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Review Article

Effects of Meditation and Mind–Body Exercises on Older Adults' Cognitive Performance: A Meta-analysis

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Abstract

Background and Objectives: Meditation and mind–body exercises are suggested to delay decline or enhance cognitive capabilities in older adults. However, their effectiveness remains uncertain. This study assessed the effectiveness of meditation and mind–body exercises to improve cognition in elderly people aged 60 years or above. Moderator variables were also explored.

Research Design and Methods: A databases search (MEDLINE, EMBASE, CINAHL, PsycINFO, Cochrane Library, Web of Science, CNKI, and Wangfang) was conducted from the first available date to January 10, 2018. Inclusion criteria include (a) human older adults aged 60 years or above, (b) meditation, Tai Chi, Qigong, or yoga intervention, (c) intervention should be structured, (d) inclusion of a control group, (e) at least one outcome measure of cognition was measured at baseline and post-training, and (f) peer-reviewed journal articles in English or Chinese.

Results: Forty-one studies (N = 3,551) were included in the meta-analysis. In general, meditation and mind–body exercises improve cognition in the elderly people (SMD = 0.34, 95% CI: 0.19 to 0.48), but the cognition-enhancing effects depend on the type of exercise. In addition, cognitive performance is only improved when the length of intervention is longer than 12 weeks, exercise frequency is 3–7 times/week, or duration of an exercise session is 45–60 min/session.

Discussion and Implications: This study suggests that meditation and mind–body exercises are effective to improve cognition of older adults aged 60 years or above, and exercise parameters should be considered for intervention planning.

Keywords: Alternative and complementary medicine/care/therapy, Cognition, Dementia, Exercise/physical activity

The world population is aging. The proportion of older adults aged 60 years or above is expected to increase from 12% to 22% between the years 2015 and 2050 (World Health Organization, 2018). Normal aging is associated not only with reduced physical health but also with cognitive decline. Other than healthy aging, some older people may have some forms of dementia. It is estimated that 47 million people worldwide are having dementia, and 66 million people could be affected by the year 2030 (Prince et al., 2013). Given a large number of affected people and the great burden imposed on the health care system, a search for effective interventions to ameliorate cognitive decline or improve cognitive functions in the older population is of immense significance.

Older adults of different cognitive statuses can improve cognitive functions through exercise participation (Angevaren, Aufdemkampe, Verhaar, Aleman, & Vanhees, 2008; Groot et al., 2016). Although cognition is usually reduced in older adults, abundant research has demonstrated the malleability of elderly people's neural system, which enables them to acquire new skills or restore the affected capabilities (Cai, Chan, Yan, & Peng, 2014; Wu, Chan, & Yan, 2016). Behavioral and psychological interventions (including physical exercises and cognitively stimulating activities) are recommended for improving cognitive functions of older adults. The association between physical activity and reduced risks of cognitive disorders in older adults has been documented (Buchman, Boyle, Yu, Shah, Wilson, & Bennett, 2012). The benefits of physical activity on cognition are believed to be mediated by the promotion of neurogenesis, synaptogenesis, and capillarization (Colcombe & Kramer, 2003), and increases in brain-derived neurotrophic factor and insulin-like growth factors (Cotman, Berchtold, & Christie, 2007; Vaynman, Ying, & Gomez-Pinilla, 2004). These interacting factors are supposed to contribute to the neuroprotective effects of exercises on elderly people's cognition.

