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Effect of traditional Chinese exercise on the quality of life and depression for chronic diseases: a meta-analysis of randomised trials

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Traditional Chinese exercise (TCE) has many uses in the prevention and treatment of chronic diseases. However, there is no consensus regarding the benefit of TCE for chronic diseases. Our objective is to examine the effect of TCE on the quality of life and depression for chronic diseases by performing a meta-analysis of randomized controlled trials (RCTs). We only cover published RCTs. The outcome measures included quality of life and depression. Sixty articles with a total of 4311 patients were included. The pooling revealed that TCE could improve the SF-36 physical function subscale in the short term [SMD (95% CI) = 0.35 (0.13, 0.56), $P = 0.002$] and mid-term [SMD (95% CI) = 0.49 (0.12, 0.85), $P = 0.009$], GHQ [SMD (95% CI) = -0.68 (-1.26, -0.09), $P = 0.02$], the Center for Epidemiologic Studies depression scale in the short term [SMD (95% CI) = -0.86 (-1.42, -0.31), $P = 0.002$] and mid-term [SMD (95% CI) = -0.41 (-0.64, -0.18), $P < 0.001$]. The meta-analysis of RCT demonstrates that TCE can significantly improve the quality of life and depression of patients with chronic diseases. These findings provide useful information for patients with chronic diseases as well as for medical staff.

Chronic diseases are the leading cause of death in developed and developing countries¹. These long-term diseases drastically affect the quality of life of afflicted patients and can cause depression of afflicted patients. Indeed, health-related quality of life (physical, psychological status) is increasingly important in people suffering from chronic diseases. According to the World Health Organization², more than 36 million people in the world are killed by chronic diseases each year, and approximately 80% of these deaths, accounting for 29 million people, are from low- and middle-income countries. The five main types of chronic diseases include cardiovascular and cerebrovascular diseases, chronic respiratory diseases, diabetes, cancers and musculoskeletal disorders^{2–4}. Given the prevalence of chronic diseases and mental illnesses, the World Economic Forum concluded that the world would sustain a cumulative output loss of \$47 trillion between 2011 and 2030, of which nearly \$30 trillion would be attributable to cardiovascular diseases, chronic pulmonary diseases, diabetes, and cancers⁴. Therefore, low-cost, easily accessible, and side effect-free programs must be developed to cure such chronic diseases.

Exercise is generally well accepted as significantly contributing to the prevention and treatment of chronic diseases⁵. Traditional Chinese exercise (TCE) is a representative form of exercise that is becoming

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increasingly popular worldwide for the improvement of health and well-being. TCE such as Tai Chi, Qigong, and Baduanjin does not require the use of equipment, is low in cost and easy to learn^{6–8}. TCE has been used for 2000 years and is also a promising⁹, low-risk intervention that can help improve quality of life and alleviate depression in patients with chronic diseases^{10–12}.

TCE includes different types of exercise; the main types are Tai Chi, Qigong, Baduanjin, and Liuzijue, among others. Tai Chi, which is also called “taiji,” “taijichuan” or “taijiquan,” is a famous form of TCE worldwide. Tai Chi is a type of traditional mind body exercise, that developed as a martial art and a means of self-defense in China. Qigong is a general form of TCE and comprises exercises for postural control, coordinated breathing and meditation. *Qi* refers to vital energy, and *gong* means discipline. Baduanjin translates to the Eight Section Brocades, which refers to eight individual movements for improving general health. Liuzijue is a form of breathing exercise in China that was passed down from ancient times^{6–13}. The practice of TCE usually focuses on a combination of physical and mental exercises.

Most TCE is not only exercise therapy, but also includes meditation field. Because of the meditative aspect, TCE could also improve psychological well-being and reduce stress. According to Chang *et al.*¹⁴, TCE (e.g., Tai Chi) is theorized to improve cognition by enhancing brain activation through meditation. In addition, Wayne *et al.*¹⁵ had proposed a relationship between Tai Chi and social interaction, and this positive linkage has even extended to brain function. Based upon the model of Chang *et al.*¹⁴, TCE could bring positive efficacy in cognition via multiple pathways, including motor function, cardiovascular function, coordination function, social interaction, and meditation. Although TCE is widely performed to prevent and treat chronic diseases, studies on TCE have not reached a consensus with regard to how such exercise can improve the quality of life and alleviate depression in patients with chronic diseases^{10–12,16,17}. Similarly, we have yet to find any meta-analysis that has assessed the effect of TCE on the quality of life and depression of patients with chronic diseases. Previous systematic reviews have focused on one type of TCE (such as Tai Chi) for chronic diseases. Therefore, this current meta-analysis aims to identify the effects of TCE on the quality of life and depression of patients with chronic diseases. Additionally, the meta-analysis provides an overall assessment of the effect of TCE on the quality of life and mental health of patients with chronic diseases as well as of the different TCE methods used to treat people with chronic diseases.

Methods

Protocol and registration. The meta-analysis was performed and reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta Analyses (PRISMA) guidelines. The protocol was registered prior to conducting the review. Systematic review registration: <http://www.crd.york.ac.uk/PROSPERO>. PROSPERO registration number: CRD42013006474.

Search strategy. We searched for relevant studies that were published between January 1957 and January 2015 from several electronic data sources, including PubMed, EMBASE, Web of Science, the Cochrane Library, EBSCO (CINAHL), and China National Knowledge Infrastructure. No language restrictions were employed. The search was limited to randomized controlled trials (RCTs). All of the electronic search strategies for all databases are provided in Supplementary Table S1.

Inclusion criteria.

1. Types of studies: We only covered published articles with completed RCTs.
2. Types of participants: We included articles wherein the participants suffered from five main clusters of chronic diseases: cardiovascular and cerebrovascular diseases (e.g., stroke and heart attacks), musculoskeletal disorders (e.g., fibromyalgia), chronic respiratory diseases (i.e., chronic obstructed pulmonary disease), cancers, and diabetes.
3. Types of interventions: We only considered articles that compared an intervention group, in which the members performed TCE (e.g., Tai Chi, Qigong, and Baduanjin), with a control group, in which the members performed another intervention (i.e., strength exercise or drug) or that did not undergo any intervention.
4. Types of outcome measures: The outcome measures were quality of life and depression. Outcomes were recorded for three time periods: short term (less than 3 months), mid term (from 3 months to 12 months) and long term (1 year or more).

Selection of studies. Two authors independently used the same selection criteria to screen the titles, abstracts, and bodies of the relevant articles. The studies that failed to meet the inclusion criteria were removed from the sample. In the case of disagreement, the two authors would discuss or consult a third author.

Data extraction and management. The following data were extracted from the selected articles: study characteristics (e.g., author and year), participant characteristics (e.g., age and number of subjects), intervention description, trial period duration, assessed outcomes, and time points. The two authors who

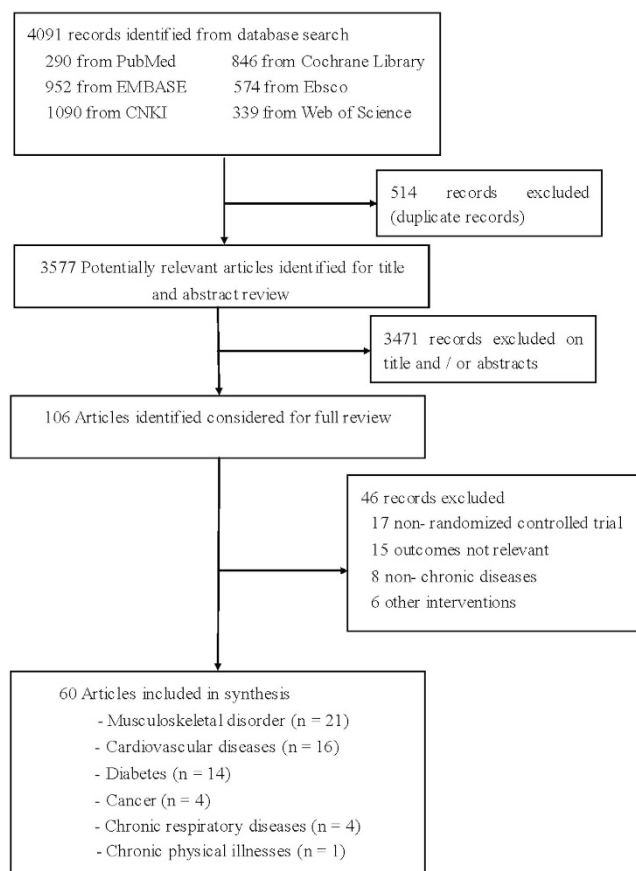


Figure 1. Flow chart of the study selection procedure.

selected the studies also extracted the data from the included articles. Any disagreement was resolved through discussion, and a third author was consulted in cases where disagreement persisted.

Quality assessment. We used the PEDro scale¹⁸ to evaluate the risk of bias for inclusion in the meta-analysis. Using a pre-determined 10-item scale, two review authors independently assessed the methodological quality of each study. The following information was evaluated: random allocation, concealed allocation, baseline comparability, blind subjects, blind therapists, blind assessors, adequate follow-up, intention-to-treat analysis, between-group comparisons, point estimates, and variability. The review authors did not evaluate their own studies. A third author was consulted when a disagreement occurred.

Statistical analysis. Review Manager software (RevMan5.3) was used to conduct the meta-analysis. The chi-square test and I^2 statistic were used to evaluate the heterogeneity among the studies. Using a random effects model, the outcome measures from the individual studies were combined through a meta-analysis. If continuous data were reported as the median and within an interquartile range (IQR), the median would be assumed to be equivalent to the mean, and the relationship of the IQR with the standard deviation was roughly $SD = IQR/1.35^{19}$. Given that all variables in the included studies were expressed as continuous data, we used the standardized mean difference or the mean difference and the 95% confidence interval (CI) to analyze the studies. We considered $p < 0.05$ as statistically significant. Sensitivity analysis was performed by removing each study individually to assess the consistency and quality of the results. Funnel plot asymmetry was employed to assess possible publication bias by Egger's regression test.

