low risk", "unclear" and "high risk".

Data extraction

Two researches separately extracted the following information: First author, publication year, sample size, age, disease degree, intervention methods, intervention dose and outcomes, according to Gavelin et al. [16], the methods to test different cognitive functions of human body are roughly divided into executive function, long-term storage and retrieval, short-term working memory, processing speed, global cognition, visual processing, fluid reasoning and cognitive-motor.

Data analysis

Review Manager 5.3 software (Review Manager 2014) was used to plot forest maps for the included literatures, and the calculated effect sizes were analyzed using standardized mean differences (SMD). 95% confidence intervals (95% CI) for fixed and random effect models were calculated. Heterogeneity is mainly judged by I^2, when I^2<50%, heterogeneity can be ignored and fixed model can be used. When 50%≤I^2<75%, the heterogeneity is moderate. When I^2≥75%, the heterogeneity is large, and the random effect model should be used, and the source of heterogeneity should be discussed and analyzed. When estimating the effect size, SMD≥0.2 was small, SMD≥0.5 was medium, and SMD≥0.8 was large. Results p<0.05 was defined as having significant effect.

RESULTS

Preliminary selection of articles

Total 1298 articles were retrieved from the database, and 883 remained after removing the repetition. After reading title and abstract, 838 articles were excluded, and the remaining 45 articles needed to be read in full. Twenty two articles were excluded, including data unavailable (n = 9), inconsistent experimental design (n = 9), inconsistent test subjects (n = 1), conference article (n = 1), and failure to download the full text (n = 2). And 2 articles were retrieved from other ways, so 25 articles were left and to be quantitatively synthesized and analyzed (Figure 1).

Methodological quality assessment for included studies

A total of 25 RCTs [17-41] were included in this study, among which two articles [22, 29] were of high quality, and the rest were of medium quality, as shown in (Figure 2. and Table 1).

Study characteristics

Among the 23 RCTs included, there was one four-arm experiment [41] and 2 three-arm experiments [32, 40], and the specific age of subjects was not described in the two studies [24, 39]. Except for two studies [18,34], the other studies presented the baseline cognitive scores of subjects in different ways, including MoCA, MMSE or years