Besides traditional physical exercises, there is a growing number of research into the benefits of mind–body exercises over the past decades. They are usually performed at a slow pace and low intensity, and thus, are particularly suitable for older adults (Guo, Shi, Yu, & Qiu, 2016; Taylor-Piliae et al., 2010). Compared to physical exercises, mind–body exercises have a higher cognitive demand and emphasize cognitive well-being. It has been suggested that exercise interventions with a higher cognitive demand are particularly efficacious to slow down age-related cognitive decline (Raichlen & Alexander, 2017). A recent meta-analysis has also shown that a combination of physical and cognitive activities is ideal for treating or preventing cognitive decline in older adults (Gheysen et al., 2018). Tai Chi, Qigong, and yoga are prime examples of mind–body exercises. Tai Chi is a multicomponent exercise that trains exercisers' aerobic, anaerobic, and flexibility capacities. Qigong involves a set of static or dynamic exercises through coordinated breathing and physical movements to cultivate one's internal energy to achieve body healing, and Baduanjin is one of the most common forms of Qigong (Chen et al., 2013). Yoga originates from ancient India and includes practice of postures, breathing, and meditation to support optimal homeostasis. There is increasing evidence to show the efficacy of mind–body exercises to improve the cognitive functions of the elderly people (Gothe & McAuley, 2015; Wu, Wang, Burgess, & Wu, 2013).

Mind–body exercises usually include meditation as a part of training. Meditation involves various emotional and attentional regulatory strategies to achieve cognitive well-being and emotional balance (Lutz, Dunne, & Davidson, 2006). There is a growing body of literature to suggest that meditation may benefit the cognitive functions in older adults and those with neurodegenerative diseases (Newberg et al., 2014), possibly through enhancements of brain regions related to interoception and attention (Hölzel et al., 2008).

In this study, we investigated if meditation and mind–body exercises (meditation, Qigong, Tai Chi, yoga) benefit older adults' cognition via the meta-analytic approach. Further examinations will be conducted to compare their effectiveness. To improve prescription of meditation and mind–body exercises in the future, we also analyzed the exercise moderators associated with cognitive benefits in older adults. It was hypothesized that, relative to the control participants, older adults in meditation and mind–body exercises show cognitive improvement. As suggested in previous research, different types of exercise may have varying influences on different cognitive domains (Voss, Nagamatsu, Liu-Ambrose, & Kramer, 2011). We hypothesized that cognitive improvement depends on the type of exercise.

Methods

The systematic review with meta-analysis was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) (Moher, Liberati, Tetzlaff, & Altman, 2009).

Search Strategy

A computer search of MEDLINE, EMBASE, CINAHL, PsycINFO, Cochrane Library, and Web of Science was conducted up to January 10, 2018, using the search phrase, (*Tai Chi* OR *Tai Ji* OR *yoga* OR *Baduanjin* OR *Qigong* OR *meditation*) AND (*cognition* OR *attention* OR *memory* OR *executive function*). The Chinese equivalent search phrase was used in the CNKI and Wangfang databases to search for Chinese articles.

All returned titles were screened by the first author (J. S. Y. Chan) to exclude duplicate and irrelevant studies based on the article title. The abstract of each remaining study was then independently reviewed by two investigators (J. Wu and YD), this stage was overinclusive. In case of disagreement of judgment, the article would be carried to the next screening stage. Subsequently, the full texts of the remaining studies were independently reviewed against the inclusion criteria. The interrater agreement was high (Cohen's kappa = 0.78). In this stage, the reviewers had to discuss with each other to reach a consensus in case of disagreements. Reviewers also looked at the bibliography of the included articles and published review articles to avoid missing potentially relevant studies.

Inclusion and Exclusion Criteria

Studies were included if they met the following criteria: (a) studies of human older adults (60 years or older); (b) participants can be cognitively impaired (e.g., mild cognitive impairment [MCI] or dementia), but should not have other neurological (e.g., stroke) and/or mental illnesses (e.g., depression); (c) a structured exercise program of any duration, frequency, or intensity; (d) a control group was included; (e) at least one outcome measure of cognition was measured at baseline and post-training; and (f) peer-reviewed articles in English or Chinese.