Results

Descriptive results. The flow chart of the study selection procedure is outlined in Fig. 1. Of the 106 potentially relevant studies that were identified, 46 were excluded for not completing an RCT or for producing irrelevant outcomes. Thus, we included 4311 patients with chronic diseases from the 60 remaining articles^{20–79} (21 articles focused on musculoskeletal disorders, 16 articles focused on cardiovascular diseases, 14 articles focused on diabetes, 4 articles focused on cancers, 4 articles focused on chronic

respiratory diseases, and 1 article focused on chronic physical illnesses). These articles were mainly published in China ($n = 21$, 35%), USA ($n = 15$, 25%), Australia ($n = 4$, 6.67%), Sweden ($n = 3$, 5%), Korea ($n = 3$, 5%), Hong Kong ($n = 3$, 5%), the UK ($n = 2$, 3.33%), Canada ($n = 2$, 3.33%), Germany ($n = 2$, 3.33%), New Zealand ($n = 1$, 1.67%), Israel ($n = 1$, 1.67%), and Japan ($n = 1$, 1.67%). The characteristics of each included study are summarized in Table 1.

Methodological quality. The methodological quality of all included articles was assessed (Table 2). The generation of the allocation sequence was reported in all articles ($n = 60$, 100%). A total of 15 articles (25%) conducted allocation concealment. A total of 23 articles (38.33%) blinded the outcome assessors to the treatment allocation. A total of 28 articles (46.67%) had an adequate follow-up period. In addition, 13 articles (21.67%) used the intention to treat as their primary analysis method.

Quality of life. Short-form (SF-36) survey. Using a random effects model, the meta-analysis of six studies^{35,39,49,62,67,76} with 591 patients showed that TCE could improve the total SF-36 score in the short term [SMD (95% CI) = 0.59 (0.32, 0.87), $P < 0.001$] (Table 3) and mid term [SMD (95% CI) = 0.61 (0.16, 1.05), $P = 0.008$] (Table 3). The meta-analysis of 22 studies with 1533 patients^{26,27,29,34,35,41,44,46,49,51,52,54–56,58,59,63–65,76,78,79} that were suitable for inclusion showed that TCE had a significant positive effect on the SF-36 physical function subscale in the short term [SMD (95% CI) = 0.35 (0.13, 0.56), $P = 0.002$] (Table 3 and Fig. 2) and mid term [SMD (95% CI) = 0.49 (0.12, 0.85), $P = 0.009$] (Table 3 and Fig. 3). A total of 22 studies with 1502 patients^{20,27,29,34,35,42,44,46,49,51,52,54–56,58,59,63–65,76,78,79} were included to estimate the effect of TCE on the SF-36 mental health subscale. The TCE group outperformed the control group in terms of the SF-36 mental health subscale in the short term [SMD (95% CI) = 0.28 (0.11, 0.46), $P = 0.002$] (Table 3, Supplementary Figure S1) and mid term [SMD (95% CI) = 0.39 (0.08, 0.71), $P = 0.02$] (Table 3, Supplementary Figure S2). No significant difference was observed among the 15 studies with 935 patients^{20,26,27,29,34,41,46,49,54,55,59,63,65,76,79} that investigated the SF-36 general health subscale in the short term [SMD (95% CI) = 0.15 (−0.00, 0.31), $P = 0.06$] (Table 3, Supplementary Figure S3) and mid term [SMD (95% CI) = 0.05 (−0.24, 0.34), $P = 0.73$] (Table 3, Supplementary Figure S4). A sensitivity analysis was performed for the total SF-36 score, the SF-36 physical function subscale, the SF-36 mental health subscale, the SF-36 general health subscale, the significance of the results was not changed when studies were removed one by one.

General Health Questionnaire (GHQ). Two studies^{22,57} were included to estimate the effect of TCE on the GHQ. The TCE group outperformed the control group in terms of improving the GHQ in a random effects model [SMD (95% CI) = −0.68 (−1.26, −0.09), $P = 0.02$] (Table 3).

WHO quality of life (WHOQOL). The meta-analysis of four studies^{23,31,53,60} with 287 patients that were suitable for inclusion revealed that TCE had a significant positive effect on the WHOQOL general health subscale [SMD (95% CI) = 0.68 (0.04, 0.47), $P = 0.04$]. However, TCE did not have a significant effect on the WHOQOL physical health subscale [SMD (95% CI) = 0.13 (−0.59, 0.85), $P = 0.73$] or the WHOQOL psychological health subscale [SMD (95% CI) = 0.22 (−0.04, 0.47), $P = 0.09$] (Table 3). The results were affected by one study⁶⁰ for WHOQOL general health, one study⁵³ for WHOQOL physical health, and one study⁵³ for WHOQOL psychological health in the sensitivity analysis. Therefore, the meta analysis provided weak evidence of the effects of TCE on the WHOQOL.

Depression. Center for Epidemiologic Studies Depression Scale (CES-D). Eight studies^{24,25,51,55,56,58,69,78} with 508 patients were included to estimate the effect of TCE on the CES-D. TCE could improve the CES-D in the short term [SMD (95% CI) = −0.86 (−1.42, −0.31), $P = 0.002$] (Table 3 and Fig. 4A) and mid term [SMD (95% CI) = −0.41 (−0.64, −0.18), $P < 0.001$] (Table 3 and Fig. 4B). Sensitivity analysis revealed that the pooled result was stable when studies were removed one by one.

Self-rating depression scale (SDS). The meta-analysis of five studies^{30,33,40,72,75} with 315 patients that were suitable for inclusion found that TCE had a significant effect on the SDS in the short term [SMD (95% CI) = −0.6 (−0.83, −0.36), $P < 0.001$] (Table 3, Supplementary Figure S5 A). Sensitivity analysis found that the pooled result was not influenced by individual trials.

Beck Depression Inventory (BDI). Three studies^{26,31,43} with data from 180 patients were included to assess the effect of TCE on the BDI. TCE had a non-significant positive effect on the BDI in a random effects model [SMD (95% CI) = −0.15 (−0.75, 0.44), $P = 0.61$] (Table 3). The significance of the result was changed in the sensitivity analysis when one study²⁶ was removed, this result offered inferior evidence for the effect of TCE on BDI.

Profile of Mood States-Depression (POMS-D). Three studies^{68,70,71} with data from 156 patients were used to estimate the effect of TCE on the POMS-D. TCE could improve the POMS-D in the short term [SMD (95% CI) = −1.64 (−2.55, −0.73), $P < 0.001$] (Table 3, Supplementary Figure S5 B). Sensitivity analysis indicated that the pooled result was not influenced by individual trials.

Article, Year	Country/region	Participant Characteristic, Sample Size	Disease	Intervention/comparison groups	Duration of trial period	Outcomes	Time point
An (2008) 20	China	28 subjects (G1 = 14, G2 = 14). Mean age(SD): G1 = 65.4 y (8.2), G2 = 64.6 y (6.7)	Musculoskeletal disorder (Knee osteoarthritis)	G1: Baduan-jin G2: No intervention	Five times a week for 8 weeks	Quality of life (SF-36)	8 weeks
Barrow (2007) 21	UK	65 subjects (G1 = 32, G2 = 33). Mean age: G1 = 68.4 y, G2 = 67.9 y	Cardiovascular diseases (Heart failure)	G1: Tai Chi G2: Usual care	Twice a week for 16 weeks	Depression (SCL-90)	16 weeks
Blake (2009) 22	UK	20 subjects (G1 = 10, G2 = 10). Mean age(SD): G1 = 46.2 y (11.27), G2 = 44.5 y (10.52)	Cardiovascular and cerebrovascular diseases (Brain injury)	G1: Tai Chi + Qigong G2: No intervention	Once a week for 8 weeks	Quality of life (GHQ)	8 weeks
Cai (2010) 23	China	60 subjects (G1 = 30, G2 = 30). Mean age(SD): G1 = 60.3 y (10.5), G2 = 61.3 y (7.4).	Cardiovascular and cerebrovascular diseases (Stroke)	G1: Baduanjin exercise + usual care G2: Usual care	Four or five times a week for 3 months	Quality of life (WHO QOL)	3 months
Chen (2008) 24	USA	162subjects(G1 = 57, G2 = 49) Mean age(SD): G1 = 61.3 y(8.4) G2 = 62.9 y(9.2)	Musculoskeletal disorder (Knee osteoarthritis)	G1: Qigong G2: Sham Qigong	Five or six sessions a week for 3 weeks	Depression (CES-D)	3 weeks 15 weeks
Chen (2013) 25	USA	96 subjects (G1 = 49, G2 = 47). Mean age(SD): G1 = 45.3 y(6.3), G2 = 44.7 y(9.7),	Cancer (Breast cancer)	G1: Qigong G2: Wait-list	Five times a week for 6 weeks	Depression (CES-D)	6 weeks 10 weeks 18 weeks
Cheung (2005) 26	Hong Kong	88 subjects (G1 = 47, G2 = 41). Mean age(SD): G1 = 57.2 y (9.5), G2 = 51.2 y (7.4)	Cardiovascular and cerebrovascular diseases (Hypertension)	G1: Qigong G2: Conventional exercise	Twice a week for 4 weeks	Quality of life (SF-36), depression (CES-D)	4 weeks 8 weeks 16 weeks
Chyu (2010) 27	USA	61 subjects (G1 = 30, G2 = 31). Mean age(SD): G1 = 72.4 y (6.2), G2 = 71.3 y (6)	Musculoskeletal disorder (Osteopaenia)	G1: Tai Chi G2: No intervention	Three times a week for 24 weeks	Quality of life (SF-36)	12 weeks 24 weeks
Fransen (2007) 28	Australia	152 subjects (G1 = 56, G2 = 55, G3 = 41). Mean age(SD): G1 = 70.8 y (6.3), G2 = 70 y (6.3), G3 = 69.6 y (6.1)	Musculoskeletal disorder (Osteoarthritis)	G1: Tai Chi 2: Hydrotherapy G3: No intervention	Twice a week for 12 weeks	Quality of life (SF-12)	6 weeks 12 weeks
Gemmell (2006) 29	New Zealand	18 subjects (G1 = 9, G2 = 9).	Cardiovascular and cerebrovascular diseases (Traumatic brain injury)	G1: Tai Chi G2: No intervention	Once a week for 6 weeks	Quality of life (SF-36)	6 weeks
Guan (2012) 30	China	80 subjects (G1 = 39, G2 = 40). Mean age(SD): G1 = 59.2 y (8.8), G2 = 58.7 y (8.3).	Diabetes	G1: Baduanjin + conventional treatment G2: Conventional treatment	Seven times a week for 4 months	Depression (SDS)	4 months
Haak (2008) 31	Sweden	57subjects(G1 = 29,G2 = 28) Mean age(SD): G1 = 54.0 y(9.4) G2 = 53.4 y(8.0)	Musculoskeletal disorder (Fibromyalgia Syndrome)	G1: Qigong G2: Waiting-list	7 weeks	Quality of life (WHOQOL), Depression (BDI)	4 months
Hart (2004) 32	Israel	152 subjects (G1 = 56, G2 = 55, G3 = 41). Mean age(SD): G1 = 70.8 y (6.3), G2 = 70 y (6.3), G3 = 69.6 y (6.1)	Cardiovascular and cerebrovascular diseases (Stroke)	G1: Tai Chi G2: Hydrotherapy G3: No intervention	Twice a week for 12 weeks	Quality of life (Duke Health Profile)	6 weeks 12 weeks
Ji (2012) 33	China	62 subjects (G1 = 32, G2 = 30). Mean age(SD): G1 = 60.31 y(7.23), G2 = 60.26 y(7.15)	Diabetes	G1: Baduanjin + drug G2: Drug	Once a day for 2 months	Depression (SDS)	2 months
Lam (2008) 34	Australia	53 subjects (G1 = 28, G2 = 25). Mean age(SD): G1 = 63.2 y (8.6), G2 = 60.7 y (12.2)	Diabetes (Type 2 diabetes)	G1: Tai Chi G3: No exercise	Twice a week for 6 months	Quality of life (SF-36)	6 months
Lee (2009) 35	Korea	44 subjects (G1 = 29, G2 = 15). Mean age(SD): G1 = 70.2 y (4.8), G2 = 66.9 y (6)	Musculoskeletal disorder (Osteoarthritis)	G1: Tai Chi and Qigong G2: No intervention	Twice a week for 8 weeks	Quality of life (SF-36)	8 weeks
Li (2010) 36	China	60 subjects (G1 = 30, G2 = 30). Age over 45 y	Musculoskeletal disorder (Osteoporosis)	G1: Tai Chi + usual care G2: Usual care	Once a day for 12 months	Quality of life (SF-36)	12 months
Li (2012) 37	China	68 subjects (G1 = 36, G2 = 32). Age range: 38 to 76 y	Cardiovascular and cerebrovascular diseases (Stroke)	G1: Tai Chi G2: Conventional exercise	Twice a week for 5 weeks	Depression (HAMD)	5 weeks
Continued							

