The Influence of Physical and Mental Exercises on the Mental Health of Middle-Aged and Old People: A Systematic Review and Meta-Analysis

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Abstract

Background

To evaluate the influence effect of physical and mental exercises on the mental health of the middle-aged and old people by using Meta analysis method.

Methods

Retrieve databases such as CNKI, WanFang data, VIP Database for Chinese Technical Periodicals, Pubmed, Scopus, web of science, etc. to collect randomized controlled trials of the effect of physical and mental exercises on the mental health of the middle-aged and old people.

Results

The effects of physical and mental exercises on the somatization and obsessive-compulsive symptoms of middle-aged and old women belongs to a medium effect, and their influence effect on symptoms such as interpersonal sensitivity, depression, anxiety, hostility, phobic anxiety, paranoid ideation belongs to a small effect. The effects of physical and mental exercises on the middle-aged people is greater than that of the old people for symptoms such as obsessive-compulsive, interpersonal sensitivity, depression, and hostility, which belongs to a small-to-medium effect. For the symptoms such as somatization, anxiety, and paranoid ideation, the influence effect of physical and mental exercises on the old is greater than that of the middle-aged, which belongs to a small-to-medium effect. The effects of physical and mental exercises for 45-60 minutes each time, 3 times a week, lasting 12-20 weeks on the middle-aged and old for symptoms such as somatization, obsessive-compulsive, interpersonal sensitivity, depression, anxiety, hostility, phobic anxiety, paranoid ideation is significant, which belongs to a small-to-medium effect. The effects of Tai Chi exercise on somatization, obsessive-compulsive, interpersonal sensitivity, depression, anxiety, hostility, phobic anxiety, paranoia and other symptoms of middle-aged and elderly people were small to medium.

Conclusion

Physical and mental exercises have a small-to-medium effect on the middle-aged and old people for the symptoms such as somatization, obsessive-compulsive, interpersonal sensitivity, depression, anxiety, hostility, phobic anxiety, and paranoid ideation, but they have no significant effect on psychosis.

Background

Mental health is a manifestation of a person's good psychological quality and a necessary part of a person's overall health status[1]. The middle-aged and old people are a population with frequent mental diseases. The middle-aged people are easily excited, irritable, and depressed as the occurrence of slightly sad thing may cause them to have intense emotional reactions, or psychological problems such as depression and silence. The old may experience bereavement or retirement events, which may lead to

mental diseases[2-4]. The WHO defines the middle age as being 45-59 years old, while China defines the middle age as being 36-59 years old, and 60 years as the starting point of the old[5,6]. Today, the global population is rapidly aging, and the World Health Organization data shows that between 2015 and 2050, the proportion of the world's population over 60 will increase from 12% to 22%, nearly double that of the current population[7]. Poor mental states can cause various diseases, which can affect health and longevity[8]. Therefore, the middle-aged and old people need to take some corresponding measures to prevent the occurrence of mental diseases

As a non-pharmaceutical intervention, physical exercise plays an important role in controlling mild-to-medium mental diseases[9]. Physical and mental exercises serve to promote the dynamic balance between body, mind and the external environment through exercises such as pranayama, relaxation and meditation, and health qigong, Tai Chi and yoga are good examples[10-12]. Health Qigong is an integral part of Chinese long-standing culture, which is a traditional national sports program that combines physical activity, breathing and psychological adjustment as the main form of exercise[13]. It has the functions to improve fitness, health and bodybuilding[14]. There are currently nine types of popular health qigong: Yijinjing, Wuqinxi, Liuzijue; Baduanjin, Shierduanjin, Dawu, 12 - Step Daoyin Health Preservation Exercises, Mawangdui Daoyin Exercises, and Taiji health stick. Tai Chi in the traditional Chinese sports emphasizes "intention" and "quietness of mind", and has the effect of postponing aging and regulating emotions[15]. Additionally, yoga emphasizes the combination of the body, breathing, and consciousness, which can effectively promote mental health[16-18].

In recent years, the intervention effect of physical and mental exercises on the mental health of the middle-aged and old people has received attention from the scientific circle, and meta-analysis has shown that physical and mental exercises are effective in adjusting the mental health of the middle-aged and old people[19-24]. However, in these meta-analysis, two scales of depression or anxiety were used to measure mental health, and no SCL-90 scale was used to measure mental health. and the time, frequency and period of the physical and mental exercises are not quantified. Therefore, it is necessary to update the existing meta-analysis.

Symptom Checklist 90 is a symptom self-assessment scale in commonly used in clinics. The scale contains nine main symptomatic dimensions: somatization, obsessive-compulsive, interpersonal sensitivity, depression, anxiety, hostility, phobic anxiety, paranoid ideation and psychosis[25,26]. In the measurement of the symptom self- assessment scale, 9 randomized controlled studies reported that physical and mental exercises have a good effect on promoting the mental health of the middle-aged and old people[27-35]. However, there are great differences in aspects such as the sample size, exercise method, exercise time, exercise frequency, exercise cycle, etc., and single studies may have uncertain results. Therefore, in this paper, based on the SCL-90 scale, a Meta analysis has been made on the research of the effect of physical and mental exercises on the mental health of the middle-aged and old people, to objectively evaluate the effect of physical and mental exercises on the mental health of the middle-aged and old people, and provide basis for the middle-aged and old people to use scientific and reasonable exercise prescriptions.

Methods

Searching Strategies

From the construction of the library to March 2020. Search in CNKI, Wanfang, VIP Database for Chinese Technical Periodicals, Pubmed, Scopus, web of science and other databases, including Chinese and English journals, conference papers, dissertations, etc. Keywords used in the database searches were as follows: ("Health Qigong" OR "Tai Chi" OR "Baduanjin" OR "Wuqinxi" OR "Yijingjin" OR "Liuzijue" OR "Shierduanjin" OR "Dawu" OR "12 - Step Daoyin Health Preservation Exercises" OR "Mawangdui Daoyin Exercises" OR "Tai Chi health stick" OR "Tai Chi" OR "Yoga") AND ("menopause" OR "middle age" OR "old age") AND ("psychology" OR "mental health").

