Traditional Chinese exercise for sleep problems in healthy adults and patients: a systematic review and meta-analysis of randomized controlled trials

Yameng Li, Fang Peng, Qiuyang Wei, Meize Cui, Jianwei Zhang, Shaojun Lyu*

Abstract

Background

Adequate sleep is an essential factor contributing to mental and physical health. Because of changes in lifestyle and the aging process, sleep problems have worsened. However, to our knowledge, there have been no systematic reviews summarizing the effects of traditional Chinese exercise (Tai Chi, Qi Gong, Baduanjin, Wuqinxi, Liuzijue, and Daoyin) on sleep problems among any diagnostic population.

Objectives

This systematic review and meta-analysis were performed to systematically evaluate the evidence on the effects of traditional Chinese exercise on sleep problems.

Methods

Six databases were systematically searched for randomized controlled trials (RCT) with any type of traditional Chinese exercise for sleep problems in healthy adults and patients. The search deadline was from database inception to October 16, 2019. Outcomes were self-reported or objective sleep measurements. The Cochrane risk assessment tool was used to assess the quality of the included literature. The standardized mean difference (SMD) was calculated using random-effects models.

Results

The meta-analysis included 13 studies that assessed the Pittsburgh Sleep Quality Index (PQSI), showing that the experimental group had better global sleep quality than the control group (SMD=-0.497, 95% CI (-0.757, -0.237); p≤0.001). The subgroup analysis showed that Tai Chi and Qi Gong programs significantly improved sleep quality (SMD=-0.601, 95% CI 95% CI (-1.159, -0.043); P=0.004), as did Tai Chi alone (SMD=-0.568, 95% CI (-1.008, -0.128); P=0.001), but sleep quality was not significantly improved in the Qi Gong group alone (SMD=-0.356, 95% CI (-0.786, -0.074); P=0.105).The results indicated that traditional Chinese exercise significantly improved sleep quality in clinical patients (SMD=-0.638, 95% CI (-0.977, -0.299); p≤0.001) but did not significantly improve health and insomnia (SMD=-0.221, 95% CI (-0.561, -0.119); P=0.202). Subgroup analyses found traditional Chinese exercise at least 8-12 weeks, 181-300 min every week was likely to be more effective in improving sleep quality.

Conclusions

Traditional Chinese exercise can effectively improve sleep quality. Tai Chi and Qi Gong programs are more effective for treating sleep problems, and subjects with illness may receive more benefit than healthy subjects and those with insomnia. Tai Chi and Qi Gong programs that are 8-12 weeks long, for 120-300 min every week, are effective for treating sleep problems.

Keywords

traditional Chinese exercise; sleep problems; systematic review; Meta-analysis

Funding

National Key R&D Program of China (2018YFC2000600), Finance Department of the State Administration of Traditional Chinese Medicine (GZY-GCS-2018-011), and the Wushu Research Institute of the General Administration of Sport of China (WSH2018A00).

J. of Int. Society of Chinese Health Practices
2021 Volume 2 Number 1
Published online March 16, 2021

The authors' full names, academic degrees, and affiliations are listed in the Appendix.

Corresponding author:

Prof. Shaojun Lyu, College of P.E. and Sports, Beijing Normal University.
No.19 Xinjiekou wai street Haidian district, Beijing, China.100875.
Email: I13121860699@163.com

Introduction

Adequate sleep is an essential factor contributing to mental and physical health.[1] Because of changes in lifestyle and the aging process, sleep problems have worsened.[2,3] Insomnia is a prevalent complaint in the general population and in clinical practice. Prevalence estimates indicate that approximately one-third of the adult population have insomnia symptoms, 9%-12% experience additional daytime consequences, and approximately 6% meet formal criteria for insomnia diagnosis.[4,5] It has been recognized that sleep has a significant impact on human health.[6] Evidence has shown that short-term sleep problems are associated with an increased incidence of cardiovascular diseases, such as coronary artery disease, arrhythmias, hypertension, diabetes, and obesity,[2] whereas long-term sleep problems increase mortality according to large-scale cohort studies.[7,8] Meanwhile, investigations indicated that insomnia is more common among women, middle-aged and older adults, and patients with medical or psychiatric disorders. Insomnia increases rates of absenteeism and health care utilization,[9,10] and fewer than 15% of patients with chronic insomnia seek intervention or consultation.[11,12]