Article, Year	Country/region	Participant Characteristic, Sample Size	Disease	Intervention/comparison groups	Duration of trial period	Outcomes	Time point
Li (2012) 38	China	70 subjects (G1 = 35, G2 = 35). Mean age(SD): G1 = 72.0 y (2.5), G2 = 73.0 y (3.0)	Chronic respiratory diseases (COPD)	G1: Tai Chi + respiratory exercise G2: Respiratory exercise	Once a day for 6 months	Depression (SCL-90)	6 months
Li (2013) 39	China	216 subjects (G1 = 54, G2 = 54, G3 = 54, G4 = 54). Mean age(SD): G1 = 50.42 y (9.68), G2 = 51.62 y (7.83), G3 = 54.21 y (9.47), G4 = 52.69 y (8.37)	Diabetes	G1: Baduanjin G2: Aerobic exercise G3: Tai Chi G4: Control	Once a day for 3 months	Quality of life (SF-36)	3 months 9 months
Liu (2012) 40	China	69 subjects (G1 = 33, G2 = 36). Mean age(SD): G1 = 62.64 y (5.98), G2 = 65.64 y (8.38),	Diabetes	G1: Baduanjin + education G2: Education	Once a week for 12 weeks	Depression (SDS)	6 weeks 12 weeks
Liu (2013) 41	Australia	41 subjects (G1 = 20, G2 = 21). Mean age(SD): G1 = 59 y (8), G2 = 59 y (8)	Diabetes	G1: Tai Chi G2: Usual medical-care	Three sessions per week for 12 weeks	Quality of life (SF-36)	12 weeks
Ng (2011) 42	Hong Kong	80 subjects (G1 = 40, G2 = 40). Mean age(SD): G1 = 71.75 y (1.05), G2 = 73.12 y (1.33)	Chronic respiratory diseases (COPD)	G1: Qigong G2: Conventional treatment	Four times a week for 6 month	Quality of life (SF-36)	3 months 6 months
Putiri (2012) 43	USA	32 subjects (G1 = 11, G2 = 11, G3 = 10). Mean age(SD): G1 = 57.0 y (6.3), G2 = 58.4 y (7.4), G3 = 59.4 y (6.8)	Diabetes (Type 2 diabetes)	G1: Qigong G2: Resistance training G3: Usual care	At least twice a week for 12 weeks	Depression (BDI)	12 weeks
Rendant (2011) 44	Germany	122 subjects (G1 = 42, G2 = 39, G3 = 41). Mean age(SD): G1 = 44.7 y (10.8), G2 = 44.4 y (10.9), G3 = 47.8 y (10.3)	Musculoskeletal disorder (Chronic neck pain)	G1: Qigong G2: Conventional exercise G3: Waiting List	1 session per week in the first 3 months, and bi-weekly sessions in the following 3 months	Quality of life (SF-36)	3 months 6 months
Robins (2013) 45	USA	145 subjects. aged 27–75 years	Cancer (Breast cancer)	G1: Tai Chi G2: Usual medical-care	90 minutes each week for a total of 10 weeks	Depression (CES-D)	3 months 4.5 months 6 months
Shen(2010) 46	USA	171 subjects (G1 = 42, G2 = 38, G3 = 44, G4 = 47). Mean age(SD): G1 = 58.3y(7.7), G2 = 57.6y(6.7), G3 = 57.6 y (7.5), G4 = 56.5 y (5.5)	Musculoskeletal disorder (Postmenopausal osteopenic women)	G1: Tai Chi + Placebo G2: Tai Chi + drug G3: Placebo G4: Drug	Three sessions a week for 12 weeks	Quality of life (SF-36)	8 weeks 12 weeks 16 weeks 24 weeks
Singh-Grewal (2007) 47	Canada	80 subjects (G1 = 41, G2 = 39). Mean age(SD): G1 = 11.7y (2.5), G2 = 11.5y (2.4)	Musculoskeletal disorder (Arthritis)	G1: Qigong G2: Aerobic training	Three times a week for 12-week	Quality of life (HRQOL)	12 weeks
Skoglund (2011) 48	Sweden	37 subjects. Age range: 42 to 54 y	Musculoskeletal disorder (Neck-shoulder pain)	G1: Qigong G2: No Intervention	Four times a week for six weeks	Quality of life (SF-12)	6 weeks
Sprod (2012) 49	USA	65 subjects (G1 = 32, G2 = 33). Mean age: G1 = 68.4 y, G2 = 67.9 y	Cancer (Breast cancer)	G1: Tai Chi G2: Usual care	Three times a week for 12 weeks	Quality of life (SF-36)	12 weeks
Stephens (2008) 50	Canada	30 subjects (G1 = 16, G2 = 14). Mean age(SD): G1 = 12.9 y(2.7), G2 = 13.6 y(1.8)	Musculoskeletal disorder (Fibromyalgia)	G1: Qigong G2: Aerobic training	Three times a week for 12 weeks	Depression (Childhood depression inventory)	12 weeks
Taylor-Piliae (2012) 51	USA	20 subjects (G1 = 10, G2 = 10). Mean age(SD): G1 = 46.2 y (11.27), G2 = 44.5 y (10.52)	Cardiovascular and cerebrovascular diseases (Chronic stroke)	G1: Tai Chi G2: Usual care	Once a week for 8 weeks	Quality of life (SF-36), depressing (CES-D)	8 weeks
Trott (2009) 52	Germany	117 subjects (G1 = 38, G2 = 39, G3 = 40). Mean age(SD): G1 = 75.9 y(7.6), G2 = 76.0 y(7.2) G3 = 75.7 y(7.6)	Musculoskeletal disorder (Chronic neck pain)	G1: Qigong G2: General exercise G3: Wait-list	2 sessions a week for 3 months	Quality of life(SF-36)	3 months 6 months
Continued							