Data Extraction

Data of the study population, intervention, and outcome measures were independently extracted with a standardized form by two investigators (K. Deng and CW). For both intervention and control groups, sample size, mean values of outcome measure at baseline and post-intervention, and baseline standard errors were recorded. In addition to outcomes measures, potential moderators were also recorded. Type of exercise was categorically coded as meditation, Qigong, Tai Chi, or yoga. Previous studies have found impairments in attention (Chao & Knight, 1997), processing speed (Finkel, Reynolds, McArdle, & Pedersen, 2007), verbal fluency (Kempler, Teng, Dick, Taussig, & Davis, 1998), and memory and executive functions (Buckner, 2004) in elderly people. Thus, we focused on these cognitive domains in this study. The cognitive domain was coded as attention, processing speed, verbal fluency, short-term memory, working memory, executive function, or global cognition. On the basis of the report in the included studies, participants' cognitive status was coded as healthy, MCI, dementia, or unclear. Three exercise parameters were recorded (program length, exercise frequency, and duration). The program length (short: ≤12 weeks; medium: 13–26 weeks; long: >26 weeks), exercise frequency (per week: low: ≤2; medium: 3–4; high: 5–7), and exercise duration (per session: short: ≤45 min; medium: >45 to ≤60 min; long: >60 min) were coded using a prior meta-analytic review as a guide (Northey, Cherbuin, Pumpa, Smee, & Rattray, 2018). The mean age of participants, year of education, and female percentage in a study were also extracted as continuous moderators.

Risk of Bias Assessment

Two researchers independently assessed the risk of bias of the included studies with the Cochrane Collaboration Guidelines across the following domains: randomization; allocation concealment; blinding (outcome assessor), incomplete data, selective reporting, and any other risk of bias. The Physiotherapy Evidence Database (PEDro) scale was also used to evaluate the risk of bias of the included studies (www.pedro.org.au). The scale contains 11 items (yes/no questions), covering the domains of randomization, concealed allocation, blinding and quality of reporting. PEDro score for each study was obtained by counting the number of yes (except for item 1), the score can range from 0 to 10. A previous study has suggested that a PEDro score more than 6 indicates good quality of study (Gonzalez et al., 2018). In this study, we considered studies with a PEDro score more than 6 as having a low risk of bias. Interrater agreement was high using either the Cochrane Collaboration Guidelines (Cohen's kappa = 0.7) or the PEDro scale (Cohen's kappa = 0.72). Discrepancies in the risk of bias assessment were resolved by discussion between the reviewers.

Statistical Analyses

Cognitive measures were the primary outcomes. To account for the dependency of outcome measures within studies, a multilevel random-effects meta-analysis was conducted in R (version 3.5.0) with the metafor package (version 2.0-0) using an unrestricted maximum likelihood estimator (Viechtbauer, 2010). On the basis of the approach of Becker (1988), standardized mean difference (SMD) was computed as the effect size using formulae 1–3, where gT and gC are the standardized mean change for the intervention and control groups, respectively. $\bar{X}_{\text{pre-intervention}}$, $\bar{X}_{\text{post-intervention}}$, $SD_{\text{pre-intervention}}$, and n indicate the pre-intervention and post-intervention means, pre-intervention *SD*, and sample size, respectively. $c\,(n-1) = \sqrt{2/\,(n-1)}\;\Gamma\,[(n-1)\,/2\,]/\Gamma[\,(n-2)\,/2]$ is a bias-correction factor. The formulae assume that the pre-intervention and post-intervention variances are homogeneous. A positive SMD indicates a greater cognitive benefit in the experimental group, relative to the control group.

$$g_T = c\,(n_T - 1)\sqrt{\frac{\bar{X}_{\text{post-intervention},T} - \bar{X}_{\text{pre-intervention},T}}{SD_{\text{pre-intervention},T}}} \tag{1}$$

$$g_C = c\,(n_C - 1)\sqrt{\frac{\bar{X}_{\text{post-intervention},C} - \bar{X}_{\text{pre-intervention},C}}{SD_{\text{pre-intervention},C}}} \tag{2}$$

$$SMD = g_T - g_C \tag{3}$$

Cochran's *Q* test was used to assess heterogeneity. In addition, I^2 (proportion of variance due to heterogeneity) was also computed to quantify the extent of heterogeneity (Higgins & Thompson, 2002). Separate models were fitted to determine the main effects of different moderators. To gain better insights into this issue, we also examined the interaction of type of exercise and cognitive domain. Statistical significance was determined by omnibus tests. Exploratory analyses of the moderating effects of mean age of participants, year of education, and female percentage were conducted by meta-regression. To evaluate the influence of risk of bias on the meta-analytic results, separate random-effects models were fitted for studies of low risk of bias (PEDro score >6) and studies of high risk of bias (PEDro score ≤6).