Selection & Exclusion Criteria of Literature

Literature including all these standards will be selected: (1) randomized controlled trials (RCTs); (2) healthy or sub-healthy middle-aged and elderly people over 35 years old; (3) the intervention method of the experimental group is physical and mental exercise (Health Qigong, Tai Chi, Yoga), and the control group is not physical and mental exercise intervention or no exercise; (4) using SCL-90 scale to measure mental health; (5) the mean and standard deviation of the experimental group and the control group before and after the experiment were reported; Literature including any of these criteria will be excluded: (1) middle-aged and elderly people diagnosed with chronic diseases; (2) duplicated literature; (3) non-SCL-90 scale to measure mental health; (4) the mean and standard deviation of the experimental group and the control group before and after the experiment were not reported; (5) intervention group non-physical and mental exercise (Tai Chi, Health Qigong, Yoga) intervention; (6) reviews.

Data Extraction

According to the pre-determined literature inclusion criteria, the literature was screened and finally included 9 randomized controlled experimental studies. Extract the following information: author name, year of publication, participant characteristics (number, gender, age), experimental design (Exercise program, exercise frequency, exercise time, exercise cycle), and outcome indicators (measurement tools, mean and standard deviation).

literature quality evaluation

The physical therapy evidence database (PEDro) scale was used to assess the quality of 9 studies[36]. Evaluate the following 11 items: eligibility criteria, random allocation, concealed allocation, similar baseline, blinding of participants, blinding of instructors, blinding of assessors, more than 85% retention, intention-to-treat analysis, between-group statistical comparison for at least one outcome, and point measures and variability data. Except that the first question is not scored, each remaining item is scored 1 point, a total of 10 points. The scoring criteria are: 9-10 points are excellent, 6-8 points are good, 4-5 points are fair, and below 4 points are poor[37].

Statistical Analysis

We used Stata16.0 software for statistical analysis, and the outcome indicators were nine factors such as somatization, compulsion, interpersonal relationship, depression, anxiety, hostility, fear, paranoia, and psychosis of the SCL-90 scale. Because the measurement tools are all SCL-90 scales, the standardized mean difference (WMD) and 95% confidence interval (95% CI) were used for analysis, If $P \leq 0.05$, the combined effect size may be considered to be statistically different; otherwise, it is not statistically significant. When the heterogeneity test ($P > 0.1$ and $I^2 < 50\%$) indicated that there was no heterogeneity, the fixed effect model was adopted. When the heterogeneity test ($P \leq 0.10$ and $I^2 > 50\%$) indicates that the heterogeneity is high, the random effect model is used[38]. Evaluation standard of effect quantity: effect quantity less than 0.2 is small effect, between 0.2 - 0.8 is medium effect, and greater than 0.8 is large effect[39].

Because the difference in the combined results may be affected by the participants and the experimental design, according to the characteristics of the literature, it is divided into the following 6 subgroups: gender, age, exercise program, exercise frequency, exercise time, exercise cycle.

Results

Studies Selection

Figure 1 describes the detailed literature search process. A total of 1588 studies were obtained. After reading the title and abstract, 210 studies were screened for full-text reading analysis. After excluding irrelevant studies ($n = 201$), a total of 9 studies were finally analyzed.

Figure 1. Flow of study selection.

Characteristics of Eligible Studies

Table 1 describes the detailed characteristics of 9 studies(Xie et al.,2011; Yin.,2010; Ou.,2010; Zhong and Zhang,2012; Zheng et al.,2012; Chen.,2013; Liao.,2015; Liu.,2016; Liu.,2019). These 9 studies are all from China and all use the SCL-90 scale to measure mental health. A total of 1020 middle-aged and elderly people (experimental group = 519, control group = 501) were all healthy or sub-healthy people.

Methodological Quality Assessment

Table 2 shows the methodological quality of the 9 studies. According to the PEDro scale, 8 studies received 6 points and 1 study received 5 points. According to the evaluation criteria: (9-10 points) considered excellent, (6-8 points) considered good, (4-5 points) think it is fair, (<4) think it is bad. Therefore, the quality of 8 studies is considered good, and the quality of 1 study is fair.

Table 1. Summary characteristics of included studies.

Study	Participants			Intervention Program	physical and mental exercise		Measuring tools
	Sample size male/female n	Age (n)	Age (years)		Frequency Time (min)	Duration (week)	
Xie et al. 2008	70 EG=35 NR CG=35 NR	0/70 EG= 0/35 CG= 0/35	65±5	EG: Tai Chi CG:No exercise intervention	3 20	30	SCL-90
Yin 2010	44 4.54 EG=24 EG=44.92±5.29 CG=20 CG=43.90±3.49	0/44 EG= 0/24 CG= 0/20	44.45±	EG: Yoga CG:No exercise intervention	3 12	60	SCL-90
Ou (2010)	80 EG=40 NR CG=40 NR	0/80 EG= 0/40 CG=0/40	55-70	EG:Tai Chi CG:No exercise intervention	3 24	60	SCL-90
Zhong and Zhang 2012	214 EG=115 EG=63.49±5.84 CG=99 CG=62.54±6.28	58/156 EG =35/80 CG= 23/76	NR	EG:Yinjinjing Qigong CG:No exercise intervention	>3 24	60	SCL-90
Zheng et al. 2012	217 70 EG=110 EG=58.3±9.3 CG=107 CG=58.3±9.4	42/175 EG =20 /90 CG=22/85	41-	EG:Liuzijue Qigong CG:No exercise intervention	>3 24	30	SCL-90
Chen 2013	168 84 EG:=80 EG=69.4±7.1 CG=88 CG=70.9±7.8	79/89 EG= 38/ 42 CG= 41/47	60-	EG:Baduanjin Qigong CG:No exercise intervention	>3 20	60	SCL-90