Article, Year	Country/region	Participant Characteristic, Sample Size	Disease	Intervention/comparison groups	Duration of trial period	Outcomes	Time point
Tsang (2003) 53	Hong Kong	50 subjects (G1 = 24, G2 = 26). Mean age(SD): G1 = 72.93 y(9.53), G2 = 76.27 y(8.40)	Chronic physical illnesses	G1: Qigong G2: Usual care	Twice a week for 12-week	Quality of life (WHOQOL)	6 weeks 12 weeks
Tsang (2007) 54	Australia	38 subjects (G1 = 18, G2 = 20). Mean age(SD): G1 = 66 y (8), G2 = 65 y (8)	Diabetes	G1: Tai Chi G2: Sham Tai Chi	Twice a week for 16 weeks	Quality of life (SF-36)	16 weeks
Wang (2008) 55	USA	20 subjects (G1 = 10, G2 = 10). Mean age(SD): G1 = 48 y (10), G2 = 51 y (17)	Musculoskeletal disorder (Rheumatoid arthritis)	G1: Tai Chi G2: Stretching + education	Twice a week for 12 weeks	Quality of life (SF-36), depressing (CES-D)	12 weeks
Wang (2010) 56	USA	66 subjects (G1 = 33, G2 = 33). Mean age(SD): G1 = 49.7 y (11.8), G2 = 50.5 y (10.5)	Musculoskeletal disorder (fibromyalgia)	G1: Tai Chi G2: Stretching + education	Twice a week for 12 weeks	Quality of life (SF-36), depressing (CES-D)	12 weeks 24 weeks
Wang (2010) 57	Japan	34 subjects (G1 = 17, G2 = 17). Mean age(SD): G1 = y (), G2 = y ()	Cardiovascular and cerebrovascular diseases (Cerebral vascular disorder)	G1: Tai Chi G2: General exercise	Once a week for 12 weeks	Quality of life (GHQ)	12 weeks
Wang (2009) 58	USA	40 subjects (G1 = 20, G2 = 20). Mean age(SD): G1 = 63 y (8.1), G2 = 68 y (7.0)	Musculoskeletal disorder (Knee osteoarthritis)	G1: Tai Chi G2: Stretching + education	Twice a week for 12 weeks	Quality of life(SF-36),-depression (CES-D)	12 weeks 24 weeks 48 weeks
Wang (2009) 59	China	64 subjects (G1 = 34, G2 = 30). Mean age(SD): G1 = 48.24 y (10.06), G2 = 47.86 y (11.12)	Diabetes (Type 2 diabetes)	G1: Tai Chi + drug G2: Drug	Five or seven times a week for 6 months	Quality of life (SF-36)	6 months
Wang (2010) 60	China	120 subjects (G1 = 58, G2 = 62). Age range: 28–65 y	Cancer (Breast cancer)	G1: Tai Chi G2: Conventional exercise	Twice a day for 170 days	Quality of life (WHOQOL)	170 days
Wang (2012) 61	China	69 subjects (G1 = 36, G2 = 33). Mean age(SD): G1 = 55.8 y (3.54), G2 = 51.2 y (7.8)	Cardiovascular and cerebrovascular diseases (Stroke)	G1: Tai Chi G2: Conventional exercise	Twice a week for 3 months	Depression (HAMD)	6 months
Wang (2013) 62	China	60 subjects (G1 = 30, G2 = 30). Mean age(SD): G1 = 55.25 y (11.13), G2 = 54.86 y (12.05)	Cardiovascular and cerebrovascular diseases	G1: Tai Chi + usual care G2: Usual care	Five times a week for 6 months	Quality of life (SF-36)	3 months 6 months
Wayne (2012) 63	USA	86 subjects (G1 = 43, G2 = 43). Mean age(SD): G1 = 58.8 y (5.6), G2 = 60.4 y (5.3)	Musculoskeletal disorder (Post-menopausal osteopenic)	G1: Tai Chi exercise G2: Usual care	99.5 hours over the 9 month	Quality of life (SF-36)	12 weeks
Wei (2014) 64	China	60 subjects (G1 = 20, G2 = 20, G3 = 20). Mean age(SD): G1 = 63.9y (7.6), G2 = 64.8y (5.8), G3 = 65.3 y (6.0)	Diabetes (Type 2 diabetes)	G1: Baduanjin G2: Walking G3: Control	Five times a week for 3 months	Quality of life (SF-36)	3 months
Wenneberg (2004) 65	Sweden	31 subjects (G1 = 16, G2 = 15).	Musculoskeletal disorder (Muscular dystrophy)	G1: Qigong G2: No intervention	Once a week for two months	Quality of life (SF-36)	2 months
Wu (1999) 66	USA	22 subjects (G1 = 11, G2 = 11). Mean age(SD): G1 = 37.8 y(11.7), G2 = 39.3 y(13.2)	Musculoskeletal disorder (Pain syndrome type 1)	G1: Qigong G2: Sham Qigong	Twice a week for 3 weeks, everyday for the following 7 weeks	Depression (BDI)	1 weeks 3 weeks 6 weeks 10 weeks
Wu (2012) 67	China	52 subjects (G1 = 26, G2 = 26). Mean age(SD): G1 = 55.92 y (9.25), G2 = 56.46 y (9.13).	Musculoskeletal disorder (Low back pain)	G1: Baduanjin + electrotherapy G2: Electrotherapy	Four or five times a week for 1 month	Quality of life (SF-36)	1 month
Yang (2005) 68	Korea	43 subjects (G1 = 20, G2 = 23). Mean age(SD): G1 = 72.58 y (5.41), G2 = 72.67 y (7.49)	Musculoskeletal disorder (Chronic pain)	G1: Qi gong exercise G2: Usual care	Twice a week for four weeks	Depression (POMS)	1 weeks 2 weeks 3 weeks 4 weeks 6 weeks
Continued							

Article, Year	Country/region	Participant Characteristic, Sample Size	Disease	Intervention/comparison groups	Duration of trial period	Outcomes	Time point
Yeh (2010) 69	USA	10 subjects (G1 = 5, G2 = 5). Mean age(SD): G1 = 65 y (6), G2 = 66 y (6)	Chronic respiratory diseases (COPD)	G1: Tai Chi + usual care G2: Usual care	Twice a week for 12 weeks	Depression (CES-D)	12 weeks
Yeh (2011) 70	USA	100 subjects (G1 = 50, G2 = 50). Mean age(SD): G1 = 68.1 y (11.9), G2 = 66.6 y (12.1)	Cardiovascular and cerebrovascular diseases (Chronic heart failure)	G1: Tai Chi G2: Education	Twice a week for 12 weeks	Depression (POMS-D)	12 weeks
Yeh (2013) 71	USA	16 subjects (G1 = 8, G2 = 8). Mean age(SD): G1 = 68 y (11), G2 = 63 y (11)	Cardiovascular and cerebrovascular diseases (Heart failure)	G1: Tai Chi G2: Aerobic exercise	Twice a week for 12 weeks	Depression (POMS-D)	12 weeks
Zhou (2014) 72	China	25 subjects (G1 = 13, G2 = 12). Age range: 58–80 y	Diabetes	G1: Qigong G2: Education	Once a week for 12 weeks	Depression (SDS)	12 weeks
Wang (2014) 73	China	60 subjects (G1 = 30, G2 = 30). Mean age(SD): G1 = 72.9 y (9.09), G2 = 71.1 y (8.4)	Chronic respiratory diseases (COPD)	G1: Liuzijue G2: Conventional therapy	Seven times a week for 12 weeks	Depression (HAMD)	12 weeks
Wang (2014) 74	China	70 subjects (G1 = 35, G2 = 35). Mean age(SD): G1 = 67.8 y (6.6), G2 = 68.0 y (7.5)	Diabetes (Type 2 diabetes)	G1: Taichi G2: Conventional therapy	Five times a week for 8 weeks	Depression (SCL-90)	8 weeks
Sun (2014) 75	China	80 subjects (G1 = 38, G2 = 42). Mean age(SD): G1 = 68.1 y (4.4), G2 = 69.1 y (4.2)	Cardiovascular and cerebrovascular diseases	G1: Taichi G2: Education	Seven times a week for 8 weeks	Depression (SDS)	8 weeks
Meng (2014) 76	China	200 subjects (G1 = 100, G2 = 100). Age range: 60–89 year	Diabetes (Type 2 diabetes)	G1: Taichi G2: Conventional exercise	Four times a week for 12 weeks	Quality of life (SF-36)	8 weeks
Fang (2014) 77	China	89 subjects (G1 = 30, G2 = 29, G3 = 30). Mean age(SD): G1 = 56.6 y (8.85), G2 = 58.2 y (8.9), G3 = 57.1 y (9.2)	Diabetes	G1: Qigong + education G2: Walk + education G3: Education	Five times a week for 12 weeks	Depression (SCL-90)	12 weeks
Taylor (2014) 78	USA	145 subjects (G1 = 53, G2 = 44, G3 = 48). Mean age(SD): G1 = 71.5 y (10.3), G2 = 69.6 y (9.4), G3 = 68.2 y (10.3)	Cardiovascular and cerebrovascular diseases (Stroke)	G1: Tai Chi G2: Strength exercise G3: Usual care	Three times a week for 12 weeks	Quality of life (SF-36) and depression (CES-D)	12 weeks
Park (2014) 79	Korea	40 subjects (G1 = 19, G2 = 21). Mean age(range): G1 = 52 y (43–61), G2 = 54 y (45–62)	Cardiovascular and cerebrovascular diseases	G1: Qigong G2: No intervention	Three times a week for 8 weeks	Quality of life (SF-36)	4 weeks 8 weeks

Table 1. Characteristics of included studies. BDI: Beck Depression Inventory, CES-D: Center for Epidemiologic Studies Depression Scale, COPD: Chronic obstructive pulmonary disease, GHQ: General Health Questionnaire, HAMD: Hamilton Depression Scale, POMS-D: Profile of Mood States-Depression, SCL-90: Symptom Checklist 90, SDS: Self-rating depression scale, SF-36: Short-form 36, WHOQOL: World Health Organization Quality of Life.

Hamilton Depression Scale (HAMD). The meta-analysis of three studies^{37,61,73} with 189 patients that were suitable for inclusion indicated that TCE had a significant effect on the HAMD in the short term [SMD (95% CI) = −1.36 (−1.97, −0.75), $P < 0.001$] (Table 3, Supplementary Figure S5 C). Sensitivity analysis revealed that the pooled result was stable when studies were removed one by one.

Symptom Checklist-90 (SCL-90). Four studies^{21,38,74,77} presenting data from 284 patients were included to assess the effect of TCE on the SCL-90. The result showed that TCE improved the SCL-90 [SMD (95% CI) = −0.7 (−1.32, −0.08), $P = 0.03$] (Table 3). Sensitivity analysis indicated that the pooled result was not influenced by individual trials.

Publication bias. The results of the Egger's regression test did not reveal any publication bias for the total SF-36 (asymmetry test $P = 0.128$), SF-36 physical function (asymmetry test $P = 0.207$), the SF-36 mental health subscale (asymmetry test $P = 0.678$), the SF-36 general health subscale (asymmetry test $P = 0.906$), and the CES-D (asymmetry test $P = 0.361$).