Publication bias was assessed with Egger's regression. In Egger's regression, a significant deviation of the *y*-intercept from zero might indicate the presence of publication bias. In addition, a Rosenthal fail-safe N test was also conducted to estimate the number of unpublished null studies required to nullify the overall effects at the 95% level.

Results

The PRISMA flowchart was presented in Figure 1. In the initial search, 5,113 records were returned of which 427 studies were retrieved for full-text reading. Eventually, 41 studies met all the inclusion criteria for quantitative analyses, involving 3,551 participants. The included studies can be grouped by the type of exercise into meditation (*k* = 11), Qigong (*k* = 9), Tai Chi (*k* = 14), and yoga (*k* = 9). Characteristics of the included studies are summarized in Supplementary Table 1 and a forest plot of the included studies was presented in Supplementary Figure 1. As was observed in Supplementary Table 1 and Supplementary Figure 1, studies of a large sample size usually have a narrower confidence interval (CI).

Risk of Bias

Risk of bias of the included studies is shown in Figure 2. Most of the studies have low risks in sequence generation, incomplete outcome data, selective reporting, and other bias. However, in terms of allocation concealment and blinding, the risks are unclear in most of the included studies. Risk of bias of each included study is summarized in Supplementary Tables 2 and 3. On the basis of the PEDro scale score, 78% of the included studies can be classified as having a low risk of bias.

Effects of Meditation and Mind–Body Exercises on Cognition

Results of this meta-analysis show that meditation and mind–body exercises, relative to controls, improve cognition in the elderly people (SMD = 0.34, 95% CI: 0.19 to 0.48, $p < .001$), and there is significant heterogeneity across studies ($Q(152) = 604.30$, $p < .001$). Additional analyses showed that the pooled effect size was lower for studies of low risk of bias (SMD = 0.27, 95% CI: 0.12 to 0.43) than for studies of high risk of bias (SMD = 0.59, 95% CI: 0.26 to 0.93) (Supplementary Figure 2). This suggests that an inclusion of studies of high risk of bias may inflate the pooled effect size but not change the conclusion (i.e., meditation and mind–body exercises have small-to-moderate effects to improve cognition in the elderly people).

The funnel plot appears asymmetrical (Figure 3), however, Egger's regression indicates an absence of funnel plot asymmetry ($p = .26$). According to previous simulation results (Fragkos, Tsagris, & Frangos, 2014), for a meta-analysis of 41 studies, the threshold of fail-safe N is 369. The estimated fail-safe N (12,699) is far above the threshold. On the basis of the Egger's regression and fail-safe N, the meta-analytic results should be robust to publication bias. I^2 indicates that heterogeneity is high across studies (80.5%).

Moderator Analysis

To investigate the potential sources of heterogeneity, moderators were analyzed in separate models. Results of

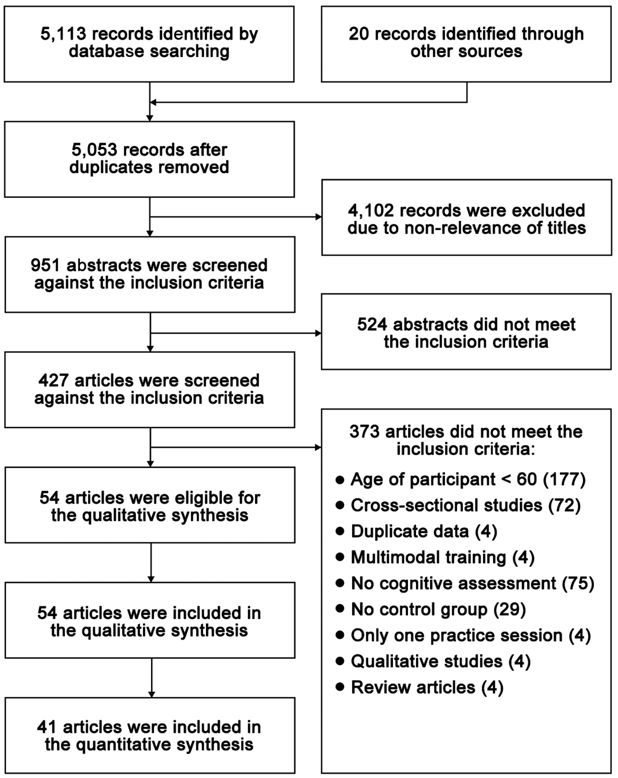

Figure 1. Study selection flowchart.