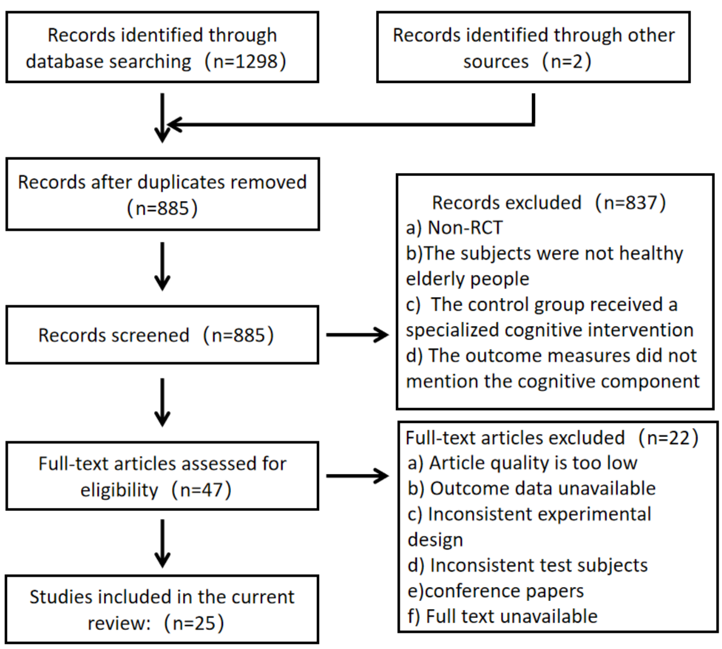


Figure 1. The selection of studies

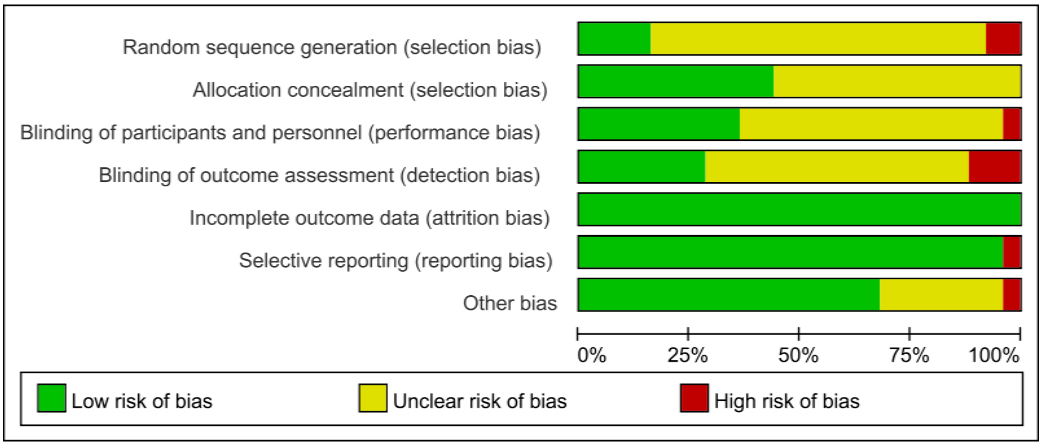


Figure 2. Percentage of text bias items

Table 1. Incorporate the quality of the article (from older year of publication).

First author/year	Random Sequence Generation	Allocation concealment	Blinding of participants	Blinding of outcome Assessment	Incomplete outcome Data	Selective reporting	Other bias	The quality fraction
Hall 2009 [17]	U	U	U	U	L	L	L	B
Taylor-Piliae 2010 [18]	U	L	U	U	L	L	L	B
Mortimer 2012 [19]	U	20L	U	U	U	H	L	B
Nguyen 2012 [20]	U	U	U	U	L	L	L	B
Sun 2015 [21]	L	L	L	H	L	L	L	B
Walsh 2015 [22]	U	U	U	U	L	L	U	B
Lu 2016 [23]	U	L	L	H	L	L	L	B
Tao 2016 [24]	U	L	U	U	U	L	L	B
Tao 2017 [25]	U	L	L	L	L	L	L	B
You 2018 [26]	L	L	L	H	L	L	L	B
Wu 2018 [27]	U	U	H	L	L	L	L	B
Xiaolin H 2018 [28]	L	L	L	L	L	L	L	A
Jinjin Z 2019 [29]	U	U	U	U	L	L	U	B
Shaohua L 2019 [30]	U	L	L	L	L	L	L	B
Yuan Y 2019 [31]	U	U	U	U	L	L	L	B
Ziyi Y 2019 [32]	L	U	U	U	L	L	U	B
Chewning 2020 [33]	U	U	U	U	L	L	L	B
Yang 2020 [34]	L	L	L	L	L	L	L	A
Gerritsen 2021 [35]	U	U	U	U	L	L	U	B
Qi 2021 [36]	H	U	L	L	L	L	U	B
Solianik 2021 [37]	U	U	U	U	L	L	L	B
Su 2021 [38]	U	U	U	U	L	L	L	B
Wu 2021 [39]	U	U	U	U	L	L	U	B
Yi 2021 [40]	U	U	U	U	L	L	U	B

Note: U unclear; H high bias; L low bias; A high quality; B medium quality of education. The intervention methods of the experimental group included *taijichuan*, *Baduanjin*, Wuqinxi, *Qigong*, etc., while the intervention methods of the control group included no intervention, health education, social interaction, physical activity, etc. The intervention dose ranged from once every two weeks to more than five times a week, with each intervention lasting from 30 minutes to 120 minutes and the intervention period from 6 weeks to 40 weeks. See Table 2 for details.

Summary of evidence

Various direction of cognitive

Executive function 13 RCTs [17-21, 23, 24, 27-31, 34, 35, 41] examined the effect of CTE on executive function in older adults. The results were statistically significant [SMD = −0.72, 95CI% (−0.48, −0.96), p<0.00001], and the random effect model (p<0.00001, I² = 87%) was adopted (Figure 3a).

Table 2. Include basic information of the article (from older year of publication).