Article(Year)	Random allocation	Concealed allocation	Baseline comparability	Blind subjects	Blind therapists	Blind assessors	Adequate follow-up	Intention to treat analysis	Between-group comparisons	Point estimates and variability
An (2008) 20	Yes	No	Yes	No	No	No	No	No	Yes	Yes
Barrow (2007) 21	Yes	No	Yes	No	No	No	No	No	Yes	Yes
Blake (2009) 22	Yes	No	Yes	No	No	No	Yes	Yes	Yes	Yes
Cai (2010) 23	Yes	No	Yes	No	No	No	No	No	Yes	Yes
Chen (2008) 24	Yes	No	Yes	No	No	Yes	No	Yes	Yes	Yes
Chen (2013) 25	Yes	No	Yes	No	No	No	Yes	No	Yes	Yes
Cheung (2005) 26	Yes	No	Yes	No	No	No	No	Yes	Yes	Yes
Chyu (2010) 27	Yes	No	Yes	No	No	Yes	Yes	No	Yes	Yes
Fransen (2007) 28	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes	Yes
Gemmell (2006) 29	Yes	No	Yes	No	No	Yes	No	No	Yes	Yes
Guan (2012) 30	Yes	No	Yes	No	No	No	No	No	Yes	Yes
Haak (2008) 31	Yes	No	Yes	No	No	No	Yes	No	Yes	Yes
Hart (2004) 32	Yes	No	No	No	No	Yes	No	No	Yes	Yes
Ji (2012) 33	Yes	No	Yes	No	No	Yes	No	No	Yes	Yes
Lam (2008) 34	Yes	No	Yes	No	No	Yes	Yes	No	Yes	Yes
Lee (2009) 35	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes	Yes
Li (2010) 36	Yes	No	No	No	No	No	No	No	Yes	Yes
Li (2012) 37	Yes	No	Yes	No	No	Yes	No	No	Yes	Yes
Li (2012) 38	Yes	No	Yes	No	No	No	No	No	Yes	Yes
Li (2013) 39	Yes	No	Yes	No	No	No	No	No	Yes	Yes
Liu (2012) 40	Yes	No	Yes	No	No	No	No	No	Yes	Yes
Liu (2013) 41	Yes	No	No	No	No	No	No	Yes	Yes	Yes
Ng (2011) 42	Yes	Yes	Yes	No	No	Yes	No	Yes	Yes	Yes
Putiri (2012) 43	Yes	No	Yes	No	No	No	No	No	Yes	Yes
Rendant (2011) 44	Yes	Yes	Yes	No	No	No	Yes	Yes	Yes	Yes
Robins (2013) 45	yes	No	Yes	No	No	No	Yes	No	Yes	Yes
Shen (2010) 46	Yes	No	Yes	No	No	Yes	Yes	Yes	Yes	Yes
Singh-Grewal (2007) 47	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes	Yes
Skoglund (2011) 48	Yes	No	Yes	No	No	No	Yes	No	Yes	Yes
Sprod (2012) 49	Yes	Yes	Yes	No	No	No	No	No	Yes	Yes
Stephens (2008) 50	Yes	Yes	Yes	No	No	Yes	No	Yes	Yes	Yes
Taylor-Piliae (2012) 51	Yes	Yes	Yes	No	No	Yes	Yes	No	Yes	Yes
Trott (2009) 52	Yes	No	Yes	No	No	No	No	Yes	Yes	Yes
Tsang (2003) 53	Yes	No	Yes	No	No	No	No	No	Yes	Yes
Tsang (2007) 54	Yes	Yes	Yes	No	No	No	Yes	Yes	Yes	Yes
Wang (2008) 55	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes	Yes
Wang (2010) 56	Yes	Yes	Yes	No	No	No	Yes	Yes	Yes	Yes
Wang (2010) 57	Yes	No	Yes	No	No	Yes	Yes	Yes	Yes	Yes
Wang (2009) 58	Yes	Yes	Yes	No	No	No	Yes	Yes	Yes	Yes
Wang (2009) 59	Yes	No	Yes	No	No	No	No	No	Yes	Yes
Wang (2010) 60	Yes	No	Yes	No	No	No	Yes	No	Yes	Yes
Wang (2012) 61	Yes	No	Yes	No	No	No	No	No	Yes	Yes
Wang (2013) 62	Yes	No	Yes	No	No	No	Yes	No	Yes	Yes
Wayne (2012) 63	Yes	No	Yes	No	No	Yes	Yes	Yes	Yes	Yes
Wei (2014) 64	Yes	No	Yes	No	No	No	No	No	Yes	Yes
Wenneberg (2004) 65	Yes	No	Yes	No	No	Yes	Yes	No	Yes	Yes
Wu (1999) 66	Yes	No	Yes	No	No	No	Yes	No	Yes	Yes
Continued										

Article(Year)	Random allocation	Concealed allocation	Baseline comparability	Blind subjects	Blind therapists	Blind assessors	Adequate follow-up	Intention to treat analysis	Between-group comparisons	Point estimates and variability
Wu (2012) 67	Yes	No	Yes	No	No	No	No	No	Yes	Yes
Yang (2005) 68	Yes	No	Yes	No	No	No	Yes	No	Yes	Yes
Yeh (2010) 69	Yes	No	Yes	No	No	Yes	Yes	Yes	Yes	Yes
Yeh (2011) 70	Yes	No	Yes	No	No	Yes	Yes	Yes	Yes	Yes
Yeh (2013) 71	Yes	No	Yes	No	No	Yes	No	Yes	Yes	Yes
Zhou (2014) 72	Yes	No	Yes	No	No	No	No	No	Yes	Yes
Wang (2014) 73	Yes	No	Yes	No	No	No	No	No	Yes	Yes
Wang (2014) 74	Yes	No	Yes	No	No	No	No	No	Yes	Yes
Sun (2014) 75	Yes	No	Yes	No	No	No	No	No	Yes	Yes
Meng (2014) 76	Yes	No	Yes	No	No	No	No	No	Yes	Yes
Fang (2014) 77	Yes	Yes	Yes	No	No	No	No	No	Yes	Yes
Taylor (2014) 78	Yes	Yes	Yes	No	No	Yes	No	Yes	Yes	Yes
Park (2014) 79	Yes	Yes	Yes	No	No	Yes	Yes	No	Yes	Yes

Table 2. Risk of bias assessment of included studies.

Discussion

Summary of findings. Several types of TCE are used to prevent and treat chronic diseases. However, the extant systematic reviews primarily focus on either one type of disease (e.g., cardiovascular disease) or one type of TCE (e.g., Tai Chi). In this review and meta-analysis, we combined all of the evidence from the numerous relevant studies evaluating the various forms of TCE into one review to assess the overall effect of TCE on patients with chronic diseases.

We gathered information on 4311 subjects from 60 articles that provided evidence on the effects of TCE on improving the quality of life and alleviating depression in patients with chronic diseases. The meta-analysis revealed that TCE had a significant positive effect on the quality of life (SF-36 physical function, SF-36 mental health, SF-36 total, GHQ, and WHOQOL general health) and depression (CES-D, SDS, POMS-D, HMAD, SCL-90) in patients with chronic diseases. Therefore, TCE had a significant clinical effect on improving the quality of life and reducing depression in patients with chronic diseases. We used the chi-square test and I^2 statistic to assess the heterogeneity among the studies, and identified obvious heterogeneity for some outcomes. To solve this problem, sensitivity analysis was conducted for to assess the consistency and quality of the results. Sensitivity analysis revealed that most of the pooled results (SF-36, CES-D, SDS, POMS-D, HAMD, SCL-90) were stable when studies were removed one by one. But the significance of the result (WHOQOL, BDI) was changed through sensitivity analysis, these results offered inferior evidence for the effect of TCE on WHOQOL and BDI. Because TCE does not require the use of equipment, the exercises are low in cost and easy to learn. Chronic patients who performed TCE demonstrated considerable improvements in their conditions^{80,81}. According to the theory of Traditional Chinese medicine, TCE could help one's body to dredge the meridians and collaterals, facilitate blood circulation, relax the mind, balance emotion, and regulate the internal organs to enhance one's physical health and quality of life and to improve one's psychological state⁶. TCE generally combines postural control, breath regulation and mediation. The primary benefit of TCE stems from the holistic nature, and TCE benefits both physical and psychosocial health. However, the exact mechanism by which TCE affects patients with chronic diseases is complex and remains unclear. Thus, further evidence on the mechanism by which TCE affect chronic diseases should be obtained.

Strengths and limitations. Relevant articles were searched from a wide range of electronic databases (e.g., PubMed, EMBASE, Web of Science, and Cochrane Library). Considering that TCE originated in China, we searched for relevant information from the largest Chinese information database. The current study was the first meta-analysis to estimate the effects of TCE on the quality of life and depression of patients with chronic diseases by comparing an intervention group with a no intervention group. Given that the selected articles were published in America, Asia, Europe, and Oceania, the results of this study may be generalizable to most parts of the world. Furthermore, most of the included articles were published over the last five years (from 2010 to 2015). To reduce bias and transcription errors, two authors independently performed the study selection, data extraction, and quality assessment processes.