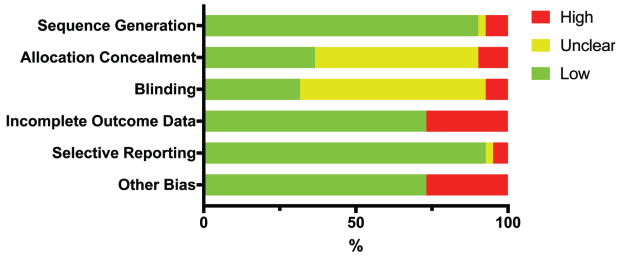

Figure 2. Risk of bias of the included studies.

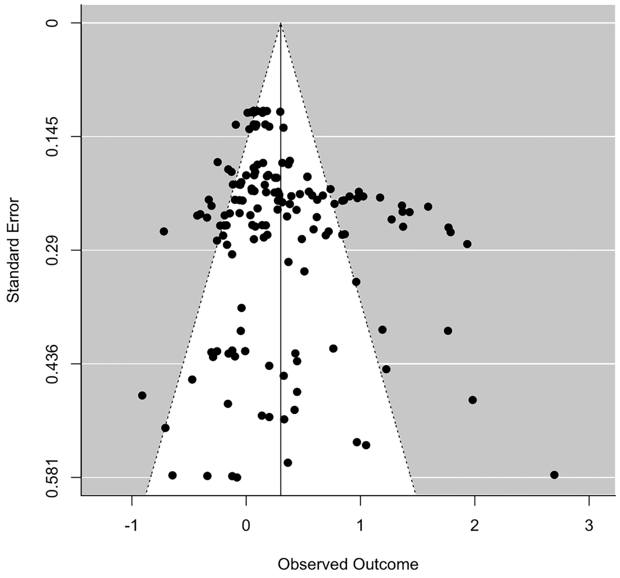

Figure 3. Funnel plot for visual inspection of publication bias.

moderator analyses are presented in Table 1. Although separate analyses were conducted for different moderators, heterogeneity remains high ($I^2 > 70\%$). This may implicate that the high heterogeneity observed is attributed to an interaction of multiple moderators or related to factors not considered in the moderator analyses.

Exercise moderators

Concerning the type of exercise, only meditation ($p < .001$) and Qigong ($p = .001$) produce significant positive effects on cognition. Studies, where the program length is medium to high, have shown significant cognitive improvement ($p < .001$). Only medium-to-high exercise frequency is related to cognitive improvement ($p < .02$). In terms of exercise duration, only medium duration is associated with positive effects on cognition ($p < .001$), whereas short and long durations produce nonsignificant effects on cognition ($p > .34$).

Cognitive moderators

The effect of meditation and mind–body exercises on cognition is significant for all cognitive domains ($p < .01$), except processing speed ($p = .06$). The cognition-enhancing effects are only observed in studies of participants with MCI ($p < .001$) or unclear cognitive status ($p = .006$). Furthermore, there is a significant interaction between type of exercise and cognitive domain ($p < .001$) (Table 2), suggesting that the effectiveness of different types of

