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Review Article

The Effect of Mind-Body Exercise on Blood Pressure in Middle-Aged and Elderly Patients with Hypertension: A Systematic Review and Meta-Analysis of Randomized Controlled Trials

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Objectives. The effects and safety of mind-body exercise in improving blood pressure in middle-aged and elderly patients with hypertension were explored in this meta-analysis. *Methods*. A meta-analysis of studies from the China National Knowledge Infrastructure, Web of Science, PubMed, and Cochrane was performed to identify related experimental studies by screening out the randomized controlled trials from the time of respective database creation until January 22, 2021. In addition, first, we completed the research registration on the INPLASY platform on March 20, 2021 (registration number: INPLASY202130072) and, second, on the PROSPERO platform on December 28, 2021 (registration number: CRD42021289125). The data were analyzed using a random-effects model with the help of Stata 14.0 software. *Results*. A total of 2,277 patients from 30 studies were reflected in the present study. The results show that mind-body exercise can effectively improve systolic blood pressure [SMD = −0.994, 95% CI: −1.239~−0.748, $P < 0.01$] and diastolic blood pressure [SMD = −0.757, 95% CI: −1.009~−0.505, $P < 0.01$] in middle-aged and elderly patients with hypertension. *Conclusion*. The results of this meta-analysis show that mind-body exercise can effectively improve blood pressure in middle-aged and elderly patients with hypertension without adverse events.

1. Introduction

The symptoms of hypertension vary across individuals. In the early stage, for example, there may be no symptoms at all, or there may be symptoms that are not apparent. Moreover, there will be occasional symptoms such as fatigue and palpitation. Still, these conditions generally occur only after fatigue, mental tension, and mood swings and can quickly return to normal after rest [1]. However, the chronic effects of hypertension often slowly deteriorate people's health [2]. Studies have demonstrated the existence of a certain correlation between the symptoms of hypertension and the level of blood pressure. When hypertension symptoms are severe, confusion and convulsions will occur, which can easily cause irreversible pathological changes and damage to the heart, brain, kidney, and other target organs in a short time [3]. Data from the Lancet showed that the number of patients with hypertension in the world had exceeded 1.1 billion, seriously endangering people's health [4]. As Majid Ezzati of the School of Public Health at Imperial College, UK, stated, high blood pressure is a significant risk factor for stroke and heart disease, with about 7.5 million deaths worldwide each year [5]. Therefore, how to actively treat hypertension is worthy of research and discussion in this century. Mind-body exercise originates from the East and includes Taijiquan, Baduanjin, and Qigong, etc.

It has been proven that mind-body exercise is beneficial to health and can improve happiness and satisfaction [6]. In addition, studies have demonstrated that Baduanjin and Qigong have positive effects on blood pressure in patients with hypertension, which provides a specified reference basis. However, the subjects' ages in these studies are between 18 and 75 [7]. According to clinical observations, middle-aged and older people are the multi-incidence patient populations with hypertension [8], Despite this, the existing research results do not have the related research characteristics aimed at this population. However, as low-cost exercise therapy, mind-body exercise may be a good choice for middle-aged and elderly patients with hypertension.

Compared with traditional experimental research, meta-analysis is a systematic review method with a combination of quantitative and qualitative analysis, contributing to expanding the sample size of this research topic and obtaining more objective and scientific results [9]. The existing research uses mind-body exercise (Taijiquan, Baduanjin, and Qigong) as a scheme to improve blood pressure. However, extant research has not reached a unified consensus among the related results of research design, exercise time, exercise frequency, exercise volume, and other variables, which is not conducive to the wide range of mind-body exercise to the treatment of patients with hypertension. The purpose of this study is to evaluate the efficacy and safety of mind-body exercise in improving blood pressure in middle-aged and elderly patients with hypertension. The study also aims to provide operative suggestions for middle-aged and elderly patients with hypertension and clinicians to improve blood pressure.

2. Methods

2.1. Search Strategy. In this study, the following research databases were searched: China National Knowledge Infrastructure (CNKI), Web of Science (WOS), PubMed, and Cochrane. In addition, because mind-body exercise originated in the East, and China has the largest number of people practicing oriental mind-body exercise, the research database includes the CKNI in this study. The end date of the consistent retrieval of this study is January 22, 2021. Simultaneously, the references included in the literature were searched manually, and the relevant literature was achieved by contacting the original authors. This study uses two groups of keywords: (1) mind-body exercise, Taijiquan, Baduanjin, and Qigong; and (2) blood pressure, essential hypertension, and hypertension. Two authors (L.X.H. and C.H.) retrieved the literature while another collaborator (G.B.H.) confirmed it to ensure data retrieval accuracy.

We conducted this systematic review following the Guidelines for the Preferred Reporting Project (PRISMA) for systematic reviews and meta-analysis. First, we completed the research registration on the INPLASY platform on March 20, 2021 (registration number: INPLASY202130072) and, second, on the PROSPERO platform on December 28, 2021 (registration number: CRD42021189125).

2.2. Inclusion and Exclusion Criteria

2.2.1. Inclusion Criteria

(1) Type of Studies. We included randomized controlled trials (RCTs).

(2) Type of Participants. The experimental subjects included in this study are all hypertensive patients aged 45 years and older.

(3) Type of Interventions. In general, there are two ways to include the intervention subjects in this study. First, the intervention group adopted the mind-body exercise: the intervention group adopted Taijiquan or Baduanjin or Qigong, and the control group adopted other measures (mental health education, slow walking, sedentary, regular life, or medicine) other than mind-body exercise. Second, the intervention group adopted the mind-body exercise method plus other measures: the intervention group adopted mind-body exercise (Taijiquan or Baduanjin or Qigong) plus other measures (mental health education, walking slowly, sedentary, or regular life or medicine), and the control group simply adopted other measures (mentioned above).

(4) Type of Outcome Measures. The purpose of this study is to measure the blood pressure of hypertensive patients. At this stage, the most intuitive way to evaluate blood pressure is to observe its systolic blood pressure (SBP) and diastolic blood pressure (DBP). Therefore, the outcome measure of this study are SBP and DBP.

2.2.2. Exclusion Criteria. To complete this study accurately, this article has the following exclusion criteria: (1) RCTs not in peer-reviewed journals; (2) compared with the control group, mind-body exercise is not the main factor in the intervention group measures; (3) subjects are less than 45 years old, are not hypertensive or essential hypertension patients, or have a history of myocardial infarction or stroke; (4) publication of meetings, publication of abstracts and reviews, publication of no detailed data, repeated publications, low-level academic literature, etc.

2.3. Quality Assessment. To evaluate the methodology of the included studies independently, the two authors (L.X.H. and G.B.H.) utilized the PEDro scale. If there was any difference, it was discussed with the third researcher (C.H.). The widely accepted methodological quality assessment tool includes 11 items: (1) description of the inclusion conditions of the subjects, (2) random assignment of subjects to each group, (3) the mode of distribution is hidden, (4) there is no significant difference in baseline between the experimental group and the control group, (5) all the subjects were blind, (6) all the physiotherapists were blind, (7) all the evaluators of at least one major result were blind, (8) at least 85% of the subjects had major measurement results, (9) all the participants were treated according to a randomly assigned scheme, (10) the intragroup statistical results of at least one major result were reported, and (11) the study provided point measurements and variation measurements of at least one major result.

However, during the actual mind-body intervention, it is not realistic to blind the participants in Item 5 and the therapists in Item 6. Therefore, these two items are not required in the quality evaluation of this study. In the end, there are nine evaluation items, each of which is 1 point. If the evaluation literature meets the standard, the score will be 0. Hence, the quality evaluation score reflects the quality of the literature, and the final score of this study is compiled in Table 1.

Table 1: Quality assessment of included studies.