Nevertheless, our meta-analysis had several limitations. First, although all of the included articles were RCTs, only 15 studies (25%) reported how the patient allocation was concealed. According to the intention-to-treat principle, 13 articles (21.67%) used the intention to treat as their primary analysis

Outcome	Trials	Participants	Statistical Method	Effect Estimate	Heterogeneity	P value
Short term						
Quality of life						
SF-36 total	6 ^{35,39,49,62,67,76}	591	Std. Mean Difference (IV, Random, 95% CI)	0.59 [0.32, 0.87]	0.05	<0.001
SF-36 physical function	19 ^{27,29,35,41,44,46,49,51,52,54,55,56,58,63,64,65,76,78,79}	1332	Std. Mean Difference (IV, Random, 95% CI)	0.35 [0.13, 0.56]	<0.001	0.002
SF-36 mental health	19 ^{20,27,29,35,44,46,49,51,52,54,55,56,58,63,64,65,76,78,79}	1312	Std. Mean Difference (IV, Random, 95% CI)	0.28 [0.11, 0.46]	<0.001	0.002
SF-36 general health	11 ^{20,27,29,41,46,49,54,55,65,76,79}	648	Std. Mean Difference (IV, Random, 95% CI)	0.15 [−0.00, 0.31]	0.66	0.06
GHQ	2 ^{22,57}	49	Std. Mean Difference (IV, Random, 95% CI)	−0.68 [−1.26, −0.09]	0.73	0.02
WHO-QOL physical health	4 ^{23,31,53,60}	287	Std. Mean Difference (IV, Random, 95% CI)	0.13 [−0.59, 0.85]	<0.001	0.73
WHO-QOL psychological health	4 ^{23,31,53,60}	287	Std. Mean Difference (IV, Random, 95% CI)	0.22 [−0.04, 0.47]	0.32	0.09
WHO-QOL general health	4 ^{23,31,53,60}	287	Std. Mean Difference (IV, Random, 95% CI)	0.68 [0.04, 1.32]	<0.001	0.04
Depression						
CES-D	8 ^{24,25,51,55,56,58,69,78}	508	Std. Mean Difference (IV, Random, 95% CI)	−0.86 [−1.42, −0.31]	<0.001	0.002
SDS	5 ^{30,33,40,72,75}	315	Std. Mean Difference (IV, Random, 95% CI)	−0.6 [−0.83, −0.36]	0.37	<0.001
BDI	3 ^{26,31,43}	180	Std. Mean Difference (IV, Random, 96% CI)	−0.15 [−0.75, 0.44]	0.03	0.61
POMS	3 ^{68,70,71}	156	Std. Mean Difference (IV, Random, 95% CI)	−1.64 [−2.55, −0.73]	<0.001	<0.001
HAMD	3 ^{37,61,73}	189	Std. Mean Difference (IV, Random, 96% CI)	−1.36 [−1.97, −0.75]	0.03	<0.001
Mid term						
Quality of life						
SF-36 total	2 ^{39,62}	276	Std. Mean Difference (IV, Random, 95% CI)	0.61 [0.16, 1.05]	0.12	0.008
SF-36 physical function	9 ^{26,27,34,44,46,52,56,58,59}	771	Std. Mean Difference (IV, Random, 95% CI)	0.49 [0.12, 0.85]	<0.001	0.009
SF-36 mental health	10 ^{27,34,42,44,46,52,56,58,59,63}	846	Std. Mean Difference (IV, Random, 95% CI)	0.39 [0.08, 0.71]	<0.001	0.02
SF-36 general health	7 ^{26,27,34,42,46,59,63}	592	Std. Mean Difference (IV, Random, 95% CI)	0.05 [−0.24, 0.34]	0.007	0.73
Depression						
CES-D	4 ^{24,25,56m,58}	308	Std. Mean Difference (IV, Random, 95% CI)	−0.41 [−0.64, −0.18]	0.78	<0.001
SCL-90	4 ^{21,28,74,77}	284	Std. Mean Difference (IV, Random, 95% CI)	−0.7 [−1.32, −0.08]	<0.001	0.03

Table 3. Summary of results. BDI: Beck Depression Inventory, CES-D: Center for Epidemiologic Studies Depression Scale, GHQ: General Health Questionnaire, HAMD: Hamilton Depression Scale, POMS-D: Profile of Mood States-Depression, SCL-90: Symptom Checklist 90, SDS: Self-rating depression scale, SF-36: Short-form 36, WHOQOL: World Health Organization Quality of Life.

method. A total of 23 articles (38.33%) blinded the outcome assessors to the treatment allocation. Second, the outcome assessors could not be blinded for the comparison between the TCE group and the no-intervention group, therefore generating potential performance and response bias. Third, most articles had no long-term follow-up period (over one year). Therefore, we did not conduct a meta-analysis to estimate the long-term effect of TCE on chronic diseases. Fourth, we used Egger's regression test to assess publication bias. Additionally, we systematically searched several electronic databases for publications. Although we found no publication bias, we did not search for any unpublished trials. Fifth, due to the lack of studies with training time ranging from 6 months to 12 months, especially 12 months, we did not perform a subgroup meta analysis focusing on exercise training time. Sixth, some studies included in our meta analysis had small sample sizes. Future meta-analyses including more large-scale, high-quality

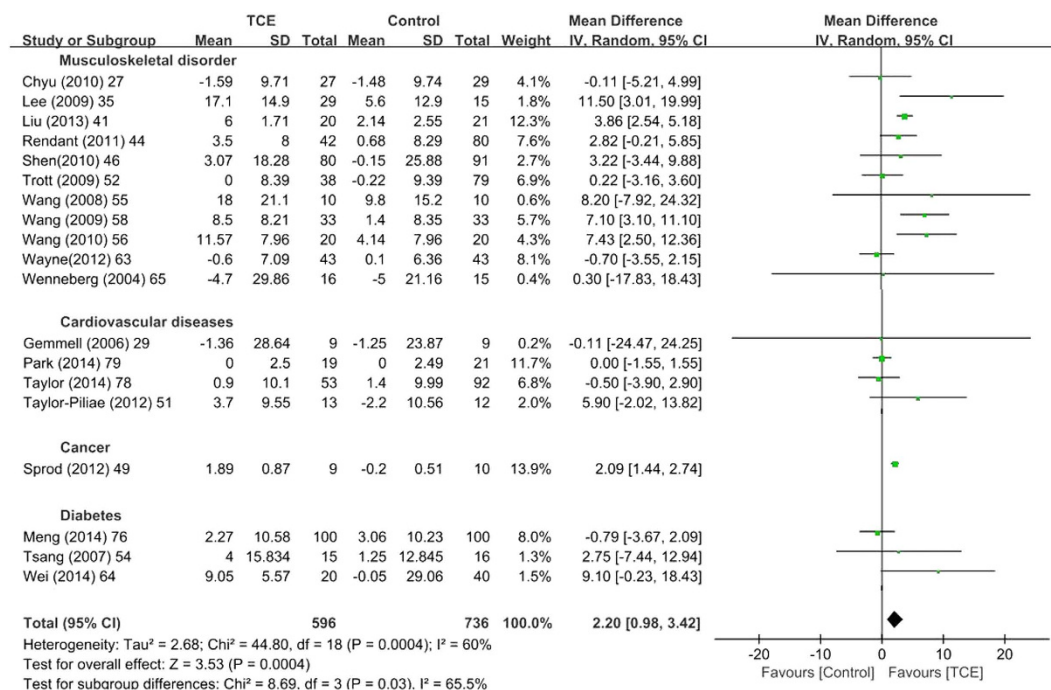


Figure 2. Meta-analyses of traditional Chinese exercises on short form-36 physical function at the short term. SD = standard deviation; 95% CI = 95% confidence intervals; IV = inverse variance.

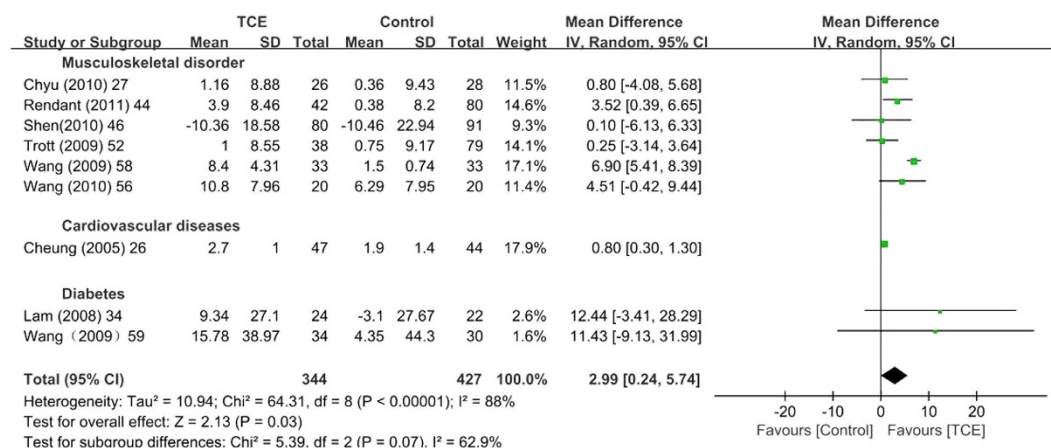
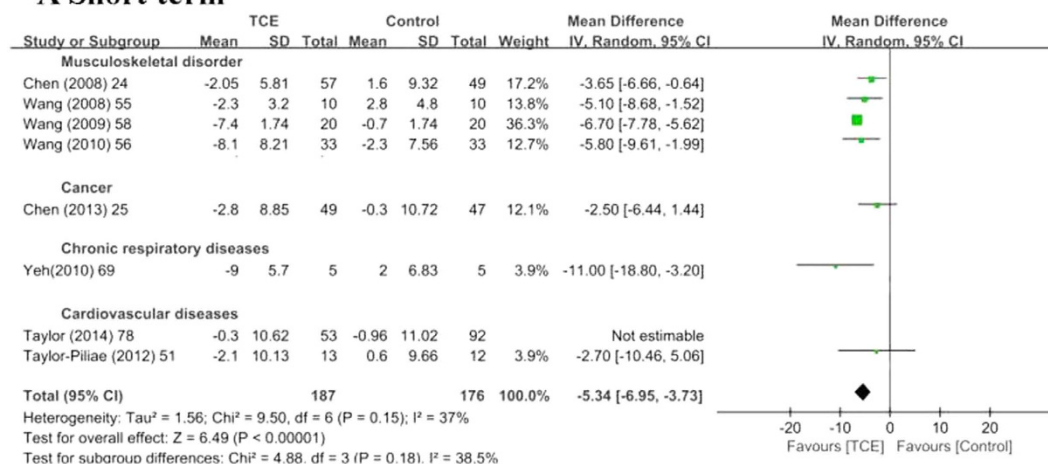


Figure 3. Meta-analyses of traditional Chinese exercises on short form-36 physical function at the mid-term. SD = standard deviation; 95% CI = 95% confidence intervals; IV = inverse variance.

RCTs are required to obtain further proof of the effects of TCE. Seventh, most of the Chinese studies from our meta analysis were not registered in the international clinical trials registry platform of the World Health Organization. To reduce bias, all studies should be performed in accordance with the standards of clinical trials (e.g., the Consolidated Standards of Reporting Trials statement).