Table 1. Results of Moderator Analyses

Moderator	No. of effect sizes	Estimated mean SMD (95% CI)	*p* value	*Q* statistic	I^2	Omnibus test of moderators
Type of exercise				$Q(149) = 447.3$, $p < .001$	72.4%	$Q(4) = 32.8$, $p < .001$
Meditation	45	0.41 (0.16 to 0.65)	.001			
Qigong	21	0.72 (0.41 to 1.03)	<.001			
Tai Chi	48	0.19 (−0.03 to 0.41)	.09			
Yoga	39	0.15 (−0.13 to 0.44)	.3			
Cognitive domain				$Q(146) = 577.5$, $p < .001$	79.6%	$Q(7) = 26.5$, $p < .001$
Attention	6	0.33 (0.01 to 0.65)	.04			
Executive function	32	0.39 (0.21 to 0.56)	<.001			
Global cognition	23	0.42 (0.24 to 0.61)	<0001			
Processing speed	6	0.36 (−0.02 to 0.74)	.06			
Short-term memory	32	0.28 (0.10 to 0.46)	.002			
Verbal fluency	17	0.27 (0.06 to 0.48)	.01			
Working memory	37	0.27 (0.10 to 0.44)	.002			
Cognitive status				$Q(149) = 592.5$, $p < .001$	79.9%	$Q(4) = 25.8$, $p < .001$
Healthy	21	0.17 (−0.20 to 0.53)	.4			
MCI	53	0.53 (0.28 to 0.78)	<.001			
Dementia	4	−0.14 (−1.08 to 0.79)	.8			
Unclear	75	0.29 (0.08 to 0.49)	.006			
Program length				$Q(150) = 555.7$, $p < .001$	79%	$Q(3) = 25.4$, $p < .001$
Short (≤12 weeks)	42	0.14 (−0.15 to 0.44)	.4			
Medium (13–26 weeks)	82	0.36 (0.17 to 0.55)	<.001			
Long (>26 weeks)	29	0.72 (0.38 to 1.05)	<.001			
Exercise frequency				$Q(146) = 540.4$, $p < .001$	78.8%	$Q(3) = 23.7$, $p < .001$
Low (≤2)	37	0.22 (−0.04 to 0.48)	.1			
Medium (3–4)	60	0.29 (0.04 to 0.55)	.02			
High (5–7)	52	0.50 (0.25 to 0.74)	<.001			
Exercise duration				$Q(131) = 425.0$, $p < .001$		$Q(3) = 29.2$, $p < .001$
Short (≤45 min)	54	0.03 (−0.20 to 0.27)	.8			
Medium (>45 to ≤60 min)	67	0.51 (0.32 to 0.70)	<.001			
Long (>60 min)	13	0.21 (−0.22 to 0.65)	.3			

Note: CI = confidence interval; MCI = mild cognitive impairment; SMD = standardized mean difference.

Table 2. The Effects of Different Types of Mind–Body Exercise on Cognition

	No. of effect sizes	Estimated mean SMD (95% CI)	p value
Attention			
Meditation	2	1.01 (0.20 to 1.81)	.01
Qigong	1	0.53 (−0.12 to 1.19)	.11
Tai Chi	0	NA	NA
Yoga	3	0.20 (−0.23 to 0.62)	.4
Executive function			
Meditation	12	0.29 (−0.02 to 0.61)	.07
Qigong	1	0.86 (−0.11 to 1.82)	.08
Tai Chi	9	0.30 (0.04 to 0.56)	.03
Yoga	10	0.33 (0.03 to 0.63)	.03
Global cognition			
Mediation	5	0.56 (0.21 to 0.92)	.002
Qigong	9	0.72 (0.39 to 1.05)	<.0001
Tai Chi	9	0.28 (0.02 to 0.53)	.03
Yoga	0	NA	NA
Processing speed			
Meditation	5	−0.05 (−0.52 to 0.42)	.8
Qigong	0	NA	NA
Tai Chi	0	NA	NA
Yoga	1	0.99 (0.36 to 1.63)	.002
Short-term memory			
Meditation	7	0.24 (−0.10 to 0.58)	.2
Qigong	6	0.86 (0.48 to 1.24)	<.0001
Tai Chi	7	0.25 (−0.04 to 0.53)	.09
Yoga	12	−0.01 (−0.31 to 0.29)	.9
Verbal fluency			
Meditation	9	0.24 (−0.10 to 0.57)	.2
Qigong	0	NA	NA
Tai Chi	6	0.15 (−0.13 to 0.44)	.3
Yoga	2	0.24 (−0.22 to 0.70)	.3
Working memory			
Meditation	5	0.55 (0.18 to 0.93)	.004
Qigong	4	0.54 (0.12 to 0.95)	.01
Tai Chi	17	0.19 (−0.05 to 0.43)	.1
Yoga	11	0.07 (−0.23 to 0.37)	.6