The first author	Age	Sample size	Cognitive standard	Means of intervention		Intervention dose (treatment group)	Outcomes
				The experimental group	The control group		
Hall 2009 [17]	72.2 ±7.7	8 7	MMSE ≥24	24-form Yang-style TCC	Health education	90 min each session, 2 sessions per week for 12 weeks	Cognitive-motor
Taylor-Piliae 2010 [18]	70.6± 5.9 68.5±5	37 39	Education years 15.9±2.7 16.1±1.9	Yang-style TCC	Western Exercise	45 min each session, 2 sessions per week for 24 weeks	Long-Term Storage and Retrieval, Short-Term and Working Memory
	70.6± 5.9 68.2 ±6.2	37 56	Education years 15.9±2.7 16.3±1.6		Health education		
Mortimer 2012 [19]	67.3±5.3 67.9±6.5	29 27	Education years 11.8±2.6 11.4±3.3	TCC	Walking	50 min each session, 3 sessions per week for 40 weeks	Executive function, Short-term memory, Processing speed, Long-Term Storage and Retrieval, global cognition
	67.3±5.3 68.2±6.5	29 24	Education years 11.8±2.6 12.5±3.8		No intervention		
Nguyen 2012 [20]	69.23±5.30 68.73±4.95	48 48	MMSE ≥25	24-form TCC	No intervention	60 min each session, 2 sessions per week for 24 weeks	Executive functions
	70.6± 5.9 68.5±5	37 39	Education years 15.9±2.7 16.1±1.9	Yang-style TCC	Western Exercise		
Sun 2015 [21]	68.3 ± 5.9 70.1 ± 5.7	72 66	MMSE 26.4 ± 2.4 26.8 ± 1.7	24-form TCC	Social interaction	60 min each session, 2 sessions per week for 24 weeks	global cognition
	67.3±5.3 67.8±5	29 27	Education years 11.8±2.6 10.9±3.9	TCC	Walking		
Walsh 2015 [22]	63.94±8.02 64.45±7.42	27 28	MMSE 29.03±1.17 29.21±0.82	TCC	usual care	30 min each session, 2 sessions per week for 24 weeks	Executive function, Long-Term Storage and Retrieval, Short-Term and Working Memory
Lu 2016 [23]	72.8 ±6.7 67.6±6.6	13 14	CMMSE ≥21	Yang-style TCC	Social interaction	90 min each session, 3 sessions per week for 16 weeks	Executive function
	62.38±4.55 59.76±4.83	21 25	Education years 9.61±3.02 8.52±3.65	24-form TCC			
Tao 2016 [24]	62.38±4.55 59.76±4.83	21 25	Education years 9.61±3.02 8.52±3.65	24-form TCC	Health education	60 min each session, 5 sessions per week for 12 weeks	Short-Term and Working Memory