Implications for policy and practice. Traditional medicine/exercise, including TCE is an important and often underestimated part of health services worldwide⁸². TCE is extensively performed in most countries; however, in many countries and regions, the public, medical professionals, and healthcare policymakers remain confused about the effectiveness, safety, and quality of TCE. In our meta-analysis, we identified both the scientific and clinical importance of TCE. Unlike other exercises, TCE may contribute to improving the quality of life (e.g., SF-36 and GHQ) and reducing depression (e.g., CESD, SDS, BDI) in patients with chronic diseases. These findings provide useful information for chronic disease patients, medical professionals, and healthcare policymakers. As public health professionals, we believe

A Short term



B Mid-term

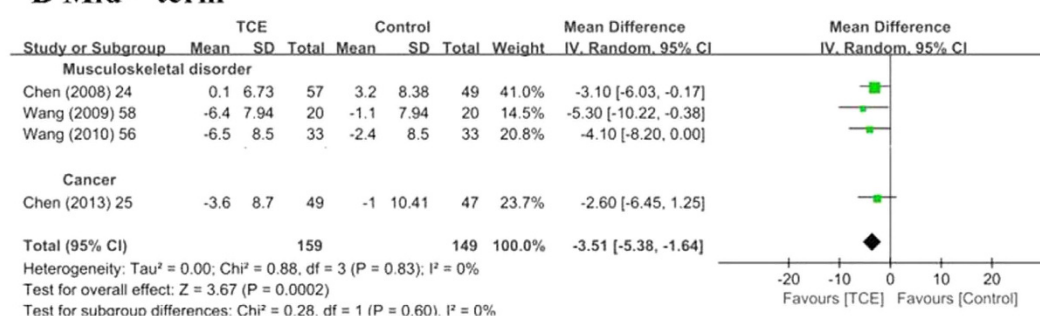


Figure 4. Meta-analyses of traditional Chinese exercises on Center for Epidemiologic Studies Depression Scale. A: in the short term. B: in the mid-term. SD = standard deviation; 95% CI = 95% confidence intervals; IV = inverse variance.

that healthcare policymakers and medical professionals must consider how TCE improves the health of patients with chronic diseases.

Implications and future research. Further evidence from larger and better quality studies must be collected to determine the effects of TCE on chronic diseases. Most of the articles with small sample sizes that were included in our meta-analysis only observed patients over a short-term follow-up period. Multicenter RCTs with large sample sizes must be conducted to validate the effects of TCE in patients with chronic diseases. Future studies should improve their methodological standards in the following aspects: random allocation, allocation concealment, long-term follow-up, intention-to-treat analysis, and assessor blinding. Likewise, such studies should adhere to generally accepted standards for reporting clinical trials (e.g., the Consolidated Standards of Reporting Trials statement). To estimate the duration of TCE-induced improvements, long-term follow-up periods must be adopted in future studies. In addition, the long-term effectiveness of TCE for patients with chronic diseases must be estimated.

References

- Lachat, C. *et al.* Diet and physical activity for the prevention of noncommunicable diseases in low- and middle-income countries: a systematic policy review. *PLoS Med.* **10**, e1001465 (2013).
- World Health Organization. *Global status report on noncommunicable diseases*. Geneva: World Health Organization (2011).
- Lozano, R. *et al.* Global and regional mortality from 235 causes of death for 20 age groups in 1990 and 2010: a systematic analysis for the Global Burden of Disease Study 2010. *Lancet.* **380**, 2095–2128 (2012).
- Hunter, D. J. & Reddy, K. S. Noncommunicable diseases. *N Engl J Med.* **369**, 1336–1343 (2013).
- Dans, A., Ng, N., Varghese, C., Tai, E. S., Firestone, R. & Bonita, R. The rise of chronic non-communicable diseases in southeast Asia: time for action. *Lancet.* **377**, 680–689 (2011).
- Jiang, Y. & Zou, J. Analysis of the TCM theory of traditional Chinese health exercise. *Journal of Sport and Health Science.* **2**, 204–208 (2013).
- Stevens, J. A., Voukelatos, A. & Ehrenreich, H. Preventing falls with Tai Ji Quan: A public health perspective. *Journal of Sport and Health Science.* **3**, 21–26 (2014).
- Guo, Y. C., Qiu, P. X. & Liu, T. G. Tai Ji Quan: An overview of its history, health benefits, and cultural value. *Journal of Sport and Health Science.* **3**, 3–8 (2014).

9. Fung, F. Y. & Linn, Y. C. Developing traditional chinese medicine in the era of evidence-based medicine: current evidences and challenges. *Evid Based Complement Alternat Med.* **2015**, 425037 (2015).
10. Jahnke, R., Larkey, L., Rogers, C., Etnier, J. & Lin, F. A comprehensive review of health benefits of qigong and tai chi. *Am J Health Promot.* **24**, e1–e25 (2010).
11. Winters-Stone, K. M. Tai Ji Quan for the aging cancer survivor: Mitigating the accelerated development of disability, falls, and cardiovascular disease from cancer treatment. *Journal of Sport and Health Science.* **3**, 52–57 (2014).
12. Pan, L., Yan, J., Guo, Y. & Yan, J. Effects of Tai Chi training on exercise capacity and quality of life in patients with chronic heart failure: a meta-analysis. *Eur J Heart Fail.* **15**, 316–23 (2013).
13. Wang, F. *et al.* The Effects of Tai Chi on Depression, Anxiety, and Psychological Well-Being: A Systematic Review and Meta-Analysis. *Int J Behav Med.* **21**, 605–617 (2014).
14. Chang, Y. K., Nien, Y. H., Chen, A. G. & Yan, J. Tai Ji Quan, the brain, and cognition in older adults. *Journal of Sport and Health Science.* **3**, 36–42 (2014).
15. Wayne, P. M. & Kaptchuk, T. J. Challenges inherent to tai chi research: part I—tai chi as a complex multicomponent intervention. *J Altern Complement Med.* **14**, 95–102 (2008).
16. Li, F. Z. Transforming traditional Tai Ji Quan techniques into integrative movement therapy—Tai Ji Quan: Moving for Better Balance. *Journal of Sport and Health Science.* **3**, 9–15 (2014).
17. Lee, M. S., Choi, T. Y. & Ernst, E. Tai chi for breast cancer patients: a systematic review. *Breast Cancer Res Treat.* **120**, 309–16 (2010).
18. Higgins, J. P. *et al.* The Cochrane Collaboration's tool for assessing risk of bias in randomised trials. *BMJ.* **343**, d5928 (2011).
19. Wang, X., Pi, Y., Chen, P., Liu, Y., Wang, R. & Chan, C. Cognitive motor interference for preventing falls in older adults: a systematic review and meta-analysis of randomised controlled trials. *Age Ageing.* **44**, 205–12 (2015).
20. An, B. *et al.* Baduanjin alleviates the symptoms of knee osteoarthritis. *J Altern Complement Med.* **14**, 167–174 (2008).
21. Barrow, D. E., Bedford, A., Ives, G., O'Toole, L. & Channer, K. S. An evaluation of the effects of Tai Chi Chuan and Chi Kung training in patients with symptomatic heart failure: a randomised controlled pilot study. *Postgrad Med J.* **83**, 717–721 (2007).
22. Blake, H. & Batson, M. Exercise intervention in brain injury: a pilot randomized study of Tai Chi Qigong. *Clin Rehabil.* **23**, 589–598 (2009).
23. Cai, W. Influence of sitting Baduanjin on quality of life of cerebral apoplexy patients with sequela in community. *Chinese Nursing Research.* **24**, 2667–2668 (2010).
24. Chen, K. W. *et al.* Effects of external qigong therapy on osteoarthritis of the knee. A randomized controlled trial. *Clin Rheumatol.* **27**, 1497–1505 (2008).
25. Chen, Z. *et al.* Qigong improves quality of life in women undergoing radiotherapy for breast cancer: results of a randomized controlled trial. *Cancer.* **119**, 1690–1698 (2013).
26. Cheung, B. M. *et al.* Randomised controlled trial of qigong in the treatment of mild essential hypertension. *J Hum Hypertens.* **19**, 697–704 (2005).
27. Chyu, M. C. *et al.* Effects of tai chi exercise on posturography, gait, physical function and quality of life in postmenopausal women with osteopaenia: a randomized clinical study. *Clin Rehabil.* **24**, 1080–1090 (2010).
28. Fransen, M., Nairn, L., Winstanley, J., Lam, P. & Edmonds, J. Physical activity for osteoarthritis management: a randomized controlled clinical trial evaluating hydrotherapy or Tai Chi classes. *Arthritis Rheum.* **57**, 407–414 (2007).
29. Gemmell, C. & Leatham, J. M. A study investigating the effects of Tai Chi Chuan: individuals with traumatic brain injury compared to controls. *Brain Inj.* **20**, 151–156 (2006).
30. Guan, Y. X., Wang, S. S. & Ma, M. N. Effect of Baduanjin -based exercise intervention on the related parameters in type 2 diabetes patients. *Journal of Nursing Science.* **27**, 23–24 (2012).
31. Haak, T. & Scott, B. The effect of Qigong on fibromyalgia (FMS): a controlled randomized study. *Disabil Rehabil.* **30**, 625–33 (2008).
32. Hart, J. *et al.* Tai Chi Chuan practice in community-dwelling persons after stroke. *Int J Rehabil Res.* **27**, 303–304 (2004).
33. Ji, X. D., Wang, Q. S. & Fang, C. X. Effect of exercise therapy on anxiety and depression in the patients with diabetes mellitus. *Pract Geriatr.* **26**, 331–333 (2012).
34. Lam, P., Dennis, S. M., Diamond, T. H. & Zwar, N. Improving glycaemic and BP control in type 2 diabetes. The effectiveness of tai chi. *Aust Fam Physician.* **37**, 884–887 (2008).
35. Lee, H. J. *et al.* Tai Chi Qigong for the quality of life of patients with knee osteoarthritis: a pilot, randomized, waiting list controlled trial. *Clin Rehabil.* **23**, 504–511 (2009).
36. Li, W. Q., Huang, X. F. & Bai, M. Impact of Tai Chi exercise on the quality of life of women with osteoporosis in perimenopausal period. *Journal of Qilu Nursing.* **16**, 16–17 (2010).
37. Li, Y. L., Hu, X. J. & Cui, L. N. Clinical observation on sitting Tai Chi exercise used for 30 cases of patients with depression after stroke. *Chinese nursing Research.* **26**, 2254–2256 (2012).
38. Li, Q., Fang, W. H. & Liu, C. The effect of taijiquan combined with respiratory exercise training on rehabilitation of patients with The stable chronic obstructive pulmonary diseases. *Chinese Journal of Rehabilitation Medicine.* **27**, 825–828 (2012).
39. Li, Z. B., Qi, L. L., Zhao, L. & Liu, H. L. Study on Advantages of Treating Type 2 Diabetes Mellitus with Baduanjin for Aerobic Exercise. *Liaoning Journal of Traditional Chinese Medicine.* **40**, 1858–1860 (2013).
40. Liu, Y. *et al.* Community-based Study on Effects of Chinese Qigong-Baduanjin on Depression Symptoms and Life Quality of Patients with Type 2 Diabetes Mellitus. *Chin J Sports Med.* **31**, 215–220 (2012).
41. Liu, X., Miller, Y. D., Burton, N. W. J., Chang, J. H. & Brown, W. J. The effect of Tai Chi on health-related quality of life in people with elevated blood glucose or diabetes: a randomized controlled trial. *Qual Life Res.* **22**, 1783–1786 (2013).
42. Ng, B. H., Tsang, H. W., Jones, A. Y., So, C. T. & Mok, T. Y. Functional and psychosocial effects of health qigong in patients with COPD: a randomized controlled trial. *J Altern Complement Med.* **17**, 243–251 (2011).
43. Putiri, A. L. *et al.* Psychological effects of Yi Ren Medical Qigong and progressive resistance training in adults with type 2 diabetes mellitus: a randomized controlled pilot study. *Altern Ther Health Med.* **18**, 30–34 (2012).
44. Rendant, D. *et al.* Qigong versus exercise versus no therapy for patients with chronic neck pain: a randomized controlled trial. *Spine (Phila Pa 1976).* **36**, 419–427 (2011).
45. Robins, J. L. *et al.* Psychoneuroimmunology-Based Stress Management during Adjuvant Chemotherapy for Early Breast Cancer. *Evid Based Complement Alternat Med.* **2013**, 372908 (2013).
46. Shen, C. L. *et al.* Green tea polyphenols supplementation and Tai Chi exercise for postmenopausal osteopenic women: safety and quality of life report. *BMC Complement Altern Med.* **10**, 76 (2010).
47. Singh-Grewal, D. *et al.* The effects of vigorous exercise training on physical function in children with arthritis: a randomized, controlled, single-blinded trial. *Arthritis Rheum.* **57**, 1202–1210 (2007).
48. Skoglund, L., Josephson, M., Wahlstedt, K., Lampa, E. & Norbäck, D. Qigong training and effects on stress, neck-shoulder pain and life quality in a computerised office environment. *Complement Ther Clin Pract.* **17**, 54–57 (2011).
49. Sprod, L. K. *et al.* Health-related quality of life and biomarkers in breast cancer survivors participating in tai chi chuan. *J Cancer Surviv.* **6**, 146–154 (2012).