Liao.2015	80	0/80	NR	EG: Tai Chi	3 24	60	SCL-90
	EG=40 EG=63.1 ± 4. 20	EG =0/40		CG:No exercise intervention			
	CG:=40 CG=62.8 ± 3. 65	CG= 0/40					
Liu(2016)	63	0/63	60-70	EG: Tai Chi	5 16	60	SCL-90
	EG=32 EG=66.3±2. 7	EG= 0/32		CG:No exercise intervention			
	CG=31 CG=65.8±3. 2	CG= 0/31					
Liu(2019)	84 59	49/35	35-	EG: Tai Chi	>3 12	45-60	SCL-90
	EG=43 EG=41.49±5.62	EG=26/17		CG:No exercise intervention			
	CG=41 CG= 42.09±6.18	CG=23/18					

Note: EG = experimental group; CG = control group; SCL-90 =Symptom Checklist 90; NR = not report.

Table 2. Methodological quality of the included studies (PEDro analysis).

Study	1	2	3	4	5	6	7	8	9	10	11	Score	Methodological Quality
Xie et al. (2011)	0	1	0	1	0	0	0	1	1	1	1	6	Good
Yin2010	1	1	0	1	0	0	0	1	1	1	1	6	Good
Ou2010	1	1	0	1	0	0	0	1	1	1	1	6	Good
Zhong and Zhang.(2012)	0	1	0	1	0	0	0	1	1	1	1	6	Good
Zheng et al.(2012)	1	1	0	1	0	0	0	1	1	1	1	6	Good
Chen(2013)	1	1	0	1	0	0	0	1	0	1	1	5	Fair
Liao(2015)	1	1	0	1	0	0	0	1	1	1	1	6	Good
Liu(2016)	1	1	0	1	0	0	0	1	1	1	1	6	Good
Liu(2019)	1	1	0	1	0	0	0	1	1	1	1	6	Good

Note: Item 1 =clearly describe the subject inclusion criteria; Item 2 = random allocation; Item 3 = concealed allocation;Item 4 = similarity at baseline on key measures; Item 5 =participant blinding; Item 6 =instructor blinding; Item 7 =assessor blinding;Item 8 = more than 85% retention rate of at least one

outcome; Item 9 = intention-to-treat analysis; Item 10 = between-group statistical comparison for at least one outcome; Item 11 = point estimates and measures of variability provided for at least one outcome. 1 = explicitly described and present in details; 0 = absent, inadequately described, or unclear.

Meta-Analysis of Outcome Indicators

Effects of physical and mental exercise on somatization of middle-aged and elderly people

In a meta-analysis of 9 studies, physical and mental exercise has a significant effect on reducing somatic symptoms in middle-aged and elderly people (WMD=-0.17, 95%CI: -0.27 to -0.07, p=0, I²=72.7%,Figure 2). z = 3.45, p = 0.001<0.05, the difference was statistically significant.

Figure 2. Effects of physical and mental exercise on somatization of middle-aged and elderly people

The results of the subgroup analysis show that: (1) gender subgroup: the effect of physical and mental exercise on the somatization symptoms of middle-aged and elderly women is a medium effect. (2) age subgroup: the effect of physical and mental exercise on the somatic symptoms of the elderly is greater than that of the middle-aged, and it is a medium effect. (3) exercise program subgroup: the effect of Tai Chi on somatic symptoms of the elderly is a medium effect.4exercise time subgroup: the effect of each exercise 45-60min on the somatic symptoms of middle-aged and elderly people is a medium effect.5exercise frequency subgroup: the effect of exercising 3 times per week is greater than that of exercise (> 3) per week, which is a medium effect.6exercise cycle subgroup: the effect of continuous exercise for 12-20 weeks is greater than that of continuous exercise for 24 weeks, which is a moderate effect. No statistical significance in other subgroups (Table 3).

Table 3. Results of subgroup analysis

Subgroups	Group standard	Number of studies	Z	P	Heterogeneity	WMD [95%CI]
gender	male	0	-	-	-	-
age	female	5	4.37	0.000	I ² =0%,p=0.559	-0.25(-0.36,-0.14)
program	middle-aged	2		0.000	I ² =0%,p=0.630	-0.20(-0.31,-0.09)
time	elderly	3	3.49	0.000	I ² =0%,p=0.439	-0.25(-0.37,-0.13)
frequency	tai chi	5	4.04	0.000	I ² =0%,p=0.591	-0.23(-0.32,-0.15)
	health qigong	3		0.011		-0.03(-0.06,-0.01)
	yoga	1	5.57	0.579	I ² =60.9%,p=0.077	-0.11(-0.50,0.28)
	30min	1	2.53	0.044	-	-0.03(-0.05,-0.00)
	45-60min	8	0.55	0.000	-	-0.20(-0.27,-0.14)
	3	4		0.000	I ² =0%,p=0.646	-0.26(-0.38,-0.14)
	>3	5	2.01	0.001	I ² =0%,p=0.461	-0.04(-0.06,-0.02)
					I ² =71.7%,p=0.007	-0.03(-0.06,-0.01)
			6.04			-0.22(-0.31,-0.14)
			4.28			
			3.27			
cycle	24	4	2.65	0.008	I ² =63.8%,p=0.040	
	12-20	5		0.000	I ² =0%,p=0.693	
			5.31			

Effects of physical and mental exercise on obsessive-compulsive symptoms of middle-aged and old people

In a meta-analysis of 9 studies, physical and mental exercise has a significant effect on reducing obsessive-compulsive symptoms in the middle-aged and elderly (WMD = -0.15, 95% CI: -0.25 to -0.06, p = 0.002, I² = 67%, **Figure 3**), z = 3.18, p = 0.001 <0.05, the difference is statistically significant.