The first author	Age	Sample size	Cognitive standard	Means of intervention		Intervention dose (treatment group)	Outcomes
				The experimental group	The control group		
	62.18±2.75 60.16±4.48	16 24	MMSE 27.87±0.98 27.2±1.92	Baduanjin			
Tao 2017 [25]	62.38±5.5 60.16±4.48	21 24	MMSE 27.67±2.34 27.2±1.92	24-form Yang-style TCC	non-intervention	60 min each session, 5 sessions per week for 12 weeks	Short-Term and Working Memory
	62.18±2.75 60.16±4.48	16 24	MMSE 27.87±0.98 27.2±1.92	Baduanjin			
You 2018 [26]	74.27±7.48 74.78±7.17	22 23	MMSE 27.59±1.82 28.3±1.99	8-form Yang-style TCC	light physical exercise	60 min each session, semiweekly for 12 weeks	executive function, Processing Speed
Wu 2018 [27]	64.9±2.8 64.9±3.2	16 15	MoCA 28.3±1.5 28.4±1.5	24-form Yang-style TCC	non-intervention	60 min each session, triweekly for 12 weeks	executive function, Electrophysiological signals in the brain
Xiaolin H 2018 [28]	82.86±4.37 83.94±3.38	36 35	MMSE 23.47±3.33 23.54±2.48	Baduanjin	Resistance intervention	35-45 min each session, triweekly for 12 weeks	Global Cognition
Jinjin Z 2019 [29]	67.8±3.6 66.3±3.2	13 12	None data	24-form TCC	non-intervention	60 min each session, triweekly for 12 weeks	Cognitive-motor
Shaohua L 2019 [30]	66.66±4.89 65.97±4.13	38 36	MoCA 22.32±3.86 23.94±2.03	Wuqinxi	non-intervention	60 min each session, weekly for 40 weeks	executive function, Global Cognition, Long-Term Storage and Retrieval, Processing Speed, Short-Term and Working Memory
Yuan Y 2019 [31]	66.31±4.25 65.92±3.48	13 13	MMSE 26.73±2.63 27.47±1.69	24-form simplified TCC	non-intervention	45 min each session, triweekly for 8 weeks	executive function, Brain physiological signal
Ziyi Y 2019 [32]	64.5±3.9 63.2±5.3	16 17	Education years 7.5±1.2 7.2±0.8	TCC	non-intervention	75 min each session, no less than 5 times per weeks, 24 weeks	executive function, Brain physiological signal
Chewning 2020 [33]	75±7.4 72.8±7	94 103	None data	Yang-style TCC	non-intervention	90 min each session, semiweekly for 6 weeks	executive function
Yang 2020 [34]	66.31±4.25 65.92±3.48	13 13	MMSE 26.73±2.63 27.47±1.69	24-form simplified TCC	non-intervention	45 min each session, triweekly for 8 weeks	executive function
Gerritsen 2021 [35]	63.95±7.25 63.17±7.73	20 23	MMSE 29.45±0.89 29.17±1.15	Yang-style TCC+Dao yin QG	health educational videos	45 min each session, semiweekly for 10 weeks	executive function
Qi 2021 [36]	63.91±4.06 64.5±4.41	22 26	MoCA 27.64±1.56 26.96±1.46	QG	Healthy education	120 min each session, semiweekly for first 6 weeks; 120 min each session, weekly for second 6 weeks	processing Speed,Short-Term and Working Memory
Solianik 2021 [37]	≥60	15 15	MMSE ≥24	8-form Yang-style TCC	non-intervention	60 min each session, Once every two weeks, 10 weeks	Processing Speed, Short-Term and Working Memory, executive function
Su 2021 [38]	64.4±6.57 65.37±6.31	32 33	MoCA 26.97±1.15 27.23±1.14	Baduanjin	physical education classes	60 min each session, 5 sessions per week	Long-Term Storage and Retrieval, Processing Speed, executive function
Wu 2021 [39]	63.6±4 63.2±4.4	19 19	MoCA 28.3±1.4 28.5±1.4	24-form Yang-style TCC	non-intervention	60 min each session, triweekly for 12 weeks	executive function
Yi 2021 [40]	75.1±4.9 78±5.5	25 18	MMSE 26.8±2 26.2±2.2	Forest QG	Forest Walking	120 min each session, semiweekly for 6 weeks	global Cognition, Brain physiological signal

Note: MoCA Montreal Cognitive Assessment; MMSE Mini-mental State Examination; TCC taijichuan; QG qigong

Brain physiological signal 5 RCTs [20, 21, 26, 29, 31] examined the effect of CTE on the improvement of physiological signals in the brain of the elderly. The results were statistically significant [SMD = 0.50, 95CI% (0.28, 0.71), p<0.00001], using a random effect model (p<0.00001, I^2 = 74%) (Figure 3b).

Short-term and working memory 8 RCTs [19, 24, 25, 32, 33, 38, 40, 41] examined the effect of CTE on short-term working memory in the elderly. The results were statistically significant [SMD = 0.44, 95CI% (0.25, 0.64), p<0.00001], using a random effect model (p<0.00001, I^2 = 75%) (Figure 3c).

Processing speed 8 RCTs [19, 23-25, 30, 33, 37, 41] examined the effect of CTE on improving processing speed in older adults. The results were statistically significant [SMD= −0.32, 95CI% (−0.49, −0.15), p = 0.0003] using a random effect model (p<0.00001, I^2 = 61%) (Figure 3d).