Commonly, most individuals who sought treatment for insomnia were prescribed sleep medications.[13,14] Such medications are considered an effective treatment for insomnia.[15,16] These drugs can cause some potential adverse effects for long-term users, such as dependency and drug resistance, cognitive slowing, daytime fatigue, and an increased risk for falls.[17,18] Recent evidence indicated that chronic use of hypnotics is associated with an increased risk of depression, suicide, and overall mortality.[19] A systematic review and meta-analysis indicated that cognitive behavioral therapy (CBT) is as effective in the long term as pharmacotherapy for sleep problems.[20] Because few clinicians are experts in the use of CBT for the treatment of chronic insomnia, these techniques are not in widespread use.[21]

Mind-body interventions (MBI) are modalities focusing on interactions among the brain, mind, body, and behavior, with the intent to use the mind to affect physical functioning and promote health.[22] MBIS are increasingly being incorporated into mainstream scientific research; at the same time, systematic reviews have indicated that MBI may potentially be useful in the treatment or prevention of geriatric mental illnesses, cognitive disorders[23] and sleep disturbances[22]. Tai Chi is considered a moving meditation in which practitioners are guided to be mindful of their postures, movements, and breathing, with an intensive inwardly directed focus.[24] Tai Chi is a common mind-body intervention.[25] Baduanjin is a form of Qi Gong and is mainly composed of five elements: visualization, meditation, relaxation, deep breathing, and qi circulation.[26] These elements are integrated with regulation of the mind, body, and breath.[27] A previous review briefly summarized the research on the physical benefits, including balance and muscle strength, and the psychological benefits, including attentiveness, sleep, and anxiety, of Tai Chi.[28] Baduanjin significantly improved insomnia as measured by the PSQI.[29] In addition to Tai Chi Baduanjin, which is highly accepted worldwide, Wuqinxi, Liuzijue, and Daoyin also play an important role in improving the quality of life of patients with hypertension and chronic obstructive pulmonary disease.[30,31] However, to our knowledge, there have been no systematic reviews summarizing the effects of traditional Chinese exercise (Tai Chi, Qi Gong, Baduanjin, Wuqinxi, Liuzijue, and Daoyin) on sleep problems among any diagnostic population. The goal of this review was to systematically evaluate the evidence on the effects of traditional Chinese exercise on sleep problems to investigate whether the effects of traditional Chinese exercise differ according to the type, duration, and frequency of interventions and subjects, and to provide an overall understanding of the current situation.

Methods

Data sources and search strategy

Six databases were searched for eligible studies, including Wanfang, the China National Knowledge Infrastructure (CNKI), the Chinese Scientific Journal Database (VIP), PubMed the Cochrane Library, and Ovid Embase. The search terms included Tai Chi, Qi Gong, Baduanjin, eight-section brocade, Wuqinxi, Yijinjin, Liuzijue, Daoyin, mind body therapy, dyssomnias, sleep disorders, disorders of initiating and maintaining sleep, insomnias, fatal familial insomnias, and randomized controlled trial. The search deadline was from database inception to October 16, 2019.

Inclusion criteria

1) RCTs comparing traditional Chinese exercise (Tai Chi, Qi Gong, Baduanjin, Wuqinxi, Liuzijue, and Daoyin) with at least one control group were included.

2) Participants were adults over 18 years old with sleep problems documented by objective measures (e.g., polysomnography) or standardized subjective measures (e.g., the Pittsburgh Sleep Quality Index or the Epworth Sleepiness Scale). Insomnia associated with other clinical conditions was also included.

3) The intervention group included those using one form of traditional Chinese exercise (Tai Chi, Qi Gong, Baduanjin, Wuqinxi, Liuzijue, or Yijinjing Daoyin) without conventional medication. The control group included those using other kinds of physical activity, health education, cognitive behavioral therapy, or no treatment at all.

Exclusion criteria

1) The age of the participants was younger than 18 years.

2) The study used a mixed intervention, such as Tai Chi with health education.

3) The full article could not be found.