Figure 3. Effects of physical and mental exercise on obsessive-compulsive symptoms of middle-aged and old people

The results of subgroup analysis showed that: (1) gender subgroup: physical and mental exercise had a moderate effect on the obsessive-compulsive symptoms of middle-aged and elderly women. (2) age subgroup: physical and mental exercise has a greater effect on compulsive symptoms in middle-aged

people than in the elderly, which is of moderate effect. (3) exercise program subgroup: the effect of Tai Chi on the obsessive-compulsive symptoms of middle and old people is moderate. (4) exercise time subgroup: the effect of each exercise 45-60min on the obsessive-compulsive symptoms of the middle-aged and the elderly is a small effect. (5) exercise frequency subgroup: the effect of exercising 3 times a week was greater than that of exercising weekly (>3) times, which is a medium effect. (6) exercise cycle subgroup: continuous exercise for 12-20 weeks has a moderate effect on the obsessive-compulsive symptoms in middle-aged and elderly people. No statistical significance was found in other subgroups (Table 4)

Table 4. Results of subgroup analysis

Subgroups	Group standard	Number of studies	Z	P	Heterogeneity	WMD 95%CI
gender	male	0	-	-	-	-
age	female	5	3.91	0.000	$I^2=0\%,p=0.753$	-0.23(-0.34,-0.11)
program	middle-aged	2	3.04	0.002	$I^2=0\%,p=0.796$	-0.21(-0.35,-0.08)
time	elderly	3	2.89	0.004	$I^2=0\%,p=0.479$	-0.18(-0.31,-0.06)
frequency	tai Chi	5	4.86	0.000	$I^2=0\%,p=0.768$	-0.23(-0.32,-0.14)
	health qigong	3	1.72	0.085	$I^2=0\%,p=0.768$	-0.02(-0.05,0.00)
	yoga	1	0.73	0.468	$I^2=51.3\%,p=0.128$	-0.16(-0.59,0.27)
	30min	1	1.24	0.216	-	-0.02(-0.04,0.01)
	45-60min	8	5.31	0.000	-	-0.19(-0.26,-0.12)
	3	4	3.90	0.000	$I^2=0\%,p=0.850$	-0.24(-0.36,-0.12)
	>3	5	2.24	0.025	$I^2=0\%,p=0.692$	-0.03(-0.05,-0.00)
					$I^2=64.7\%,p=0.023$	-0.02(-0.05,0.00)
cycle	24	4	1.95	0.051	$I^2=70.3\%,p=0.018$	-0.20(-0.29,-0.10)
	12-20	5	4.18	0.000	$I^2=0\%,p=0.800$	

Effects of physical and mental exercise on interpersonal sensitivity in middle and old people

In a meta-analysis of 9 studies, physical and mental exercise has a significant effect on reducing the sensitivity of interpersonal relationships in the middle and old aged (WMD = -0.15, 95% CI: -0.24 to -0.06, $p = 0.001$, $I^2 = 71.1\%$, **Figure 4**), $z = 3.17$, $p = 0.002 < 0.05$, the difference is statistically significant.

Figure 4. Effects of physical and mental exercise on interpersonal sensitivity in middle and old people

The results of subgroup analysis showed that: (1) gender subgroup: physical and mental exercise has a small effect on interpersonal sensitivity in middle-aged and elderly women. (2) age subgroup: physical and mental exercise has a greater effect on interpersonal sensitivity in middle-aged people than on the elderly, which is a medium effect. (3) exercise program subgroup: the effect of Tai Chi on interpersonal sensitivity of middle and old people is medium. (4) exercise time subgroup: each exercise 45-60min has a small effect on interpersonal sensitivity of middle-aged and elderly people. (5) exercise frequency subgroup: exercising 3 times a week has a small effect on interpersonal sensitivity of middle-aged and elderly people. (6) exercise cycle subgroup: continuous exercise for 12-20 weeks has a moderate effect on interpersonal sensitivity in middle-aged and elderly people. The analysis results of other subgroups were not statistically significant (**Table 5**)

Table 5. Results of subgroup analysis

Subgroups	Group standard	Number of studies	Z	P	Heterogeneity	WMD[95%CI]
gender	male	0	-	-	-	-
age	female	5	3.54	0.000	$I^2=0\%,p=0.818$	-0.18(-0.28,-0.08)
program	middle-aged	2	3.25	0.001	$I^2=0\%,p=0.413$	-0.21(-0.34,-0.08)
time	elderly	3	3.35	0.001	$I^2=0\%,p=0.568$	-0.19(-0.30,-0.08)
frequency	tai chi	5	4.87	0.000	$I^2=0\%,p=0.856$	-0.21(-0.29,-0.12)
	health qigong	3	1.19	0.232	$I^2=0\%,p=0.856$	-0.01(-0.04,0.01)
	yoga	1	0.38	0.702	$I^2=72.7\%,p=0.026$	-0.07(-0.43,0.29)
	30min	1	0.57	0.570	-	-0.01(-0.03,0.02)
	45-60min	8	5.60	0.000	-	-0.18(-0.25,-0.12)
	3	4	3.03	0.002	$I^2=0\%,p=0.944$	-0.16(-0.27,-0.06)
	>3	5	1.90	0.058	$I^2=0\%,p=0.960$	-0.02(-0.05,0.00)
					$I^2=80.8\%,p=0$	-0.02(-0.04,0.01)
cycle	24	4	1.29	0.196	$I^2=65.5\%,p=0.034$	-0.20(-0.28,-0.12)
	12-20	5	4.66	0.001	$I^2=0\%,p=0.764$	

Effects of physical and mental exercises on middle-aged and elderly depressive symptoms

In a meta-analysis of 9 studies, physical and mental exercise has a significant effect on reducing depression in middle-aged and elderly (WMD = -0.14, 95% CI: -0.21 to -0.06, $p = 0.009$, $I^2 = 60.5\%$, **Figure 5**), $z = 3.35$, $p = 0.001 < 0.05$, the difference is statistically significant.