Author (Year) Country [References]	Item 1	Item 2	Item 3	Item 4	Item 5	Item 6	Item 7	Item 8	Item 9	Total score
Young (1999) Korea [10]	1	1	1	1	1	1	1	1	1	9
Tsai (2003) China/Taiwan [11]	1	1	1	1	1	0	1	1	1	8
Wolf (2006) USA [12]	1	1	1	1	1	1	1	1	1	9
Lo (2012) China/Taiwan [7]	1	0	0	1	1	0	1	1	1	6
Sun (2015) China [13]	1	1	1	1	1	0	1	1	1	8
Pan (2015) China [14]	1	1	1	1	1	0	1	1	1	8
Xiao (2016) China [15]	1	1	0	1	1	0	1	1	1	7
Lee (2003) Korea [16]	1	0	0	1	1	0	1	1	1	6
Lee (2004) Korea [17]	1	0	0	1	1	0	1	1	1	6
Pan (2010) China [18]	1	1	1	1	1	0	1	1	1	8
Liang (2014) China [19]	1	1	1	1	1	0	1	1	1	8
Lin (2013) China [20]	1	1	0	1	1	0	1	1	1	7
He (2015) China [21]	1	1	0	1	1	0	1	1	1	7
Chen (2015) China [22]	1	0	0	1	1	0	1	1	1	6
Lin (2014) China [23]	1	1	0	1	1	0	1	1	1	7
Miao (2018) China [24]	1	1	1	1	1	0	1	1	1	8
Fu (2014) China [25]	1	1	1	1	1	0	1	1	1	8
Cai (2016) China [26]	1	1	0	0	1	0	1	1	1	6
Mao (2006) China [27]	1	1	0	1	1	0	1	1	1	7
Tang (2009) China [28]	1	1	0	1	1	0	1	1	1	7
Han (2010) China [29]	1	1	0	1	1	0	1	1	1	7
Wang (2011) China [30]	1	0	0	1	1	0	1	1	1	6
Sun (2014) China [31]	1	0	0	1	1	0	1	1	1	6
Xie (2014) China [32]	1	1	0	1	1	0	1	1	1	7
Lu (2015) China [33]	1	1	0	1	1	0	1	1	1	7
Jin (2011) China [34]	1	1	0	1	1	0	1	1	1	7
Liang (2016) China [35]	1	1	0	1	1	0	1	1	1	7
Chen (2012) China [36]	1	0	0	1	1	0	1	1	1	6
Zheng (2014) China [37]	1	1	0	1	1	0	1	1	1	7
Yang (2013) China [38]	1	0	0	1	1	0	1	1	1	6

2.4. Extraction of Basic Information Included in the Study. Each article was extracted by two independent researchers (L.X.H. and G.B.H.). The third researcher (C.H.) confirmed and transformed the articles into two standard forms: (1) descriptive data, including the first author and year of publication, research location and language, subjects' health status, sample size, average age and age range, intervention schemes between the intervention group and the control group, and main measurement results; and (2) quantitative data, including the randomly assigned number of subjects, mean ± standard deviation (SD) of baseline data between the intervention group and the control group, and mean ± SD of the data after intervention between the intervention group and the control group.

2.5. Data Analysis. Stata 14.0 software was used to analyze the heterogeneity, sensitivity, and publication bias of all the outcome indicators included in the literature, and forest and funnel maps were drawn. Literature outcome indicators included in this article belong to continuous variables, and the test units of each index are the same; therefore, mean ± SD is selected for statistics, and 95% CI is determined simultaneously. The heterogeneity test was performed by P-value and I^2. If $P > 0.10$, there was no heterogeneity among the studies. If $P < 0.10$, there was heterogeneity among the studies. If $I^2 < 25\%$, then the heterogeneity between studies is considered small. If $I^2 > 50\%$, then the studies were considered to be noticeably heterogeneous. Subgroup analysis was utilized to explore the potential influencing factors of the outcome index of essential hypertension in the middle-aged and elderly.

3. Results

3.1. Data Selection. After the pertinent literature was retrieved from the database, the titles and abstracts of all the literature were screened by two researchers (L.X.H. and G.B.H.) to exclude the literature that had nothing to do with this study. Then, according to the inclusion and exclusion criteria for this study, the remaining literature was reviewed by the next step to determine the literature that meets this study's criteria. In addition, the researchers manually selected and included the literature that meets the requirements of this study. The researchers' evaluation is independent. When there were differences in the inclusion and exclusion of the literature, the third researcher (C.H.) re-evaluated the literature to ensure that a consensus is achieved. The inclusion and exclusion technology flow chart in this study is reproduced below (Figure 1).

3.1.1. Characteristics of Included Trials. In this meta-analysis, 1,311 articles were retrieved via literature search and 10 articles were manually retrieved. In summary, a total of 1,321 articles were retrieved. After removing duplicate references,

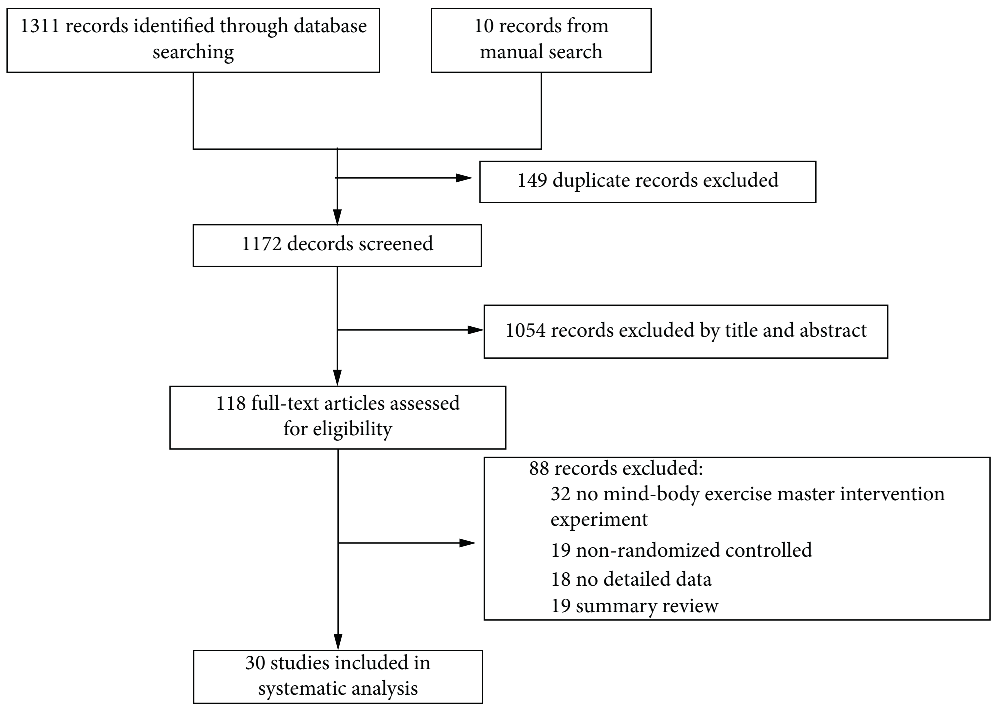

FIGURE 1: Document retrieval and incorporation into the technology roadmap based on PRISMA.

1,172 articles were still subject to title and abstract screening, and 118 were considered eligible for full-text review. After the full-text screening, 30 studies were finally included, with a total of 2,277 patients. The included studies were mainly from China, South Korea, and the United States. Studies from China, South Korea, and the United States accounted for 86.7%, 10%, and 3.3%, respectively. Please refer to Table 2 for all the basic characteristics of the included studies.

3.2. SBP and DBP Forest Maps. SBP was finally included in 30 studies, as shown in Figure 2. The heterogeneity test results show that there is heterogeneity: $I^2 = 86.1\%$, $P < 0.01$. It indicated that there was heterogeneity, so the random-effects model was used for analysis. The meta-analysis results show a combined effect (SMD = −0.994, 95% CI: −1.239, −0.748, $P < 0.01$), indicating that mind-body exercise in the intervention group could effectively improve SBP in middle-aged and elderly patients with hypertension compared with the control group.