50. Stephens, S. *et al.* Feasibility and effectiveness of an aerobic exercise program in children with fibromyalgia: results of a randomized controlled pilot trial. *Arthritis Rheum.* **59**, 1399–1406 (2008).
51. Taylor-Piliae, R. E. & Coull, B. M. Community-based Yang-style Tai Chi is safe and feasible in chronic stroke: a pilot study. *Clin Rehabil.* **26**, 121–131 (2012).
52. von Trott, P. *et al.* Qigong and exercise therapy for elderly patients with chronic neck pain (QIBANE): a randomized controlled study. *J Pain.* **10**, 501–508 (2009).
53. Tsang, H. W., Mok, C. K., Yeung, Y. T. & Chan, S. Y. The effect of Qigong on general and psychosocial health of elderly with chronic physical illnesses: a randomized clinical trial. *Int J Geriatr Psychiatry.* **18**, 441–449 (2003).
54. Tsang, T., Orr, R., Lam, P., Comino, E. J. & Singh, M. F. Health benefits of Tai Chi for older patients with type 2 diabetes: the “Move It For Diabetes study”—a randomized controlled trial. *Clin Interv Aging.* **2**, 429–439 (2007).
55. Wang C. Tai Chi improves pain and functional status in adults with rheumatoid arthritis: results of a pilot single-blinded randomized controlled trial. *Med Sport Sci.* **52**, 218–229 (2008).
56. Wang, C. *et al.* A randomized trial of tai chi for fibromyalgia. *N Engl J Med.* **363**, 743–754 (2010).
57. Wang, W. *et al.* Tai Chi exercise versus rehabilitation for the elderly with cerebral vascular disorder: a single-blinded randomized controlled trial. *Psychogeriatrics.* **10**, 160–166 (2010).
58. Wang, C. *et al.* Tai Chi is effective in treating knee osteoarthritis: a randomized controlled trial. *Arthritis Rheum.* **61**, 1545–1553 (2009).
59. Wang, P., Han, Q. Y. & Liang, R. D. The effect of Taijiquan exercise on health-related quality of life in patients with type 2 diabetes in Community. *CHINA MODERN MEDICINE.* **16**, 108–109 (2009).
60. Wang, Y. L. *et al.* Effect of Taijiquan Exercise on the Recovery of Limb Function and the Quality of Life after Surgery of Breast Cancer Patients. *China Sport Science and Technology.* **46**, 125–128 (2010).
61. Wang, L. *et al.* Effect of Tai Chi exercise on depression for stroke. *Chinese Community Doctors.* **14**, 222 (2012).
62. Wang, X. K., Zhang, X. L., Ding, F. M. & Jiang, W. Q. Effects of Tai Chi exercise on quality of life and NT-proBNP in patients with STEMI. *Guide of China Medicine.* **11**, 659–661 (2013).
63. Wayne, P. M. *et al.* Impact of Tai Chi exercise on multiple fracture-related risk factors in post-menopausal osteopenic women: a pilot pragmatic, randomized trial. *BMC Complement Altern Med.* **12**, 7 (2012).
64. Wei, Q. B. & Wu, Y. C. Clinical Study of Baduanjin on Health Status in Patients with Type 2 Diabetes. *Journal of Liaoning University of TCM.* **16**, 103–105 (2014).
65. Wenneberg, S., Gunnarsson, L. G. & Ahlström, G. Using a novel exercise programme for patients with muscular dystrophy. Part II: a quantitative study. *Disabil Rehabil.* **26**, 595–602 (2004).
66. Wu, W. H. *et al.* Effects of qigong on late-stage complex regional pain syndrome. *Altern Ther Health Med.* **5**, 45–54 (1999).
67. Wu, X. The effect of electrotherapy combined with Baduanjin exercise for chronic low back pain. *Chinese Medicine Modern Distance Education of China.* **10**, 87–88 (2012).
68. Yang, K. H., Kim, Y. H. & Lee, M. S. Efficacy of Qi-therapy (external Qigong) for elderly people with chronic pain. *Int J Neurosci.* **115**, 949–963 (2005).
69. Yeh, G. Y. *et al.* Tai chi exercise for patients with chronic obstructive pulmonary disease: a pilot study. *Respir Care.* **55**, 1475–1482 (2010).
70. Yeh, G. Y. *et al.* Tai chi exercise in patients with chronic heart failure: a randomized clinical trial. *Arch Intern Med.* **171**, 750–757 (2011).
71. Yeh, G. Y. *et al.* Tai chi in patients with heart failure with preserved ejection fraction. *Congest Heart Fail.* **19**, 77–84 (2013).
72. Zhou, T. Effects of Qigong on blood glucose and psychologic status for 25 patients with diabetes. *Nei Mongol Journal of Traditional Chinese Medicine.* **24**, 70 (2014).
73. Wang, Z. W. *et al.* A multi-center randomized controlled clinical study on the clinical efficacy of strengthened “Liu ZiJue” on COPD in stable phase. *SH. J. TCM.* **48**, 51–54 (2014).
74. Wang, H. P. Effects of Tai Chi on psychologic status for elderly patients with diabetes. *Nei Mongol Journal of Traditional Chinese Medicine.* **28**, 115 (2014).
75. Sun, F. & Sun, C. F. Effects of Tai Chi for elderly patients with hypertension. *Chinese Journal of Gerontology.* **34**, 6862–6864 (2014).
76. Meng, E. Tai chi exercise for patients with type 2 diabetes mellitus. *Chinese Journal of Gerontology.* **34**, 5358–5360 (2014).
77. Fang, C. P. *et al.* Influence of health care Qigong Baduanjin on mental health of patients with impaired glucose tolerance. *Journal of Guangzhou University of Traditional Chinese Medicine.* **31**, 731–734 (2014).
78. Taylor-Piliae, R. E. *et al.* Effect of Tai Chi on physical function, fall rates and quality of life among older stroke survivors. *Arch Phys Med Rehabil.* **95**, 816–824 (2014).
79. Park, J. E. *et al.* Randomized, controlled trial of qigong for treatment of prehypertension and mild essential hypertension. *Altern Ther Health Med.* **20**, 21–30 (2014).
80. Lan, C., Chen, S. Y., Lai, J. S. & Wong, A. M. Tai Chi chuan in medicine and health promotion. *Evid Based Complement Alternat Med.* **2013**, 502131 (2013).
81. Li, G. Yuan, H. & Zhang W. Effects of Tai Chi on health related quality of life in patients with chronic conditions: a systematic review of randomized controlled trials. *Complement Ther Med.* **22**, 743–755 (2014).
82. World Health Organization. *WHO traditional medicine strategy: 2014–2023*. Geneva: World Health Organization (2013).

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Author Contributions

X.Q.W., Y.L.P. and P.J.C. Conceived and designed the experiments. X.Q.W., Y.L.P. and X.L. screened the titles and abstracts, assessed trials for inclusion and trial quality, and extracted data. X.Q.W., Y.L.P., Y.L. and R.W. performed statistical analyses and wrote the draft manuscript. B.L.C., Y.Z., X.Q.W., Y.L.P., Y.J.Y. and Z.B.N. contributed to the revision and final version of the paper. P.J.C. is guarantor.

Additional Information

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