Cognitive-motor 3 RCTs [18, 30, 39] examined the effect of CTE on the improvement of cognitive-motor in the elderly. The results were statistically significant [SMD=0.48, 95CI% (0.17, 0.78), p = 0.002] using a random effect model (p = 0.02, I^2 = 52%) (Figure 3e).

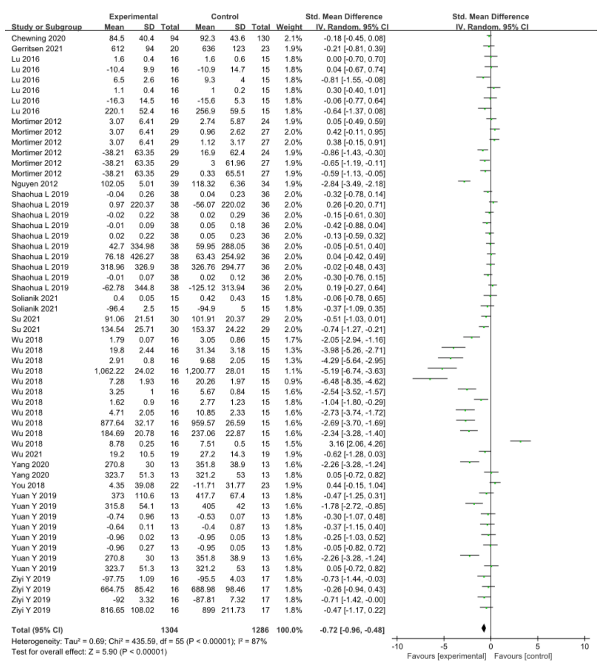
Long-Term Storage and Retrieval 5 RCTs [19, 23, 33, 38, 41] examined the effect of CTE on long-term memory and retrieval in older adults. The results were statistically significant [SMD = 0.31, 95CI% (0.15, 0.48), p = 0.0002] using a random effect model (p = 0.003, I^2 = 52%) (Figure 3f).

Global cognitive 6 RCTs [17, 19, 22, 26, 36, 41] examined the effect of CTE on overall cognition in older adults. The results were not statistically significant [SMD = 0.26, 95CI% (0.16, 0.35), p<0.00001], and the fixed-effect model was adopted (p = 0.02, I^2 = 38%) (Figure 3g).

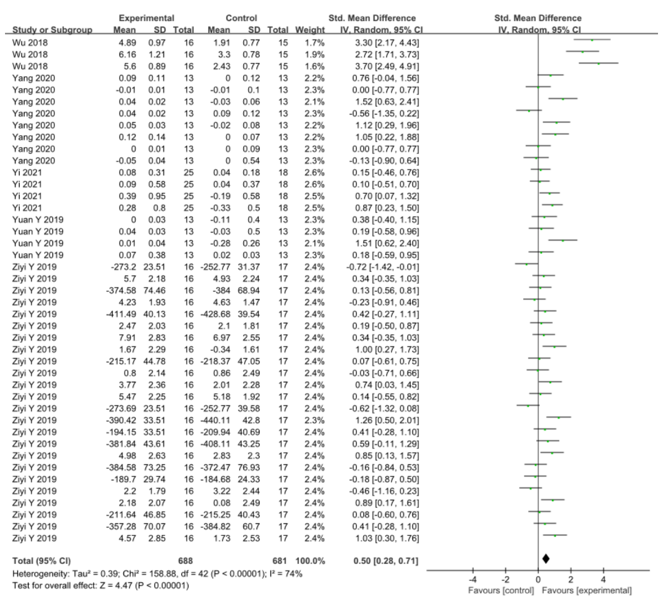
Subgroup analysis

Age In age subgroup analysis, compared with the control group, CTE had the best effect on the improvement of cognitive function in the elderly aged 60-65 years [SMD = 0.77, 95CI% (0.53, 1.01), p<0.00001], followed by the elderly aged 65-70 years [SMD = 0.23, 95CI% (0.13, 0.33), p<0.00001], and there was no significant difference in age 70 years and older [SMD = 0.12, 95CI% (−0.08, 0.32), p = 0.25].