Note: NA = not available; SMD = standardized mean difference.

exercise may vary in different cognitive domains. It is shown that meditation improves attention, global cognition, and working memory (moderate-to-large effects). Qigong improves global cognition, short-term memory, and working memory (moderate-to-large effects). Tai Chi improves executive function and global cognition (small effects). Yoga improves executive function (small effect) and processing speed (large effect). There is no significant difference of change in executive function following Tai Chi and Yoga interventions ($p = .89$). In addition, the change in global cognition following meditation does not differ from those following Qigong ($p = .54$) or Tai Chi ($p = .14$). However, the improvement in global cognition after Qigong intervention is greater than that after Tai Chi intervention ($p = .04$). The changes in working memory following meditation and Qigong interventions do not differ significantly ($p = .95$).

Participant moderators

Supplementary Table 4 shows the meta-regression results. There are nonsignificant effects of mean age of participants ($\beta = -0.01$, 95% CI: −0.04 to 0.01, $p = .20$) and year of education ($\beta = -0.02$, 95% CI: −0.05 to 0.01, $p = .21$) on the estimated effect size. However, the percentage of female participants in a study is negatively associated with the estimated effect size ($\beta = -0.01$, 95% CI: −0.02 to 0, $p = .01$), suggesting that a 1% increase in female participants is associated with a reduction of estimated effect size by 0.01. It is important to note that, when year of education is included as a moderator, heterogeneity becomes small ($I^2 = 33.9\%$), suggesting that difference of participants' education level is the main contributor to the heterogeneity across studies.

Discussion

Effectiveness of Meditation and Mind–Body Exercises on Older Adults' Cognition

We examined the effectiveness of meditation and different mind–body exercises on elderly peoples' cognitive functions through meta-analytic methods. In general, meditation and mind–body exercises enhance older adults' cognitive performance, except processing speed. Meditation and mind–body exercises are particularly beneficial for elderly people with MCI. However, this does not mean that meditation and mind–body exercises do not affect cognitive performance of participants of other cognitive statuses, as most of the included studies did not explicitly mention the cognitive status of participants. Because of this, it would be inappropriate to conclude that meditation and mind–body exercises favor older adults of a certain cognitive status over the others at this stage.

Although meditation and mind–body exercises can improve older adults' cognition in general, follow-up moderator analyses indicate that only meditation and Qigong benefit cognitive performance. This means that meditation and Qigong should be considered if our aim is to boost the general cognitive performance in the elderly people. Further analyses show an interaction between type of exercise and cognitive domain, suggesting that the cognition-enhancing effects depend on the type of exercise. Specifically, meditation can improve attention, global cognition, and working memory. Qigong improves global cognition, short-term memory, and working memory. Tai Chi improves executive function and global cognition. Yoga improves executive function and processing speed. It has been previously shown that meditation and mind–body exercises can have different impacts on brain structures and functions (Fox et al., 2014; Gothe, Hayes, Temali, & Damoiseaux, 2018; Tao et al., 2017), and this may result in the differential benefits observed. Thus, if an older adult wants to improve a specific cognitive ability, he or she should take part in the corresponding exercise. For instance, meditation, rather than other mind/mind–body exercises, should be chosen for improving attention.

Besides directly affecting brain structures and functions, mind–body exercises may influence cognition through changing one's fitness level. Tai Chi and yoga usually have a higher level of physical activity than meditation and Qigong. As suggested in previous reports, improved aerobic fitness can be associated with enhanced executive functions and reduced age-related neurodegeneration (Colcombe & Kramer, 2003), and this is consistent to the present results that only Tai Chi and yoga improve executive functions.