Figure 5. Effects of physical and mental exercises on middle-aged and elderly depressive symptoms

The results of the subgroup analysis show that: (1) gender subgroup: physical and mental exercise has a small effect on depressive symptoms in middle-aged and elderly women. (2) age subgroup: physical and mental exercise has a smaller effect on depression symptoms in middle-aged people than in the elderly. (3) exercise program subgroup: the effect of Tai Chi on depressive symptoms of middle-aged and elderly people is small. (4) exercise time subgroup: each exercise 45-60min has a small effect on depressive symptoms in middle-aged and elderly people. (5) exercise frequency subgroup: the effect of exercising 3 times a week was greater than that of exercising weekly (>3) times, it is a small effect. (6) exercise cycle subgroup: the effect of continuous exercise for 12-20 weeks is greater than that of continuous exercise for 24 weeks, which is a small effect. Results of other subgroups were not statistically significant(**Table 6**).

Table 6 Results of subgroup analysis

Subgroups	Group standard	Number of studies	Z	P	Heterogeneity	WMD 95%CI
gender	male	0	-	-	-	-
age	female	5	3.34	0.001	$I^2=0\%,p=1.000$	-0.17(-0.28,-0.07)
program	middle-aged	2	2.64	0.008	$I^2=0\%,p=0.962$	-0.17(-0.29,-0.04)
time	elderly	3	2.73	0.006	$I^2=0\%,p=0.945$	-0.16(-0.28,-0.05)
frequency	tai chi	5	4.10	0.000	$I^2=0\%,p=1.000$	-0.17(-0.26,-0.09)
	health qigong	3	2.26	0.024	$I^2=0\%,p=1.000$	-0.02(-0.04,-0.00)
	yoga	1	0.80	0.421	$I^2=75.2\%,p=0.018$	-0.16(-0.55,0.23)
	30min	1	1.66	0.098	-	-0.02(-0.04,0.00)
	45-60min	8	5.26	0.000	-	-0.17(-0.24,-0.11)
	3	4	3.13	0.002	$I^2=0\%,p=1.000$	-0.17(-0.28,-0.06)
	>3	5	2.70	0.007	$I^2=0\%,p=0.997$	-0.03(-0.05,-0.01)
					$I^2=70.5\%,p=0.009$	-0.03(-0.05,-0.00)
cycle	24	4	2.40	0.016	$I^2=71.1\%,p=0.015$	-0.16(-0.25,-0.08)
	12-20	5	3.80	0.000	$I^2=0\%,p=0.998$	

Effects of physical and mental exercise on anxiety in middle and old people

In a meta-analysis of 9 studies, physical and mental exercise has a significant effect on reducing the anxiety of middle-aged and elderly people (WMD = -0.10, 95% CI: -0.16 to -0.04, $p = 0.034$, $I^2 = 51.9\%$,

Figure 6), $z = 3.02$, $p = 0.003 < 0.05$, the difference is statistically significant.

Figure 6. Effects of physical and mental exercise on anxiety in middle and old people

The results of the subgroup analysis show that: (1) gender subgroup: the effect of physical and mental exercise on the anxiety of female middle-aged and elderly people is a small effect. (2) age subgroup: the effect of physical and mental exercise on elderly anxiety is a small effect. (3) exercise program subgroup: the effect of Tai Chi on the anxiety of middle-aged and elderly people is a small effect. (4) Exercise time subgroup: the effect of 45-60min per exercise on the anxiety of middle-aged and elderly people is a small effect. (5) Exercise frequency subgroup: the effect of exercising 3 times a week on the anxiety symptoms of middle-aged and elderly people is a small effect. (6) Exercise cycle subgroup: the effect of continuous exercise for 12-20 weeks on the anxiety symptoms of middle-aged and elderly people is a small effect. Results of other subgroups were not statistically significant (**Table 7**)

Table 7. Results of subgroup analysis

Subgroups	Group standard	Number of studies	Z	P	Heterogeneity	WMD[95%CI]
gender	male	0	-	-	-	-
age	female	5	3.13	0.002	$I^2=0\%,p=0.793$	-0.14(-0.23,-0.05)
program	middle-aged	2	1.74	0.081	$I^2=0\%,p=0.956$	-0.10(-0.21,0.01)
time	elderly	3	2.91	0.004	$I^2=0\%,p=0.831$	-0.15(-0.25,-0.05)
frequency	tai chi	5	3.46	0.001	$I^2=0\%,p=0.741$	-0.13(-0.20,-0.06)
	health qigong	3	1.55	0.120	$I^2=0\%,p=0.741$	-0.02(-0.04,0.00)
	yoga	1	0.52	0.600	$I^2=67.6\%,p=0.046$	-0.09(-0.43,0.25)
	30min	8	4.45	0.000	-	-0.01(-0.03,0.01)
	45-60min	4	2.97	0.003	$I^2=0\%,p=0.956$	-0.13(-0.19,-0.07)
	3	5	1.93	0.054	$I^2=0\%,p=0.670$	-0.02(-0.04,0.00)
	>3				$I^2=54.3\%,p=0.067$	-0.02(-0.04,0.00)
cycle	24	4	1.64	0.101	$I^2=63.8\%,p=0.041$	-0.13(-0.20,-0.05)
	12-20	5	3.32	0.001	$I^2=0\%,p=0.936$	

Influence of physical and mental exercise on the hostility of middle-aged and elderly people

In a meta-analysis of 9 studies, physical and mental exercise has a significant effect on reducing the hostility of middle-aged and elderly people (WMD = -0.03, 95% CI: -0.05 to -0.01, $p = 0.075$, $I^2 = 43.9\%$, Figure 7), $z = 3.00$, $p = 0.003 < 0.05$, the difference is statistically significant.