DBP was finally included in 29 studies, as shown in Figure 3. The heterogeneity test results showed that there is heterogeneity: $I^2 = 86.9\%$, $P < 0.01$. It indicated that there was heterogeneity; hence, the random-effects model was used only for analysis. The meta-analysis results showed a combined effect (SMD = −0.757, 95% CI: −1.009, −0.505, $P < 0.01$), indicating that mind-body exercise in the intervention group could effectively improve the DBP in middle-aged and elderly patients with hypertension compared with the control group.

3.3. Heterogeneity Test. To explore the possible causes of heterogeneity, SBP and DBP were analyzed by subgroup analysis. The following observations were made from the analysis: (1) the author and the time of publication of the literature are not the reasons for heterogeneity; (2) the object of this study is the middle-aged and elderly population, and this study is included in the literature, the inconsistent range of sample age is not conducive to grouping; therefore, age is not considered as the object of heterogeneity in this study; and (3) the gender of the sample is not an object of consideration in this study. Overall, this study, consequently, will include the subjects' hypertension grading, sample size, study quality (score), exercise frequency (weekly), exercise time (min), exercise duration (weeks), and exercise intensity (heart rate) as the probable sources of heterogeneity for subgroup analysis.

According to the subjects' hypertension grading, the patients with hypertension were divided into three groups: hypertension symptoms, Grade 1 hypertension, grade 1 hypertension and grade 2 hypertension (study samples included both grade 1 and grade 2 hypertension patients). The subjects were further divided according to the following categories: sample size: ≤50, 50~100, and >100; study quality: 6 points, 7 points, 8 points, and 9 points; exercise frequency: >5 times, 3~5 times, and <3 times; exercise time: <30 minutes, 30~60 minutes, and >60 minutes; and duration: ≤ 8 weeks, 9~12 weeks, 13~16 weeks, and >16 weeks. Last, the subjects' exercise intensity was divided into registered exercise intensity and unregistered exercise intensity.

The results of SBP subgroup analysis in Table 3 demonstrate that the sample size, exercise frequency, exercise duration, and exercise intensity are statistically significant. From the source of heterogeneity, there is no meaningful change in sample size, exercise frequency, exercise duration, and exercise intensity between the subgroups; that is, they may not be the source of heterogeneity. However, the effect

Table 2: Studies included for meta-analysis.

Author (Year) Country [References]	Subject	Sample	Sex	Age		Training			Exercise intensity (heart rate)	Intervention	Control	Outcome Measured	Adverse event; follow-up
				Years	Rang	Frequency (weekly)	Time (min)	Duration (weeks)					
Young (1999) Korea [10]	Hypertension	62	Tai chi (female): 77.4 Aerobic (female): 80.7	Tai chi: 64.5 ± 5.1 Aerobic: 67.0 ± 7.9	60~80	4~5	30~45	12	40%~60%	Tai chi exercise	Aerobic exercise or walking or dancing	SBP、DBP	No; Yes
Tsai (2003) China/ Taiwan [11]	Hypertension	76	Tai chi (male/ female): 19/ 20; Sedentary (male/ female): 19/ 18	Tai chi: 51.6 ± 16.3 Sedentary: 50.5 ± 9.8	45~75	3	50	12	64%	Tai chi exercise	Sedentary	SBP、DBP	No; Yes
Wolf (2006) USA [12]	Hypertension	311	Tai chi(male/ female): 10/ 148; Wellness education (male/ female): 10/ 143	Tai chi: 81.0 ± 6.4 Wellness education: 80.8 ± 5.9	70~97	2	60	16	—	Tai chi exercise	Wellness education	SBP、DBP	No; Yes
Lo (2012) China/ Taiwan [7]	Hypertension	58	—	—	50~65	3	60	8	—	Tai chi + routine care	Routine care	SBP、DBP	No; No
Sun (2015) China [13]	Hypertension	266	Tai chi (male/ female): 19/ 117; Control (male/ female): 29/ 101	Tai chi/ control: ≥45	45~80	5	120	48	—	Tai chi	Active control	SBP、DBP	No; No

Table 2: Continued.

Author (Year) Country [References]	Subject	Sample	Sex	Age		Training			Exercise intensity (heart rate)	Intervention	Control	Outcome Measured	Adverse event; follow-up
				Years	Rang	Frequency (weekly)	Time (min)	Duration (weeks)					
Pan (2015) China [14]	Phase I EH Phase II EH hypertension	40	Tai chi (male/female): 14/10; Control (male/female): 10/6	Tai chi: 56.37 ± 3.95 Control: 56.88 ± 3.95	50~70	6	60	12	60%	Tai chi	Stretching or Walking	SBP、DBP	No; No
Xiao (2016) China [15]	Essential hypertension	48	—	Baduanjin/control: 65.6 ± 7.8	≥45	5	40	24	—	Baduanjin	Usual activity	SBP、DBP	No; No
Lee (2003) Korea [16]	Essential hypertension	58	Qi gong (male/female): 10/19; Control (male/female): 13/16	Qi gong: 55.8 ± 6.3 Control: 57.1 ± 7.6	≥45	—	30	10	50%~60%	Qi gong	Waiting list	SBP、DBP	No; No
Lee (2004) Korea [17]	Essential hypertension	36	—	Qi gong: 52.6 ± 5.1; Control: 54.3 ± 5.5	40~65	2	60	8	—	Qi gong	Waiting list	SBP、DBP	No; No
Pan (2010) China [18]	Grade 1 hypertension	48	Baduanjin (male/female): 13/11; Control (male/female): 14/10	Baduanjin: 61.4 ± 7.1 Control: 62.1 ± 5.8	≥55	5	90	24	—	Baduanjin + medicine	Medicine	SBP、DBP	No; No
Liang (2014) China [19]	Grade 1 grade 2 hypertension	60	Baduanjin (male/female): 18/12; Control (male/female): 20/10	Baduanjin: 55.7 ± 8.8 Control: 54.8 ± 7.6	—	5	40	24	70%	Baduanjin + medicine	Walking + medicine	SBP、DBP	No; No

Table 2: Continued.

Author (Year) Country [References]	Subject	Sample	Sex	Age		Training			Exercise intensity (heart rate)	Intervention	Control	Outcome Measured	Adverse event; follow-up
				Years	Rang	Frequency (weekly)	Time (min)	Duration (weeks)					
Lin (2013) China [20]	Grade 1 grade 2 hypertension	127	Qi gong (male/ female): 31/ 37; Control (male/ female): 27/ 32	—	≥55	6	30	24	—	Qi gong + medicine	Regular life + medicine	SBP、DBP	No; No
He (2015) China [21]	Essential hypertension	84	Baduanjin (male/ female): 22/ 10; Control (male/ female): 19/ 23	Baduanjin: 68.51 ± 2.97 Control: 69.24 ± 2.45	59~74	5	30	12	—	Baduanjin + usual care + medicine	Usual care + medicine	SBP、DBP	No; No
Chen (2015) China [22]	Essential hypertension	60	Baduanjin (male/ female): 14/ 16; Control (male/ female): 17/ 13	Baduanjin: 60~75 Control: 62~73	60~75	3~4	60	12	—	Baduanjin + usual education	Usual education	SBP、DBP	No; No
Lin (2014) China [23]	Grade 1 hypertension	55	Baduanjin (male/ female): 14/ 13; Control (male/ female): 12/ 16	Baduanjin: 61.26 ± 3.74 Control: 62.03 ± 3.51	60~75	7	60	12	—	Baduanjin + usual care	Medicine + usual care	SBP、DBP	No; No
Miao (2018) China [24]	Hypertension	60	Baduanjin (male/ female): 23/ 7; Control (male/ female): 20/ 10	Baduanjin: 73.10 ± 5.77 Control: 73.25 ± 4.85	65~82	6	30	4	—	Baduanjin + usual care	Medicine + usual care	SBP	No; No

Table 2: Continued.