Data extraction and quality assessment

A Microsoft Excel spreadsheet was created by the reviewers to record the extracted data, which included information on the study (name of first author, year, country, and language), and participant characteristics (sample size, average age, sex ratio, stroke duration, and health condition), intervention and comparator characteristics (intensity, frequency, duration, and style of traditional Chinese exercise and treatments), follow-up, PSQI outcomes, other outcomes and main conclusions. Two reviewers (LYm and WQy) performed the extraction independently, and any disagreement during data extraction and quality evaluation was solved by discussion between them. Regarding insufficient or vague data, we contacted the article authors or original investigators to obtain the original data. If the attempt failed, the studies were excluded.

Two reviewers (LYm and WQy) judged the risk of bias of the included studies independently using the risk of bias assessment tool proposed by the Cochrane Back Review Group.[32] This scale includes generation of the allocation sequence, allocation concealment, blinding of participants and personnel, blinding of outcome assessors, selective outcome reporting, incomplete outcome data, and other potential sources of bias. Each item was assessed as having a low, unclear, or high risk for each of the included studies.

Data synthesis and analysis

Review Manager (version 5.3 for Windows) and STATA (version 13.0 for Windows) were used for this meta-analysis, and the primary outcomes were sleep problems. Intervention effects were defined as the standardized mean difference (SMD) and 95% confidence interval (CI) of the post-intervention score for the continuous variables. Odds ratios (ORs) and 95% confidence intervals (CIs) were used as analysis statistics for counting data. An SMD greater than 0.8 was considered a large effect size, an SMD of 0.5–0.8 was considered a moderate effect size, and an SMD of 0.2–0.5 was considered a small effect size.[33] A chi-square test was used to perform a heterogeneity analysis, and I2 was used to estimate the degree of heterogeneity. If I2 was < 50% and the p-value was > 0.1, we used a fixed-effect model. Otherwise, the results showed that statistical heterogeneity existed among studies, and a random-effects model was used.[34] For a more detailed explanation of the potential heterogeneity among the involved studies, subgroup analyses were conducted. The subgroup analyses were implemented according to the patients' characteristics, and the type, duration and frequency of the interventions, were used to understand the heterogeneity. A sensitivity analysis was also conducted if necessary. Publication bias was tested using a funnel plot. If the study had more than 1 control group, we switched the criteria in the selection of control groups to observe whether different results were achieved.[6] The significance level was $p < 0.05$.

Results

Literature search

A total of 355 studies were initially identified, 118 from English-language databases and 237 from Chinese-language databases. After removing duplicates, 236 articles remained. After screening the titles and abstracts, 30 studies remained. After reading the full text, 19 studies were left. Of those 19 suitable studies, 6 studies could not be included in the quantitative meta-analysis due to no response to our request and missing information. Thus, 13 studies were included in the meta-analysis (Fig. 1).

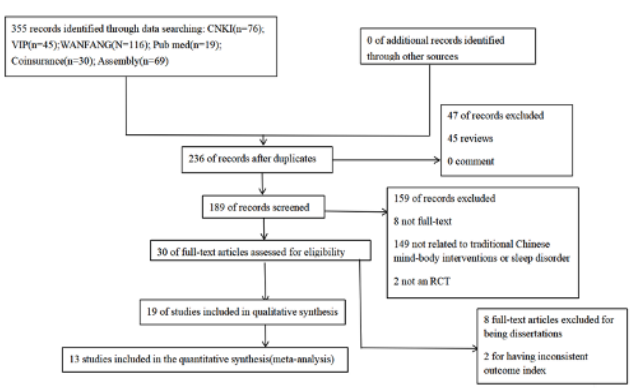

Fig. 1. Section of eligible studies.