Means of intervention In the subgroup analysis of intervention methods in the experimental group, it was found that 24-form *taijichuan* had the best effect on the improvement of cognitive function in the elderly [SMD = 1.15, 95CI% (0.86, 1.44), p<0.00001], followed by other CTE [SMD = 0.44, 95CI% (0.31, 0.57), p<0.00001], other forms



(a)



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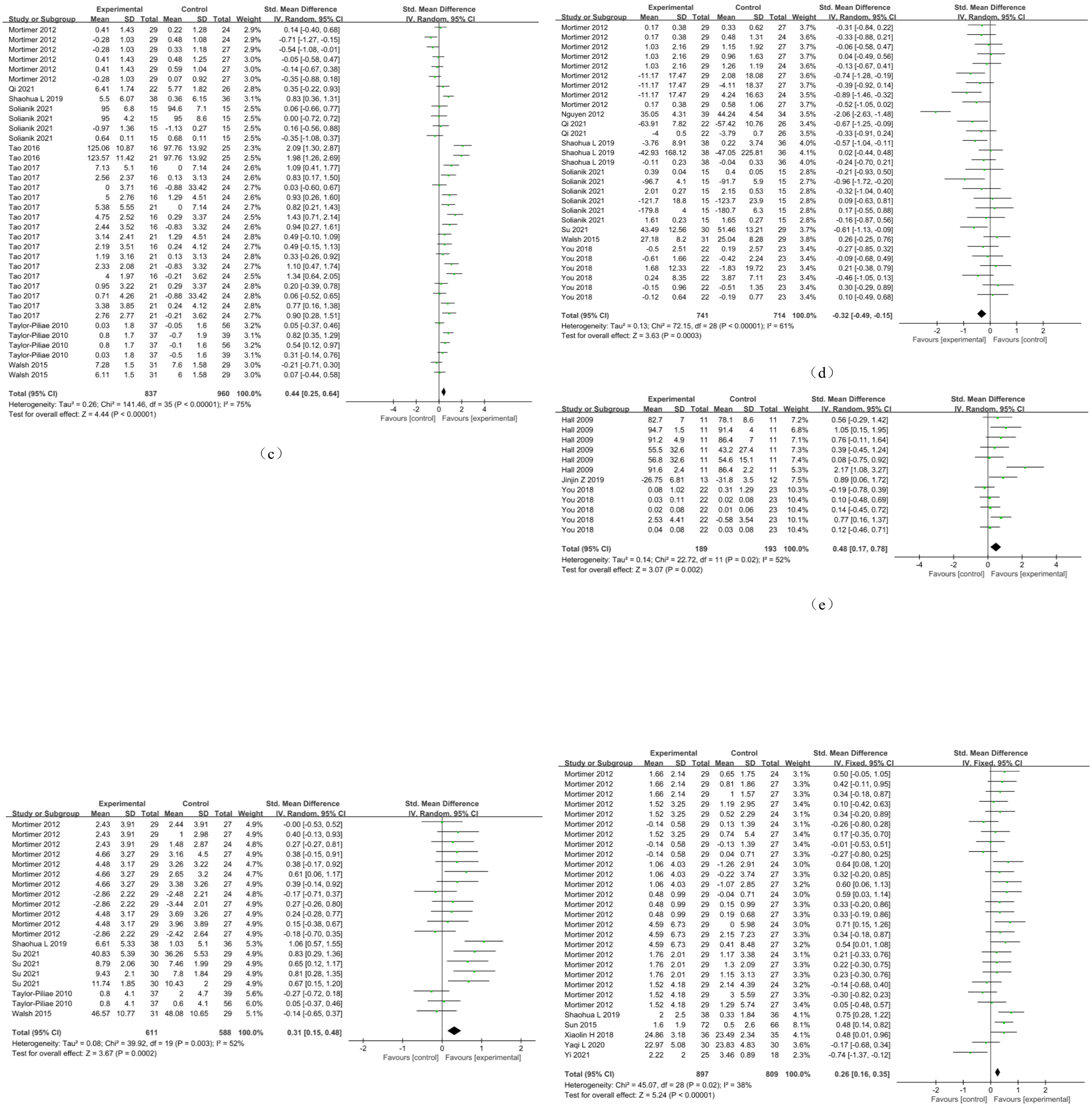