Author (Year) Country [References]	Subject	Sample	Sex	Age		Training			Exercise intensity (heart rate)	Intervention	Control	Outcome Measured	Adverse event; follow-up
				Years	Rang	Frequency (weekly)	Time (min)	Duration (weeks)					
Fu (2014) China [25]	Grade 1 grade 2 hypertension	60	Qi gong (male/female): 20/10; Control (male/female): 19/11	Qi gong: 57.93 ± 6.63 Control: 59.53 ± 7.46	45~69	6	40	12	50%~70%	Qigong + medicine	Medicine	SBP、DBP	No; No
Cai (2016) China [26]	Grade 1 hypertension	113	Baduanjin (male/female): 22/34; Control (male/female): 22/35	Baduanjin: 60.89 ± 9.71 Control: 61.33 ± 8.24	≥45	5	30~40	48	—	Baduanjin + usual education	Medicine + usual care	SBP、DBP	No; No
Mao (2006) China [27]	Essential hypertension	62	Tai chi (male/female): 13/38; Control (male/female): 2/9	Tai chi: 62.2 Control: 63.3	45~72	6	60	8	50%~60%	Tai chi + medicine	Medicine	SBP、DBP	No; No
Tang (2009) China [28]	Grade 1 grade 2 hypertension	32	Tai chi (male/female): 10/6; Control (male/female): 9/7	Tai chi: 63.65 ± 8.71 Control: 62.79 ± 7.43	60~70	3~5	30~60	24	50%~70%	Tai chi + medicine	Medicine	SBP、DBP	No; No
Han (2010) China [29]	Grade 1 grade 2 hypertension	60	Male/female: 38/22	Tai chi/control: 62.12 ± 10.51	45~75	—	45~60	48	50%~60%	Tai chi + usual care	Usual care	SBP、DBP	No; yes
Wang (2011) China [30]	Grade 1 grade 2 hypertension	60	Male/female: 18/42	—	50~70	5	55	16	40%~59%	Tai chi	Regular life	SBP、DBP	No; No

Table 2: Continued.

Author (Year) Country [References]	Subject	Sample	Sex	Age		Training			Exercise intensity (heart rate)	Intervention	Control	Outcome Measured	Adverse event; follow-up
				Years	Rang	Frequency (weekly)	Time (min)	Duration (weeks)					
Sun (2014) China [31]	Grade 1 grade 2 hypertension	80	Tai chi (male/female): 14/24; Control (male/female): 24/18	Tai chi: 68.16 ± 4.43 Control: 69.10 ± 4.28	60~75	7	120	8	—	Tai chi	Education	SBP、DBP	No; No
Xie (2014) China [32]	Grade 1 grade 2 hypertension	50	Tai chi (male/female): 11/14; Control (male/female): 14/11	—	60~70	5	60	12	—	Tai chi	Regular life	SBP、DBP	No; No
Lu (2015) China [33]	Essential hypertension	25	—	Tai chi/control: 62.00 ± 3.59	≥45	6	60	16	40%~60%	Tai chi	Regular life	SBP、DBP	No; No
Jing (2011) China [34]	Grade 1 grade 2 hypertension	31	—	Tai chi: 57.53 ± 6.35 Control: 59.12 ± 6.26	45~65	3	60	10	40%~60%	Tai chi	Regular life	SBP、DBP	No; No
Liang (2016) China [35]	Hypertension	60	Baduanjin (male/female): 17/13; Control (male/female): 16/14	Baduanjin: 68.1 ± 10.1 Control: 70.5 ± 10.2	65~75	7	30	12	—	Baduanjin + medicine	Medicine	SBP、DBP	No; No
Chen (2012) China [36]	Grade 1 grade 2 hypertension	80	Baduanjin (male/female): 25/15; Control (male/female): 23/17	Baduanjin: 59.0 ± 6.0 Control: 60.0 ± 5.0	50~72	3	20	24	—	Baduanjin + medicine	Medicine	SBP、DBP	No; No

Table 2: Continued.

Author (Year) Country [References]	Subject	Sample	Sex	Age		Training			Exercise intensity (heart rate)	Intervention	Control	Outcome Measured	Adverse event; follow-up
				Years	Rang	Frequency (weekly)	Time (min)	Duration (weeks)					
Zheng (2014) China [37]	Essential hypertension	55	Baduanjin (male/female): 13/14; Control (male/female): 16/12	Baduanjin: 69.23 ± 3.72 Control: 70.06 ± 3.51	60~75	5	30	12	—	Baduanjin + usual care + medicine	Usual care + medicine	SBP、DBP	No; No
Yang (2013) China [38]	Essential hypertension	60	Baduanjin (male/female): 14/16; Control (male/female): 17/13	Baduanjin: 62.1 ± 5.8 Control: 61.4 ± 7.1	49~71	—	—	48	—	Baduanjin + health education	Health education	SBP、DBP	No; No

SBP: Systolic blood pressure; DBP: Diastolic blood pressure.

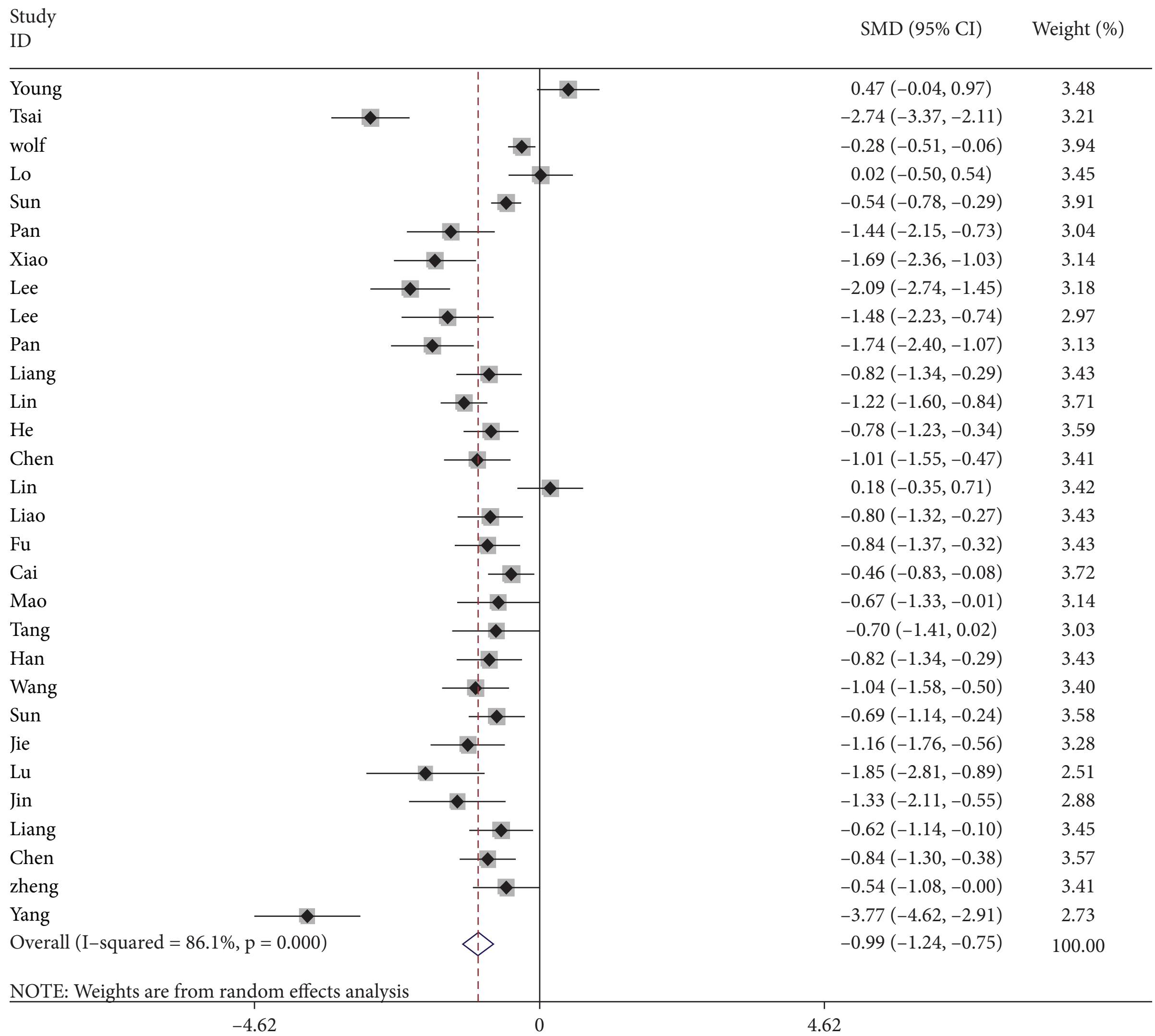

Figure 2: Systolic blood pressure (SBP) forest map.

of hypertension grading and exercise time on the subgroup decreased significantly; therefore, hypertension grade, exercise time, and study quality may be the basis of heterogeneity.