Characteristics of the study

Of the 19 included studies (N=1666), 7 were published in Chinese [37,39,40,43,45,47,48] (all conducted in China), 12 were published in English (4 conducted in China [38,46,51,53], five from the USA [36,41,42,44,52], one from Japan [49], one from Canada [50], and one from Turkey [35]). All were published between 2004 and 2018. Among the 19 studies, the sample size ranged from 34 to 180. Most studies had between 50 and 100 subjects [35-37,39,43-47,50,52,53], and five studies had more than 100 subjects [40-42,48,51]. Only one study showed how the sample size was calculated.[51] The age of the recruited participants was over 18 years. Five studies recruited young adults aged 18-24.[37,39,40,43,45] Six studies targeted older people.[36,38,42,46,49,52] The majority of studies included both females and males, although one study included males only,[52] and three studies included females only.[38,44,53] Twelve studies' subjects were patients with chronic conditions, which included mild and moderate obstructive sleep apnea,[35] knee osteoarthritis,[38] stroke,[48] cerebral vascular disorder,[36,49] fibromyalgia,[50] cancer,[44,52,53] depression,[47] cognitive impairment,[46] and non-Hodgkin's lymphoma.[51] One study's subjects were healthy people.[39] Three studies focused on people with comorbid insomnia.[44,46,47] One study identified sleep

disturbance by PSQI,[37] one study identified insomnia by ICSD-2,[40] and one study identified insomnia by DSM-IV-TR.[44]

Study design

Among the 19 studies, the majority (N=16) were two-armed with one intervention and one control arm. Four studies utilized either normal activity or usual care controls,[37,39,48,51], two utilized waitlist controls,[50,53] three utilized health education controls,[38,41,46] one performed a home exercise program,[35] two utilized low-intensity aerobic exercise,[42,43], two utilized psychotherapy,[44,45] and one utilized usual rehabilitation.[49] The other three two-armed studies reported the following control conditions: low-impact exercise[36,52] and acupuncture.[40]

Intervention

Of the 19 studies, 9 applied Tai Chi, [36,38,41-44,46,47,49] two used Tai Chi and Qi Gong, [35,52] and 8 applied Baduanjin, Wuqinxi, Liuzijue, Daoyin and Yijinjing. [37,39,40,45,48,50,51,53] The duration of the overall interventions ranged from 3 to 24 weeks. The duration per session varied with a range of 20–90 min, and most studies included interventions lasting 1 hour every session.[35-38,42,46-48] The frequency of the intervention also varied widely, ranging from once a week to twice a day. Most interventions were performed five times a week.[35-37,39,47,53] Fourteen of the included studies stated that the intervention was provided by a qualified instructor with certification or considerable teaching experience.[35,36,39,41,42,44-48,50-53] Eleven studies reported the specific training program.[35,36,38,42-45,47-49,53] Three studies provided a DVD and printed instructional materials for participants.[46,52,53] Twelve of the included studies reported the completion of interventions.[35,36,38,41,42,44,46,48,50-53]

Outcomes

Most studies used subjective sleep measures, including the PSQI; one study used both the PSQI and Epworth Sleepiness Scale (ESS),[35,42] and one study employed the Chinese version of the Verran and Snyder-Halpern Sleep Scale (VHSSS).[51] Other objective measurements included electrocardiography (EEG)[49] and polysomnography (PSG).[35,44]

Quality evaluation

The risk of bias summary for all studies included in the meta-analysis can be found in Fig. 2a. Fig. 2b shows the risk of bias for each RCT study based on the recommendations in the Main Analysis section of the methods section of the Cochrane Handbook.[32] Seven studies[38,41,42,46,48,51,52] reported performing randomization using a computer-generated random sequence, two studies used a numbered series of prefilled envelopes,[35,50] one study applied the random number table method,[47] and one study determined the group by a coin flip.[53] Seven studies lacked descriptions of the method of random sequence generation.[37,39,40,43-45,49] Eight studies did not describe how allocation concealment was conducted.[36,37,39,40,43,47,45,53] Fourteen lacked details on whether participants and administrators were blinded; however, it was clear that blinding had not occurred due to obvious differences between the intervention group and the control group.[35-37,39,40,42,43,46-48,50-53] One study did not report baseline data.[43] Two studies had a high drop-out rate, but it occurred at random. [36, 42]