Figure 7. Influence of physical and mental exercise on the hostility of middle-aged and elderly people

The results of the subgroup analysis show that: (1) gender subgroup: the effect of physical and mental exercise on the hostility of female middle-aged and elderly people is a small effect. (2) age subgroup: the effect of physical and mental exercise on the hostility of middle-aged people is greater than that of the elderly, which is a small effect. (3) exercise program subgroup: the effect of Tai Chi on the hostility of middle-aged and elderly people is a small effect. (4) exercise time subgroup: the effect of 45-60 minutes of each exercise on the hostility of the middle-aged and the elderly is a small effect. (5) exercise frequency sub-group: the effect of exercising 3 times a week is greater than that of weekly exercise (> 3), which is a small effect. (6) exercise cycle subgroup: the effect of continuous exercise for 12-20 weeks is greater than that of continuous exercise for 24 weeks, which is a small effect. Results of other subgroups were not statistically significant (Table 8)

Table 8. Results of subgroup analysis

Subgroups	Group standard	Number of studies	Z	P	Heterogeneity	WMD 95%CI
gender	male	0	-	-	-	-
age	female	5	3.11	0.002	$I^2=0\%,p=0.953$	-0.14(-0.22,-0.05)
program	middle-aged	2	2.35	0.019	$I^2=0\%,p=0.696$	-0.16(-0.30,-0.03)
time	elderly	3	2.43	0.015	$I^2=0\%,p=0.743$	-0.12(-0.22,-0.02)
frequency	tai chi	5	3.87	0.000	$I^2=0\%,p=0.944$	-0.15(-0.22,-0.07)
	health qigong	3	1.95	0.051	$I^2=0\%,p=0.944$	-0.02(-0.04,0.00)
	yoga	1	0.37	0.715	$I^2=44\%,p=0.168$	-0.08(-0.51,0.35)
	30min	1	1.45	0.148	-	-0.02(-0.04,0.01)
	45-60min	8	4.47	0.000	-	-0.13(-0.19,0.07)
	3	4	3.20	0.001	$I^2=0\%,p=0.991$	-0.15(-0.24,-0.06)
	>3	5	2.30	0.021	$I^2=0\%,p=0.992$	-0.03(-0.05,-0.00)
					$I^2=47.6\%,p=0.106$	-0.02(-0.05,-0.00)
cycle	24	4	2.17	0.030	$I^2=53.1\%,p=0.094$	-0.13(-0.21,-0.06)
	12-20	5	3.34	0.001	$I^2=0\%,p=0.913$	

Influence of physical and mental exercise on phobia of middle-aged and old people

In a meta-analysis of 9 studies, physical and mental exercise had no significant effect on reducing phobia in middle-aged and elderly people (WMD = -0.01, 95% CI: -0.03 to 0.01, $p = 0.182$, $I^2 = 29.6\%$, Figure 8), $z = 1.19$, $p = 0.233 > 0.05$.

Figure 8. Influence of physical and mental exercise on phobia of middle-aged and old people

The results of the subgroup analysis show that: (1) gender subgroup: the effect of physical and mental exercise on reducing the phobia of middle-aged and elderly women is a small effect. (2) exercise program subgroup: the effect of Tai Chi on reducing the phobia of middle-aged and elderly people is a small effect. (3) exercise time subgroup: the effect of 45-60min per exercise on reducing the phobia of middle-aged and elderly people is a small effect. (4) exercise frequency subgroup: the effect of exercising 3 times a week on reducing the phobia of middle-aged and elderly people is a small effect. (5) exercise cycle subgroup: the effect of continuous exercise for 12-20 weeks on reducing the phobia of middle-aged and elderly people is a small effect. Results of other subgroups were not statistically significant (**Table 9**)

Table 9. Results of subgroup analysis

Subgroups	Group standard	Number of studies	Z	P	Heterogeneity	WMD[95%CI]
gender	male	0	-	-	-	-
age	female	5	2.73	0.006	$I^2=0\%,p=0.542$	-0.12(-0.20,-0.03)
program	middle-aged	2	1.92	0.055	$I^2=68.6\%,p=0.074$	-0.11(-0.22,0.00)
time	elderly	5	1.41	0.159	$I^2=0\%,p=0.806$	-0.07(-0.17,0.03)
frequency	tai chi	5	2.20	0.028	$I^2=0\%,p=0.966$	-0.08(-0.15,-0.01)
	health qigong	3	0.41	0.682	$I^2=0\%,p=0.966$	-0.00(-0.03,0.02)
	yoga	1	2.45	0.014	$I^2=0\%,p=0.552$	-0.32(-0.58,0.06)
	30min	1	0.18	0.855	-	-0.00(-0.02,0.02)
	45-60min	8	2.93	0.003	-	-0.09(-0.14,-0.03)
	3	4	2.76	0.006	$I^2=0\%,p=0.758$	-0.13(-0.22,-0.04)
	>3	5	0.59	0.556	$I^2=0\%,p=0.431$	-0.01(-0.03,0.01)
					$I^2=0\%,p=0.729$	-0.01(-0.03,0.01)
cycle	24	4	0.59	0.556	$I^2=4.6\%,p=0.370$	-0.09(-0.16,-0.01)
	12-20	5	2.33	0.020	$I^2=0\%,p=0.422$	

Effects of physical and mental exercise on paranoid ideation in middle-aged and elderly people

In a meta-analysis of 9 studies, physical and mental exercise has a significant effect on reducing paranoid symptoms in middle-aged and elderly people (WMD = -0.10, 95% CI: -0.17 to -0.02, $p = 0.009$, $I^2 = 60.9\%$, Figure 9) $z = 2.58$, $p = 0.01 < 0.05$, the difference is statistically significant.