Exercise Prescription

Analyses of the moderating effects of exercise parameters may help prescribe meditation and mind–body exercises optimally. It is shown that cognitive performance is only improved when the length of exercise program is medium to long (>12 weeks), exercise frequency is medium to high (3–7 times/week), or duration of an exercise session is medium (>45 to ≤60 min/session).

The present results are similar to those in a previous meta-analysis on the effectiveness of physical exercise on elderly cognition. In that study, a medium exercise duration is associated with cognitive benefits in older adults (Northey et al., 2018). That study also reveals that cognitive benefits are independent of intervention length and exercise frequency; however, we found cognitive benefits only when the exercise frequency and intervention length are at least medium. A possible reason of such discrepancies may be due to the fact that physical exercises are more physically demanding and can improve one's physical fitness more readily, thus, inducing more prominent changes in the brain in the physical exercisers (Colcombe & Kramer, 2003).

Limitations and Future Research

Several limitations have been noted, which can be improved in future studies. Heterogeneity is significant even after moderator analyses. Because of the nature of meditation and mind–body exercises, it is conceivable that variations within each type of exercise contribute a significant amount of heterogeneity. Currently, there is a limited number of studies into different subtypes of mind/mind–body exercise; hence, it would be difficult to discern and compare their effectiveness. In addition, based on I^2 results, we found that participants' education level may be the main source of heterogeneity across studies. Thus, future researchers should consider reporting sample's education level.

In addition, the quality of the included studies is usually moderate, and the methods of allocation concealment and blinding are usually unclear (Figure 2). Allocation concealment is to ensure that the assignment of participants is not foreseeable by investigators and/or participants. In case of a breach of allocation concealment, investigators may recruit participants they prefer, and participants may decide to participate in the study or not based on the allocation results (self-selection bias). Blinding of outcome assessor is to ensure that the outcome assessor is not aware of the group assignment of a participant, such that he or she can objectively record the outcome measures. The risk of bias assessment has shown that allocation concealment and blinding of outcome assessors are seldom reported in studies on meditation and mind–body exercises. Selection and detection biases may affect the accuracy and generalizability of results. Therefore, it is important for researchers to avoid these biases and report their procedures of allocation concealment and blinding in greater detail in the future.

Furthermore, most of the included studies did not report participants' cognitive status. Conceivably, cognitive status has significant impacts on one's baseline cognitive performance and room for improvement, thus, the cognitive status of participants should be assessed and clearly stated. In order to have a more comprehensive understanding of the effectiveness of meditation and body–mind exercises, future research may compare the change of performance in participants of different cognitive statuses after interventions.

The scope of this study is limited to "traditional" mediation and mind–body exercises. In recent years, mindfulness interventions (e.g., mindfulness-based stress reduction) have been proposed to improve emotional disturbances (Baer, 2003). As mindfulness interventions and other mind/mind–body exercises are similar, we would expect mindfulness interventions to be an option for improving older people's cognition; however, research on this topic is scarce and more effort should be invested in this area of study in the future.

Conclusions

This study used a multilevel design to account for the dependency of effect sizes within studies and examined the effects of mind/mind–body exercises on cognitive improvement in the elderly people. In addition, the effects of exercise length, duration, and frequency on cognitive improvement were also explored. This knowledge informs us how to optimally prescribe these activities to the elderly people for maximal benefits. In summary, meditation and mind–body exercises improve cognition of older adults aged 60 years or above, and the cognition-enhancing effects depend on the type of exercise. To obtain optimal effectiveness, intervention length and exercise frequency should be at least medium, and the duration of an exercise session should be medium. Meditation and mind–body exercises offer an accessible and effective means to improve cognition in the elderly people, and possibly counteract against the age-related cognitive decline. Given that meditation and mind–body exercises have a low physical demand, they are particularly suitable for older adults who have reduced physical ability and/or medical conditions not permitting them from practicing high-intensity exercises. As there is high heterogeneity across the included studies, more high-quality studies should be included in the future to ascertain the efficacy of meditation and mind–body exercises.

Supplementary Material

Supplementary data are available at *The Gerontologist* online.

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Conflict of Interest

We have no conflict of interest to declare.

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