Figure 3. Meta-analysis of the effect of Traditional Chinese excercise on the cognitive improvement of the elderly (**a** executive function; **b** psyhological signals; **c** short-term and working memory; **d** processing speed; **e** cognitive-motor; **f** long-term storage and retrieval; **g** global cognition).

of *taijichuan* had the least effect [SMD = 0.09, 95CI% (0.02, 0.16), p = 0.008]. Subgroup analysis of the control group showed that the improvement effect of CTE compared with no physical activity intervention [SMD = 0.46, 95CI% (0.35, 0.57), p<0.00001] was stronger than that with physical activity intervention [SMD = 0.25, 95CI% (0.13, 0.37), p<0.0001).

Intervention dose Subgroup analysis of exercise frequency of intervention dose showed that the effect of CTE more than 3 times a week [SMD = 0.53, 95CI% (0.39, 0.67), p<0.00001] was the best, and the effect of CTE 3 times a week, 2 times a week, and less than 2 times a week decreased, respectively [SMD = 0.49, 95CI% (0.33, SMD = 0.23, 95CI% (0.05, 0.42), p = 0.01; SMD = 0.31, 95CI% (0.22, 0.41), p<0.00001]. Subgroup analysis of exercise duration of intervention dose showed that exercise duration of 60min per session had the best effect [SMD = 0.71, 95CI% (0.54, 0.88), p<0.00001], and the effect of less than 60min or greater than 60min [SMD = 0.13, 95CI% (0.036, 0.22), p = 0.009; SMD = 0.31, 95CI% (0.17, 0.45), p<0.0001] was lower and the lowest less than 60min. Subgroup analysis of the exercise cycle of the intervention dose found that the effect of 12 weeks of each intervention was the largest [SMD = 0.94, 95CI% (0.67, 1.22), p<0.00001], and the effect of less than or greater than 12 weeks [SMD = 0.33, 95CI% (0.15, 0.51), p = 0.0003; SMD = 0.18, 95CI% (0.09, 0.27), p<0.0001] was lower (Table 3).

DISCUSSION

This review found that compared with the control group, CTE significantly improved most cognitive abilities of the elderly, including executive function, processing speed, long-term memory and retrieval, short-term working memory, brain physiological signals, and overall cognitive function. Subgroup analysis found that compared with the control group, CTE significantly improved the cognitive function of the elderly aged 60-65 years, while the elderly aged 65-70 years had a smaller improvement, while the elderly aged 70 years and above had only a slight improvement and was not significant. Compared with the control group with no physical activity, the 24-form *taijichuan* significantly improved the cognitive function of the elderly, while the other methods had little significant effect. More than

Table 3. Subgroup analysis of CTE on cognitive function improvement in the elderly

Sectionalization			Number of researcher	Effectiveness	95%CI	The effect of P values	Heterogeneity (I^2/P)
Age	60≤n<65		8	0.77	0.53~1.01	<0.00001	86%, <0.00001
	65≤n<70		8	0.23	0.13~0.33	<0.00001	73%, <0.00001
	70≤n		5	0.12	−0.08~0.32	0.25	60%, <0.0001
Intervention mode of experimental group	24's tai chi		9	1.15	0.86~1.44	<0.00001	88%, <0.00001
	Other chi		9	0.09	0.02~0.16	0.008	47%, <0.00001
	Other sports		7	0.44	0.31~0.57	<0.00001	60%, <0.00001
Control group intervention	No physical activity intervention		18	0.46	0.35~0.57	<0.00001	80%, <0.00001
	There are physical activity interventions		9	0.25	0.13~0.37	<0.0001	66%, <0.00001
Intervention dose	Frequency	n<2	3	0.31	0.22~0.41	<0.00001	29%, 0.06
		2	9	0.23	0.05~0.42	0.01	79%, <0.00001
		3	8	0.49	0.33~0.64	<0.00001	84%, <0.00001
		n>3	5	0.53	0.39~0.67	<0.00001	61%, <0.00001
	Time	<60	7	0.13	0.03~0.22	0.009	62%, <0.00001
		60	11	0.71	0.54~0.88	<0.00001	85%, <0.00001
		>60	6	0.31	0.17, 0.45	<0.0001	53%, <0.0001
	Duration	<12	6	0.33	0.15~0.51	0.0003	61%, <0.00001
		12	9	0.94	0.67~1.22	<0.00001	88%, <0.00001
		>12	8	0.18	0.09~0.27	<0.0001	67%, <0.00001

3 times a week, 60min each time, 12 weeks of CTE can significantly improve the cognitive function of the elderly, other exercise dose mode also has significant effect but small.