Figure 9. Effects of physical and mental exercise on paranoid ideation in middle-aged and elderly people

The results of the subgroup analysis show that: (1) gender subgroup: the effect of physical and mental exercise on the paranoid symptoms of middle-aged and elderly women is a small effect. (2) age subgroup: the effect of physical and mental exercise on the paranoia of the elderly is a small effect. (3) exercise program subgroup: the effect of Tai Chi on the paranoia of middle-aged and old people is a small effect. (4) exercise time subgroup: the effect of each exercise 45-60min on the paranoia of middle-aged and old people is a small effect. (5) exercise frequency subgroup: the effect of exercising 3 times a week on the paranoia of middle-aged and old people is a small effect. (6) exercise cycle subgroup: the effect of continuous exercise for 12-20 weeks on the paranoid of middle-aged and old people is a small effect. Results of other subgroups were not statistically significant (**Table 10**)

Table 10. Results of subgroup analysis

Subgroups	Group standard	Number of studies	Z	P	Heterogeneity	WMD [95%CI]
gender	male	0	-	-	-	-
age	female	5	3.77	0.000	$I^2=0\%,p=0.853$	-0.17(-0.25,-0.08)
program	middle-aged	2	0.63	0.531	$I^2=0\%,p=0.587$	0.04(-0.09,0.18)
time	elderly	3	3.14	0.002	$I^2=0\%,p=0.737$	-0.16(-0.26,-0.06)
frequency	tai Chi	5	2.87	0.004	$I^2=49.4\%,p=0.095$	-0.11(-0.19,-0.04)
	health qigong	3	1.44	0.150	$I^2=72.2\%,p=0.028$	-0.02(-0.04,0.01)
	yoga	1	0.24	0.812	-	-0.04(-0.37,0.29)
	30min	1	0.72	0.473	-	-0.01(-0.03,0.02)
	45-60min	8	4.07	0.000	-	-0.12(-0.18,-0.06)
	3	4	3.45	0.001	$I^2=16.7\%,p=0.298$	-0.16(-0.25,-0.07)
	>3	5	1.41	0.158	$I^2=0\%,p=0.821$	-0.02(-0.04,0.01)
					$I^2=62.4\%,p=0.031$	-0.02(-0.04,0.00)
cycle	24	4	1.68	0.093	$I^2=73.8\%,p=0.010$	-0.09(-0.17,-0.01)
	12-20	5	2.17	0.030	$I^2=38\%,p=0.168$	

Effects of physical and mental exercises on psychosis of middle-aged and elderly people

In a meta-analysis of 9 studies, physical and mental exercise had no significant effect on reducing psychotic symptoms in middle-aged and elderly people (WMD = -0.02, 95% CI: -0.03 to 0.00, $p = 0.860$, $I^2 = 0\%$, Figure 10), $z = 1.72$, $p = 0.086 > 0.05$.

Figure 10. Effects of physical and mental exercises on psychosis of middle-aged and elderly people

The results of subgroup analysis showed that the results of each subgroup had no statistical significance (Table 11).

Table 11. Results of subgroup analysis

Subgroups	Group standard	Number of studies	Z	P	Heterogeneity	WMD [95%CI]
gender	male	0	-	-	-	-
age	female	5	1.48	0.139	$I^2=0\%,p=0.993$	-0.06(-0.14,0.02)
program	middle-aged	2	0.18	0.856	$I^2=0\%,p=1.000$	-0.01(-0.12,0.10)
time	elderly	3	0.95	0.343	$I^2=0\%,p=0.862$	-0.05(-0.14,0.05)
frequency	tai Chi	5	1.35	0.177	$I^2=0\%,p=0.959$	-0.05(-0.11,0.02)
	health qigong	3	1.41	0.160	$I^2=0\%,p=0.959$	-0.01(-0.03,0.01)
	yoga	1	0.07	0.943	$I^2=19.4\%,p=0.289$	-0.01(-0.28,0.26)
	30min	1	1.14	0.253	-	-0.01(-0.03,0.01)
	45-60min	8	1.94	0.053	-	-0.05(-0.11,0.00)
	3	4	1.44	0.149	$I^2=0\%,p=0.967$	-0.06(-0.14,0.02)
	>3	5	1.44	0.150	$I^2=0\%,p=0.975$	-0.01(-0.03,0.00)
					$I^2=0\%,p=0.637$	-0.01(-0.03,0.00)
cycle	24	4	1.56	0.119	$I^2=8.0\%,p=0.353$	-0.03(-0.10,0.04)
	12-20	5	0.83	0.405	$I^2=0\%,p=0.970$	

Discussion

In this article, an attempt is made to explore the effect of physical and mental exercises on the mental health of the middle-aged and old people through systematic reviews and meta-analysis, with a view to finding the optimal exercise prescription. From observing the combined effect of the nine factors on the SCL-90 scale, it is found that physical and mental exercises (Tai Chi, Health Qigong, Yoga) have

significant effect on reducing the somatization, compulsion, interpersonal relation sensitivity, depression, anxiety, hostility, and paranoid symptoms of the middle-aged and old people, but have no significant effect on fear and psychosis. In the subgroup analysis, physical and mental exercises (Tai Chi, Health Qigong, Yoga) have a significant effect on reducing the symptoms such as somatization, obsessive-compulsive, interpersonal sensitivity, depression, anxiety, hostility, phobic anxiety, paranoia, etc. of the middle-aged and old people, but have no significant effect on psychosis.

Due to differences in subjects (gender, age), experimental design (exercise program, exercise time, exercise frequency, and exercise cycle), etc., the combined results may be affected by these aspects. Therefore, subgroups were set up for analysis. The results of the subgroups are discussed below.

In the gender subgroup, physical and mental exercises have a medium effect on the somatization and compulsion symptoms of the middle-aged and old women, and a small effect on symptoms such as interpersonal sensitivity, depression, anxiety, hostility, phobic anxiety, and paranoia. Of the 9 studies, 5 studies[27-29,33,34] have analyzed women separately, 4 studies[30-32,35] have combined analysis on men and women, and 9 studies did not analyze men separately. Therefore, it is impossible to judge the influence effect of the mental and physical exercises on the mental health of men.