The results of the DBP subgroup analysis in Table 4 demonstrate that the sample size, exercise frequency, exercise duration, and exercise intensity are statistically significant. From the source of heterogeneity, there is no substantial change in the sample size, exercise frequency, and exercise intensity; that is, they may not be the source of heterogeneity. However, the effect of hypertension grade, exercise time, and exercise duration subgroup decreased dramatically; therefore, hypertension grade, exercise time, exercise duration, and study quality may be the sources of heterogeneity.

3.4. Meta-Regression Analysis. According to the previous subgroup analysis results, it is believed that covariates (hypertension grade, exercise time, and study quality) may be the influencing factors of SBP and DBP in patients with hypertension. Hence, a regression analysis of SBP and DBP was performed. As a result, Tables 5 and 6, respectively, list the regression analysis results of SBP and DBP in patients with hypertension, indicating that these covariates are not factors affecting changes in DBP.

3.5. Sensitivity Analysis. As shown in Figure 4, the vertical solid lines with a value of −0.994 in the middle represent the total combined effect, and the left and right vertical solid lines represent the upper and lower limits of 95% CI: −1.239, −0.748. The numerical results show that the second study (Tsai, 2003) and the 30th study (Yang, 2013) had the greatest influence on the total combined effect. After exclusion, the combined effect changed from −0.994 (−1.239, −0.748) to −0.836 (−1.035, −0.637), while further studies had little effect on the total combined effect.

As shown in Figure 5, the vertical solid lines with a value of −0.759 in the middle represent the total combined effect, and the left and right vertical solid lines represent the upper and lower limits of 95% CI: (−1.009, −0.505). From the digital results, it can be seen that the 29th study (Yang, 2013)

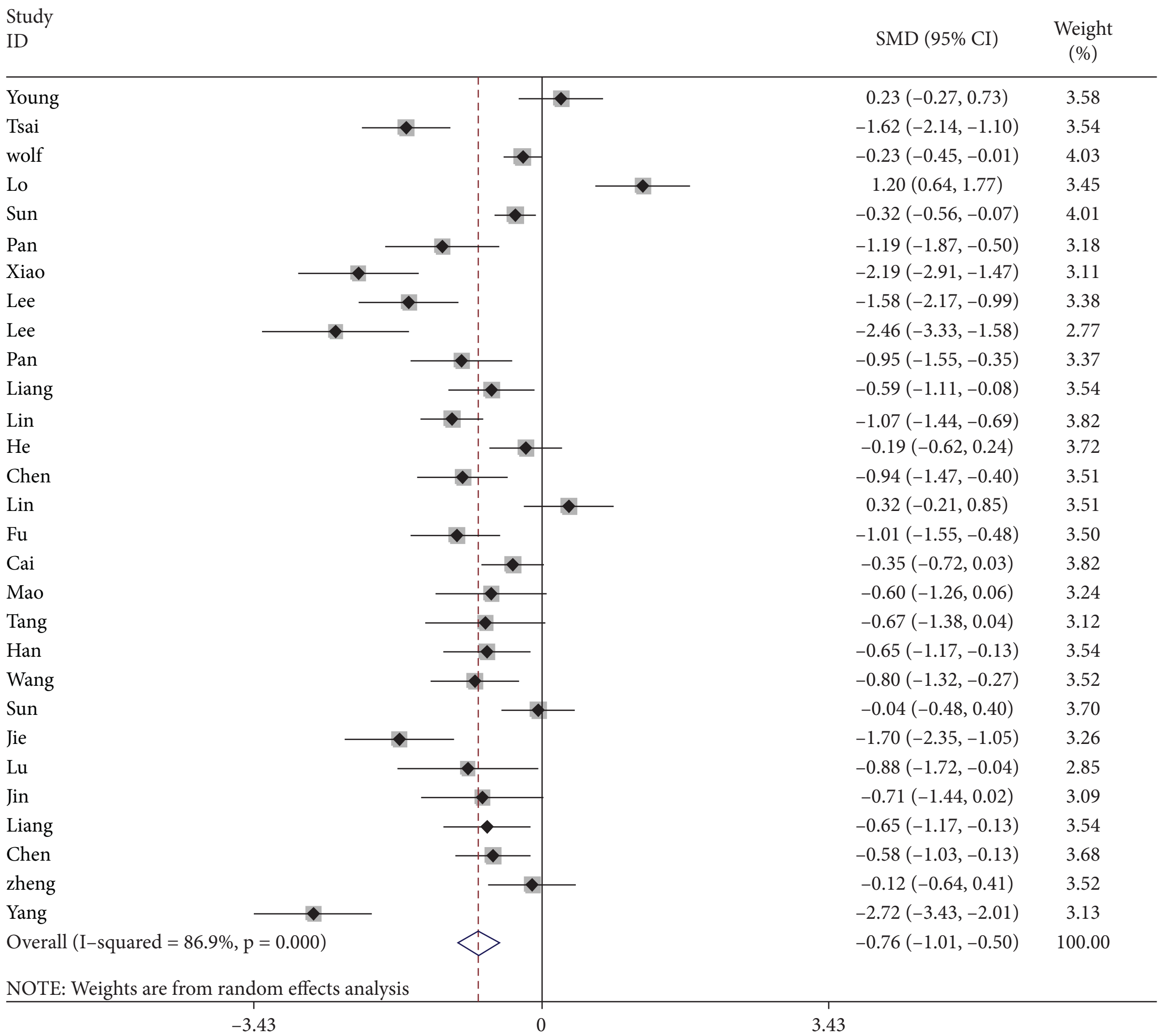

Figure 3: Diastolic blood pressure (DBP) forest map.

has the most significant influence on the total combined effect, which changes from −0.759 (−1.009, −0.505) to −0.688 (−0.924, 0.451), while other studies have little effect on the total combined effect.

3.6. Funnel Plot. In the process of meta-analysis, publication bias has to be identified and controlled. The funnel diagram method is the most common method for identifying publication bias, which assumes that the accuracy of the effect increases with increased sample size. Its width gradually narrows as the sample size increases and finally approaches the dot shape, which is similar to a symmetrical inverted funnel. In other words, research on a small sample size has a large number and low precision, and the distribution is symmetrically arranged at the bottom of the funnel diagram. Alternatively, research on a large sample size has high precision and is distributed at the top of the funnel diagram and concentrated to the middle. In the absence of bias, it presents a symmetrical inverted funnel shape, but the funnel diagram is asymmetrical if there is bias. Figures 6 and 7 show the funnel diagram of SBP and DBP, respectively. The funnel is roughly symmetrical, but some research divergence points are outside the CI of the funnel chart, so there is a certain risk of publication bias. Therefore, to further quantitatively determine the publication bias of this study, Egger's linear regression method will be utilized for the analysis.

3.7. Publication Bias. Through Egger's linear regression analysis, the bias of SBP was $t = -3.69$, $P = 0.001 < 0.05$. As shown in Figure 8, the 95% CI of bias does not contain 0, which is statistically significant and displays publication bias.

The DBP shows the bias through Egger's linear regression analysis: $t = -2.74$, $P = 0.011 < 0.05$. As shown in Figure 9, the 95% CI of DBP does not contain 0, which is statistically significant and confirms publication bias.