CET and cognitive function

Individual cognitive functions include several aspects, such as mentioned in this paper, the execution of the function, the overall cognitive function, cognitive and other sports, and executive function is one of the important part of individual cognitive functions, including a number of important functions, such as memory, processing power, attention, thought control and motion control, etc., that is a function of individual behavior control [41]. Our results show that CTE can significantly improve multiple cognitive functions in the elderly, which is similar to previous reviews [42, 43]. In the process of CTE exercise, body posture is constantly changing, so it is necessary to control the speed of action, meet the consistency of action, and keep in mind the essentials of action, so as to successfully complete the action with high quality. Among them, the frontal lobe, as one of the important brain regions of executive function, is fully exercised during this process [44]. Therefore, in the process of CTE, not only physical activities are involved, but also cognitive activities are combined in the process of continuous movement of the body. Gavelin et al. [16] also discussed the exercise relationship between physical activity and cognitive function in their review, and believed that the exercise effect was best if the two were combined.

According to studies, hippocampus is significantly correlated with individual memory[45], and hippocampus can be shaped through physical exercise [46]. For example, Erikson et al. [44] found that aerobic exercise can significantly increase hippocampus volume and enhance memory ability. Yue et al. ‘s [7] study found that the density of gray matter in the hippocampus of the *taijichuan* exercise group was higher, so the CTE intervention involving a large amount of *taijichuan* and physical activities similar to *taijichuan* could significantly improve the long-term memory and retrieval and short-term working memory of the elderly.

Physiological signals mainly refer to the signals that directly record the brain activity of individuals in the process of cognitive tasks, including brain waves and activation of brain regions. In this study, it was found that after CTE intervention, the signal intensity in the brain region of the elderly was significantly improved during cognitive activities. For example, Yuan Y et al. [31] found oxygenated hemoglobin concentrations in the left inferior left area and left superior right area increased significantly in the Flanker task after 8 weeks of *taijiquan*. Wei et al. [47] also found in the study that the group that participated in taijichuan exercise for a long time had a significantly thicker structure of gyri in some brain regions. In addition, Pan et al. [48] also found in their review that after *tai chi* intervention, individual cerebral cortex thickness and functional connectivity of brain areas showed significant changes. Ziyi Y [32] found that after *taijichuan* intervention for 24 years, the amplitude of early negative wave in frontal region, central region and top region significantly increased and the incubation period was significantly shorter in the elderly during the n-back task, while the amplitude of late positive wave significantly increased and the incubation period was significantly shortened.

Exercise prescription

According to the results of this study, the preferred exercise method for CTE is 24-form taijichuan, which is performed in the elderly group aged 70 and below, more than 3 times a week, 60 minutes each time, and the optimal exercise effect can be obtained only after at least 12 weeks of exercise.

Limitations

Although we have further clarified the application scheme of CTE in the elderly group, there are still some problems to be solved in the future experimental scheme. Firstly, which CTE can improve which cognitive fields in the elderly better, which we cannot accurately judge due to the current limitations of RCTs. Secondly, exercise prescription for the elderly in different age groups needs to be more accurate. Finally, the number of high-quality RCTs is insufficient, and some subjective evaluation process may cause some interference to the research results.

CONCLUSIONS

The results of this review show that traditional Chinese exercise has a significant effect on the cognitive function of the elderly, but it should be noted that with the increase of individual age, this effect may decrease or even have no significant effect. Older can choose 24-form *taijichuan* as the first intervention method, and more than 2 times a week, 60 min each time, at least 12 weeks to achieve the maximum effect of cognitive function improvement.

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