In the sub-group of ages, for the symptoms such as obsessive-compulsive, interpersonal sensitivity, depression, and hostility, the influence effect of the physical and mental exercises on the middle-aged people is greater than that of the old people, which belongs to a small-to-medium effect. For the symptoms such as somatization, anxiety, and paranoia, the influence effect of the physical and mental exercises on the old people is greater than that of the middle-aged people, which belongs to a small-to-medium-effect. For phobic anxiety symptom, the influence effect of physical and mental exercises on middle-aged and old people is not statistically significant. By analyzing these two subgroups that have no statistical significance, it is found that two studies[28,35] have analyzed the middle-aged people and three studies[27,32,34] have analyzed the old people. There are relatively big differences in the experimental designs of these five studies (exercise method, exercise time, and exercise frequency), which can be considered as a statistical difference caused by exercise method, exercise time and exercise frequency.

The constituent elements of exercise prescription include: reasonable exercise, intensity, frequency and time [8]. In sports, the influence effects of Tai Chi exercise on the symptoms such as somatization, obsessive-compulsive, interpersonal sensitivity, depression, anxiety, hostility, phobic anxiety, and paranoia of the middle-aged and old people belong to small-to-medium effects. Health Qigong and Yoga have not showed significant effects, which may be due to the fact that there are few studies on Health Qigong and Yoga, leading to deviations in the statistical results.

In the two subgroups of exercise time and exercise frequency, 45-60 minute exercise each time and 3 exercises each week have significant influence on symptoms such as somatization, obsessive-compulsive, interpersonal sensitivity, depression, anxiety, hostility, phobic anxiety, and paranoia of the middle-aged and old people, which belongs to a small-to-medium effect. Only exercise lasting for a

certain amount of time can produce a good effect on the body. If the exercise time is too short, which fails to cause the body to respond to stimulus, there is no exercise effect. Conversely, if the exercise time is too long, which causes excessive fatigue, the exercise effect will also be affected[40].

In the subgroup of exercise cycle, the exercise effect of 12-20 weeks is better than that of 24 weeks. The difference in this statistical result may be related to exercise intensity, exercise time and exercise frequency. Studies have shown that during the exercises, physical fitness evaluation should be made every 6-8 weeks, and the corresponding exercise adjustment should be made according to the evaluation result[41]. However, in the exercise cycle (24) subgroup, no evaluation of the subjects was mentioned. Therefore, there may be discomfort in the body during long-term exercises, but the exercise time and exercise frequency have not been adjusted accordingly, thus affecting the intervention effect.

The physical and mental exercises (Tai Chi, Health Qigong, Yoga) are characterized by aerobic exercise with a slow rhythm and low-to-medium intensity, which is suitable for the middle-aged and old people[42-45]. During exercise, everyone should follow the step-by-step principle. After a period of exercise, the intensity and time of the exercise should be adjusted according to the exerciser's situation and response[46,47].

Studies have shown that scientific physical and mental exercise can effectively promote the mental health of the middle-aged and old people. The influence mechanism of exercise on mental health: (1) Physiological mechanism: proper exercise can promote the secretion of endorphins in the brain, under whose action, it is possible to relieve tension and discharge pressure, and maintain a healthy emotional state[48]. (2) Psychological mechanism: The successful experience in exercise can also enhance the exerciser's sense of controlling the body and improve self-efficiency, thereby promoting mental health[49]. In daily life, the middle-aged and old people can carry out appropriate physical and mental exercises to maintain healthy mental states.

Limitations of Current Research

Although the results show that the influence of physical and mental exercises on the mental health of the middle-aged and old people is positive, this Meta analysis still has the following limitations and deficiencies: (1) Based on the SCL-90 scale, there are few RCT studies on the influence of physical and mental exercises on the mental health of the middle-aged and old people; (2) The randomization method of the 9 studies is unclear, the 9 studies do not mention allocation concealment and blind method, which may have a certain influence on the results; (3) The 9 studies are all from China, and the age group is based on China's classification standards; (4) The subjects of the 9 studies are the middle-aged and old people in healthy or sub-healthy states, and whether this amount of exercise is suitable for the middle-aged and old people with chronic diseases needs further verification.

Conclusions

Physical and mental exercises have a small-to-medium influence on the symptoms such as somatization, obsessive-compulsive, interpersonal sensitivity, depression, anxiety, hostility, phobic anxiety, and paranoia of the middle-aged and old people, but they have no significant effect on psychosis. In the future, the influence effect of experimental designs of physical and mental exercises (exercise program, exercise time, exercise frequency, and exercise cycle) on people of different genders and ages needs to be further explored, and it will also provide a reference for formulating optimal exercise prescriptions for different people in the future.

Abbreviations

EG = experimental group; CG = control group; SCL-90 =Symptom Checklist 90; NR = not report

Declarations

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Not applicable.

Consent for publication

Not applicable.

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Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

JH and BH contributed equally to this study and should be regarded as joint first authors. JH and BH posited the research question and were responsible for the statistical design and analyses and writing the manuscript. FW and GT supervised the statistical analyses and gave some advice concerning data analysis. All authors read and approved the final manuscript.

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Figures

Figure 1

Flow of study selection.

Figure 2

Effects of physical and mental exercise on somatization of middle-aged and elderly people

Figure 3

Effects of physical and mental exercise on obsessive-compulsive symptoms of middle-aged and old people

Figure 4

Effects of physical and mental exercise on interpersonal sensitivity in middle and old people

Figure 5

Effects of physical and mental exercises on middle-aged and elderly depressive symptoms

Figure 6

Effects of physical and mental exercise on anxiety in middle and old people

Figure 7

Influence of physical and mental exercise on the hostility of middle-aged and elderly people

Figure 8

Influence of physical and mental exercise on phobia of middle-aged and old people

Figure 9

Effects of physical and mental exercise on paranoid ideation in middle-aged and elderly people

Figure 10

Effects of physical and mental exercises on psychosis of middle-aged and elderly people

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