4. Discussion

It has been proven that the quality of life of patients with hypertension is often worse than that of normal people [39].

Table 3: Systolic blood pressure subgroup analysis results.

Characteristic of research	Subgroup	Sample	MD	95% CI	P	I^2 (%)	Heterogeneity
Hypertension grading	Hypertension	16	−10.232	−14.566, −5.898	$P<0.01$	94.3	$P<0.01$
	Hypertension 1	3	−3.94	−9.686, 1.806	$P=0.179$	91.0	$P<0.01$
	Hypertension 1 and 2	11	−9.725	−12.050, −7.401	$P<0.01$	56.3	$P=0.011$
	Sum	30	−9.487	−12.072, −6.901	$P<0.01$	91.3	$P<0.01$
Sample size	≤50	8	−11.924	−15.498, −8.351	$P<0.01$	75.3	$P<0.01$
	51~99	18	−8.737	−12.717, −4.758	$P<0.01$	93.9	$P<0.01$
	≥100	4	−7.69	−12.309, −3.071	$P<0.01$	84.6	$P<0.01$
	Sum	30	−9.487	−12.072, −6.901	$P<0.01$	91.3	$P<0.01$
Study quality (score)	6	9	−11.302	−16.670, −5.934	$P<0.01$	92.2	$P<0.01$
	7	12	−8.873	−12.441, −5.304	$P<0.01$	86.6	$P<0.01$
	8	7	−10.360	−15.334, −5.387	$P<0.01$	92.2	$P<0.01$
	9	2	−0.587	−9.897, 8.722	$P=0.902$	89.2	$P<0.01$
	Sum	30	−9.487	−12.072, −6.901	$P<0.01$	91.3	$P<0.01$
Frequency (Weekly)①	< 3	2	−9.548	−18.446, −0.650	$P=0.035$	82.4	$P=0.017$
	3~5	16	−9.086	−12.570, −5.602	$P<0.01$	90.3	$P<0.01$
	> 5	9	−7.39	−10.936, −3.843	$P<0.01$	84.8	$P<0.01$
	Sum	27	−8.588	−10.972, −6.203	$P<0.01$	88.1	$P<0.01$
Time (min)②	< 30	1	−9.5	−14.468, −4.532			
	30~45	11	−7.614	−11.126, −4.102	$P<0.01$	89.8	$P<0.01$
	46~60	13	−10.59	−15.590, −5.915	$P<0.01$	91.2	$P<0.01$
	> 60	3	−8.907	−11.091, −6.723	$P<0.01$	0.0	$P=0.724$
	Sum	28	−9.066	−11.491, −6.640	$P<0.01$	89.1	$P<0.01$
Duration (Weeks)	≤8	5	−8.109	−13.454, −2.763	$P=0.003$	63.7	$P=0.027$
	9~12	12	−8.253	−12.483, −4.024	$P<0.01$	93.9	$P<0.01$
	13~16	3	−11.898	−19.750, −4.047	$P=0.003$	80.7	$P=0.006$
	> 16	10	−10.814	−14.858, −6.771	$P<0.01$	90.1	$P<0.01$
	Sum	30	−9.487	−12.072, −6.901	$P<0.01$	91.3	$P<0.01$
Exercise intensity (heart rate)	Y	12	−11.839	−17.277, −6.400	$P<0.01$	92.1	$P<0.01$
	N	18	−8.201	−11.112, −5.290	$P<0.01$	90.8	$P<0.01$
	Sum	30	−9.487	−12.072, −6.901	$P<0.01$	91.3	$P<0.01$

① Three sample data have not been disclosed; ② Two sample data did not explain; Y: activity intensity was registered; N: unregistered activity intensity.

Most of the patients with hypertension are older people. Therefore, they require a more economical and less side effect-prone treatment than drug treatment. Reviewing previous studies, researchers on the therapeutic effects of Taijiquan or Qigong or Baduanjin on hypertension are mainly from China and South Korea. Chinese researchers believe that Taijiquan and Qigong may be supplementary and effective treatments for lowering blood pressure. However, the therapeutic effect may be related to the increase of NO and the decrease of ET-1 in the blood [40]. Therefore, the researchers believe that Qigong is effective in the treatment of hypertension. To further verify the study's conclusions, it is necessary to design a higher intensity of evidence to prove it [41, 42].

However, the ages included in the two studies are different: 30–70 years old [42] and 40–70 years old [41]. Therefore, it may be necessary to design RCT experiments to prove the therapeutic effect of 30- to 40-year-old people and eliminate other possible biased factors. From the perspective of mechanism, researchers from South Korea believe that the effect of Qigong is not to reduce blood pressure directly but to stabilize the sympathetic nervous system and thus lower the blood pressure of patients. Therefore, it is believed that Qigong is a complementary and irrational way to treat hypertension [43].

4.1. Heterogeneity. Meta-analysis is a secondary study of existing data and a retrospective study. Therefore, it is difficult to fundamentally eliminate heterogeneity in research design.

Heterogeneity and research itself often exist simultaneously. For example, after combing, there may be four reasons for heterogeneity in this study: (1) different subjects: some of the races included in this study are from Asia and some are from America; (2) different subject's classification of hypertension: essential hypertension, grade 1 hypertension, and grade 2 hypertension (it is included in the types of hypertension in this study); (3) different subject's number: the number of subjects included in some studies is five to six times or even more than that in others; and (4) different intervention measures: although all the studies included in this study are based on mind-body exercise, some studies are mind-body exercise and other exercise control, and some studies are mind-body exercise and no exercise control. Similarly, the exercise time and exercise duration are the same. Even though these heterogeneity sources affect the quality of this study to some extent, from another perspective, it also provides researchers with two ideas: (1) they provide thinking points and innovation points for further differentiation research and (2) it is difficult to fundamentally eliminate

Table 4: Diastolic blood pressure subgroup analysis results.

Characteristic of research	Subgroup	Sample	MD	95% CI	P	I^2/%	Heterogeneity
Hypertension grading	Hypertension	15	−5.556	−8.561, −2.552	$P < 0.01$	94.7	$P < 0.01$
	Hypertension 1	3	−1.713	−5.164, 1.739	$P = 0.331$	79.7	$P = 0.007$
	Hypertension 1 and 2	11	−5.949	−7.803, −4.095	$P < 0.01$	62.3	$P = 0.003$
	Sum	29	−5.273	−7.122, −3.424	$P < 0.01$	91.3	$P < 0.01$
Sample size	≤50	8	−9.189	−12.864, −5.514	$P < 0.01$	84.4	$P < 0.01$
	51~99	17	−3.800	−6.227, −1.373	$P = 0.002$	92.5	$P < 0.01$
	≥100	4	−4.241	−7.129, −1.291	$P = 0.005$	80.6	$P = 0.001$
	Sum	29	−5.273	−7.122, −3.424	$P < 0.01$	91.3	$P < 0.01$
Study quality (score)	6	8	−5.815	−11.061, −0.570	$P = 0.030$	95.2	$P < 0.01$
	7	12	−6.040	−9.000, −3.080	$P < 0.01$	90.5	$P < 0.01$
	8	7	−5.056	−7.159, −2.953	$P < 0.01$	75.5	$P < 0.01$
	9	2	−0.653	−4.470, 3.163	$P = 0.737$	74.9	$P = 0.046$
	Sum	29	−5.273	−7.122, −3.424	$P < 0.01$	91.3	$P < 0.01$
Frequency (weekly)①	< 3	2	−7.813	−18.396, −2.769	$P = 0.148$	95.8	$P < 0.01$
	3~5	16	−4.997	−7.667, −2.326	$P < 0.01$	91.8	$P < 0.01$
	> 5	8	−3.542	−5.985, −1.099	$P = 0.004$	79.9	$P < 0.01$
	Sum	26	−4.790	−6.635, −2.946	$P < 0.01$	90.1	$P < 0.01$
Time (min)②	< 30	1	−4.3	−7.544, −1.056	$P = 0.009$		
	30~45	10	−4.673	−7.288, −2.057	$P < 0.01$	89.9	$P < 0.01$
	46~60	13	−5.885	−9.344, −2.425	$P = 0.001$	93.2	$P < 0.01$
	> 60	3	−3.665	−6.097, −1.223	$P = 0.003$	32.4	$P = 0.228$
	Sum	27	−5.002	−6.832, −3.171	$P < 0.01$	90.4	$P < 0.01$
Duration (weeks)	≤8	4	−4.315	−14.197, −5.566	$P = 0.392$	95.9	$P < 0.01$
	9~12	12	−4.445	−6.804, −2.086	$P < 0.01$	88.6	$P < 0.01$
	13~16	3	−4.809	−8.243, −1.375	$P = 0.006$	51.4	$P = 0.128$
	> 16	10	−6.735	−9.410, −4.061	$P < 0.01$	86.1	$P < 0.01$
	Sum	29	−5.273	−7.122, −3.424	$P < 0.01$	91.3	$P < 0.01$
Exercise intensity (heart rate)	Y	12	−5.959	−8.265, −3.654	$P < 0.01$	74.9	$P < 0.01$
	N	17	−4.834	−7.321, −2.347	$P < 0.01$	93.9	$P < 0.01$
	Sum	30	−5.273	−7.122, −3.424	$P < 0.01$	91.3	$P < 0.01$

① Three sample data have not been disclosed; ② Two sample data did not explain; Y: activity intensity was registered; N: unregistered activity intensity.

Table 5: Systolic blood pressure regression analysis results.

_ES	Coef.	Std. err.	t	$P > t$	(95% CI conf. interval)
Hypertension grading	0.095572	1.478846	0.06	0.947	−2.933501 3.124645
Study quality (score)	1.919599	1.463302	1.31	0.200	−1.077839 4.917046
Time (min)	−1.08031	1.90316	−0.57	0.575	−4.992312 2.831692

Table 6: Diastolic blood pressure regression analysis results.

_ES	Coef.	Std. err.	t	$P > t$	(95% CI conf. interval)
Hypertension grading	−0.2062235	1.018375	−0.20	0.841	−2.295757 1.88331
Study quality (score)	1.03688	1.05064	0.99	0.332	−1.118854 3.192614
Time (min)	0.346635	1.35151	0.03	0.980	−2.748823 2.81815
Duration (weeks)	−1.080299	0,8560982	−1.26	0.218	−2.836867 0.6762697

heterogeneity for research design. Therefore, when heterogeneity is found in the research process, do not be afraid; instead, face up to it, discover its causes, and find ways to reduce it. In fact, the heterogeneity generated in this study also has a certain value concerning the research design.

4.2. Effectiveness and Security. The purpose of this review is to evaluate the efficacy and safety of mind-body exercise in improving blood pressure in middle-aged and elderly patients with hypertension. Effectiveness: meta-analysis results show that mind-body exercise (Taijiquan, Baduanjin, and Qigong) can significantly improve SBP and DBP in middle-aged and elderly patients with hypertension. The positive results of this study are consistent with the results of the meta-analysis of previous RCTs of exercise intervention [44, 45]. Furthermore, compared with other forms of exercise, mind-body exercise is moderately intensive and not limited to a particular site, showing the superiority of this type of exercise.

Security: Security is a crucial issue in intervention experiments. When the study samples' basic characteristics are statistically included, safety is considered separately in this

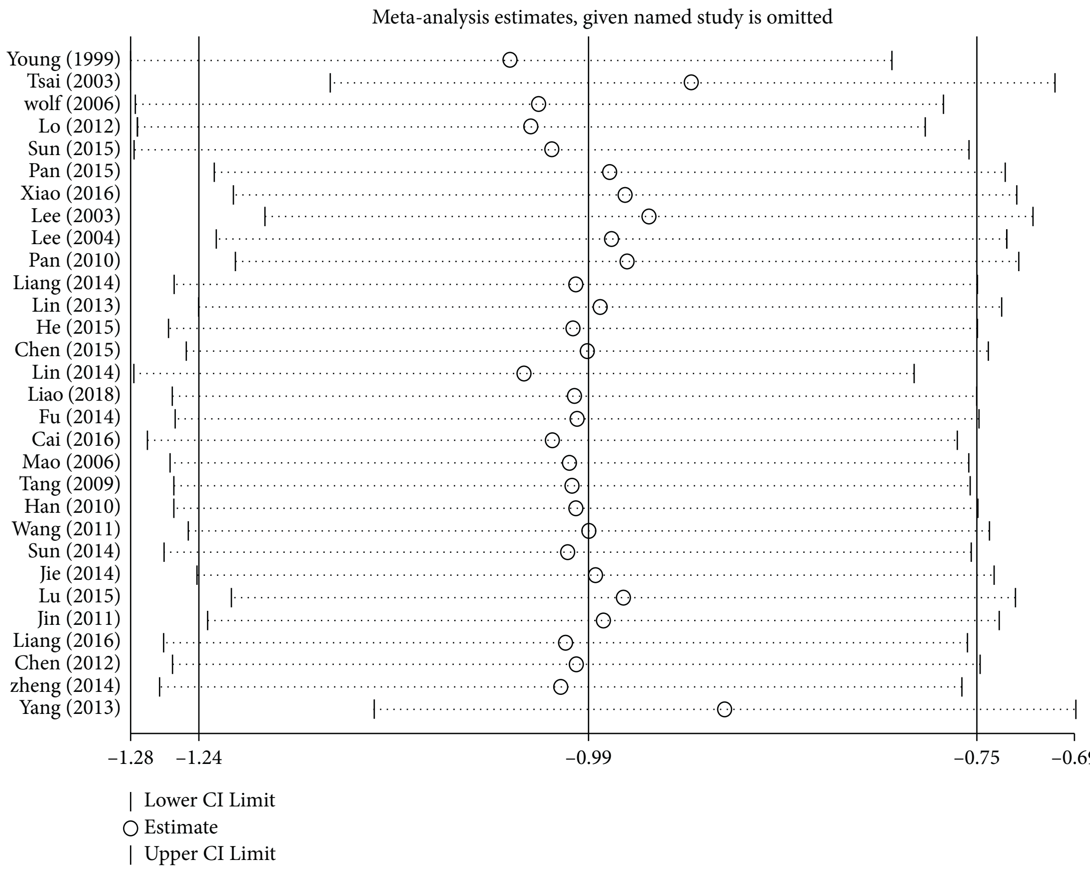

Figure 4: Sensitivity analysis of SBP.

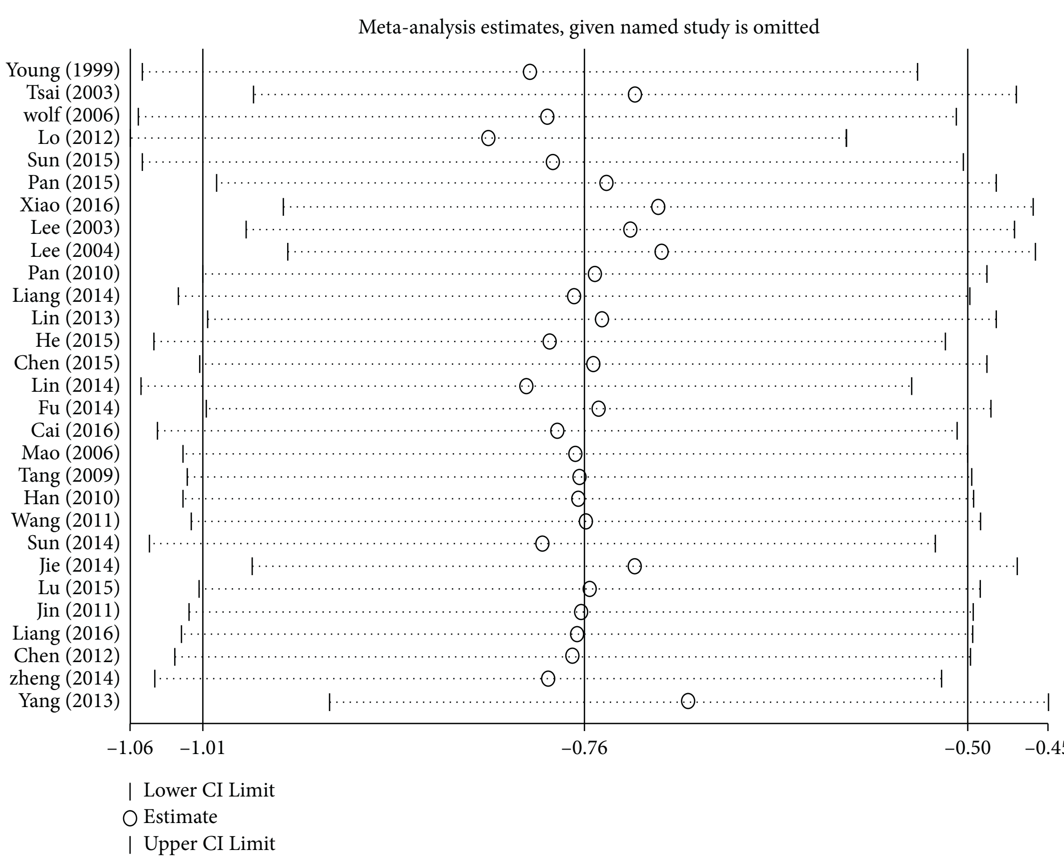

Figure 5: Sensitivity analysis of DBP.

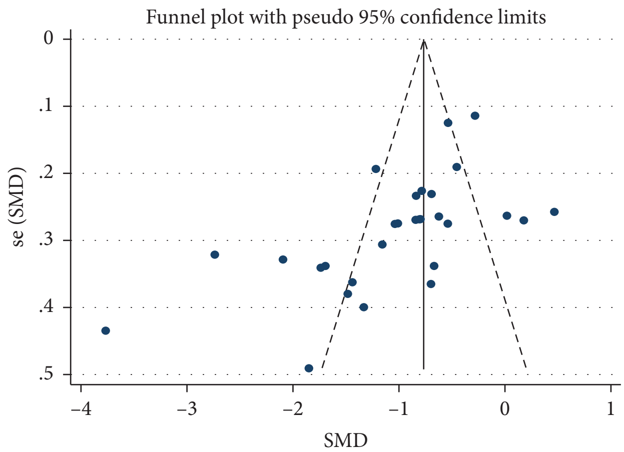

Figure 6: Funnel diagram of qualitative analysis of SBP.

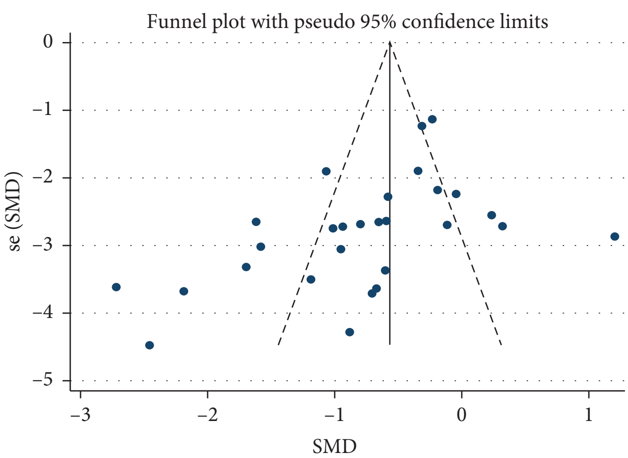

Figure 7: Funnel diagram of qualitative analysis of DBP.

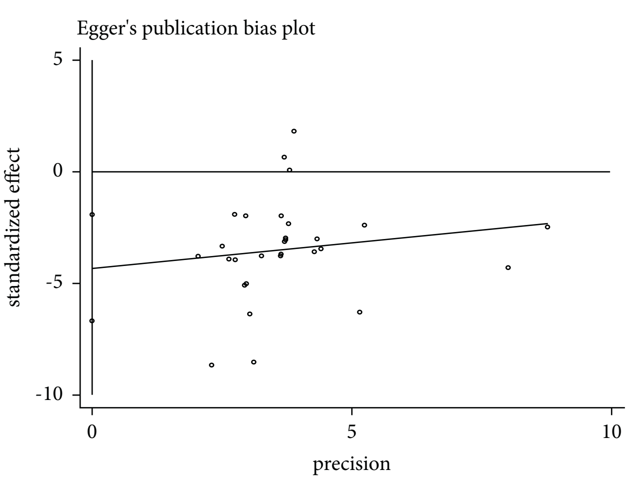

Figure 8: Quantitative analysis of SBP by Egger diagram.

study. If adverse events are found in the study, they will be recorded as YES and vice versa as NO. The results show that there are no adverse events in this study. As a result, it is considered that mind-body exercise is safe and reliable in the treatment of blood pressure in patients with hypertension and is worth popularizing.

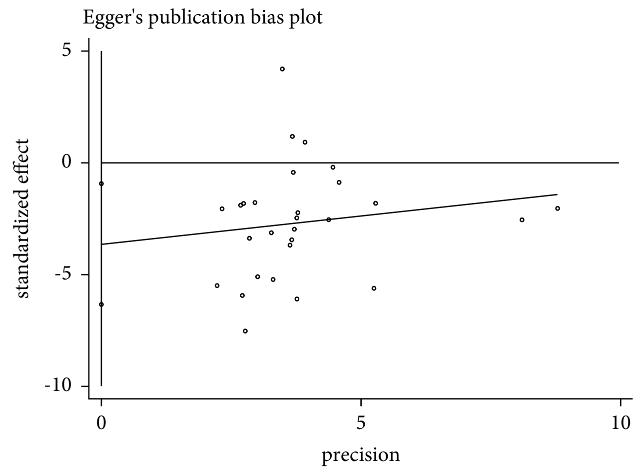

Figure 9: Quantitative analysis of DBP by Egger diagram.

4.3. Strengths and Limitations. Strength: First, mind-body exercise is the main pretreatment method, with less economic burden and fewer side effects. Psychosomatic exercise provides more treatment options for patients with hypertension. Generally speaking, the blood pressure treatment of patients with hypertension is mainly drug treatment. Although the drugs are effective, they will inevitably produce adverse side effects and cause an economic burden to patients. Therefore, as a free treatment with fewer side effects, exercise is undoubtedly a great advantage. Second, the age range of subjects included in this study is more clinically representative: the population of patients with hypertension is widely distributed, including young people. However, the main population of patients with hypertension is still middle-aged and elderly. The selection of middle-aged and elderly patients as the research population has strong clinical research representativeness. Finally, a large number of studies: compared with general meta-analysis studies, the number of literatures included is generally no more than 15, the number of studies included that is more than twice that of other studies in this research, which is more convincing.

Limitations: Research quality, heterogeneity, and publication bias have some limitations in this study. (1) Research quality: The total score of quality evaluation is nine in this study; however, only a few studies reached nine, and the main scores of other studies are 6–7.(2) Heterogeneity: There are many reasons for heterogeneity; the size of heterogeneity is directly related to the accuracy of statistical result interpretation. (3) Different subjects: Different subject classifications of hypertension, different subject numbers, different intervention measures, and other factors may be the source of heterogeneity in this study. Concurrently, there are possible sources of heterogeneity in the regression analysis. It is found that no single factor is directly responsible for heterogeneity. It further shows that the source of heterogeneity may be composed of two or more sources. (4) Publication bias: it can be seen in the funnel plot that some studies are outside the 95% CI. Furthermore, Egger's statistical results also verify the existence of a certain risk of publication bias in this study.

5. Conclusions

The results of this meta-analysis show that mind-body exercise, as an economical treatment with fewer side effects, can effectively improve the blood pressure of middle-aged and elderly patients with hypertension without adverse events.

Data Availability

All data are available in the manuscript.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Acknowledgments

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