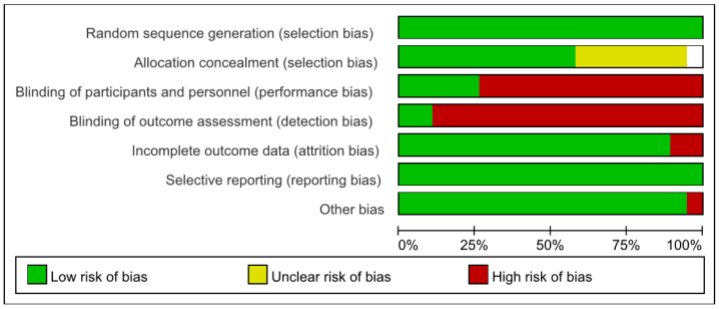

Fig. 2a. The risk of bias summary

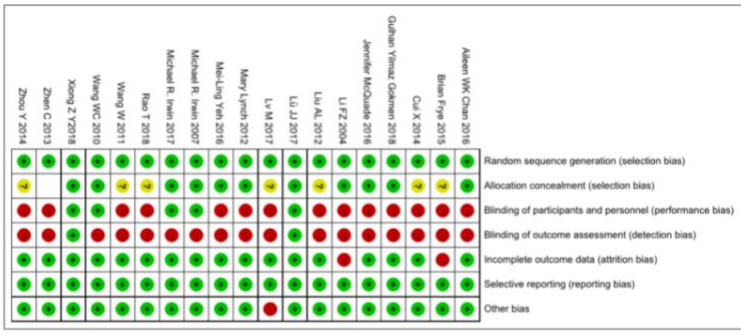

Fig. 2b. The risk of bias for each RCT study

Main analysis

Thirteen studies [35,36,38,40-42,45,47-50,52,53] assessed the PQSI, showing that the experimental group had better global sleep quality than the control group (SMD=-0.497, 95% CI 95% CI (-0.757, -0.237); p≤0.001) with high heterogeneity (I2= 77.2%, p≤0.001) (Fig. 3a). Five studies were not included due to insufficient data, [37,39,43,46,51] and one study was not included because the control group underwent cognitive behavior therapy.[44] Regarding the 7 factors of the PSQI, traditional Chinese exercise had a significant positive effect on four items, including sleep quality (SMD=-0.891, 95% CI (-1.409, -0.373); p≤0.001) with high heterogeneity (I2= 89.4%, p≤0.001)(Fig. 3b), habitual sleep efficiency (SMD=-0.762, 95% CI (-1.291, 0.232); P=0.005) with high heterogeneity (I2=89%, p≤0.001)(Fig. 3c), sleep duration (SMD=-0.632, 95% CI (-1.056, 0.207); P=0.004) with high heterogeneity

(I2=81.7%, p≤0.001)(Fig. 3d), and use of medication (SMD=-0.407, 95% CI (-0.587, 0.226); p≤0.001) with low heterogeneity (I2=32.2%, P=0.194)(Fig. 3e), but they did not affect sleep latency (SMD=-0.468, 95% CI (-0.956, 0.020); P=0.060) with high heterogeneity (I2= 84.4%, p≤0.001)(Fig. 3f), sleep disturbance (SMD=-0.351, 95% CI (-0.865, 0.163); p≤0.001) with high heterogeneity (I2= 89.9%, p≤0.001)(Fig. 3g) and daytime dysfunction (SMD=-0.318, 95% CI (-0.736, 0.099); P=0.135) with high heterogeneity (I2=84.6%, p≤0.001) (Fig. 3h)

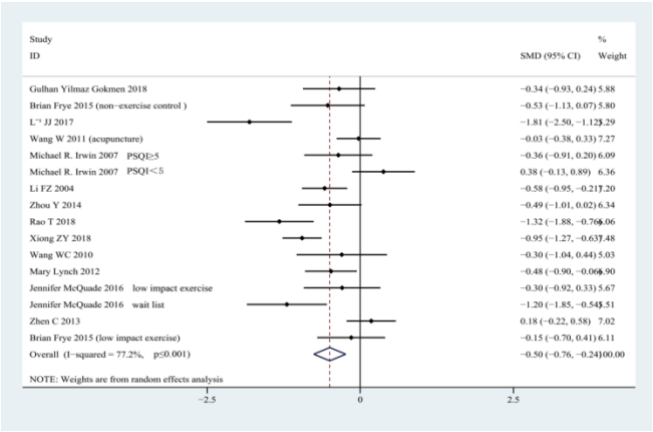

Fig. 3a. Global sleep quality

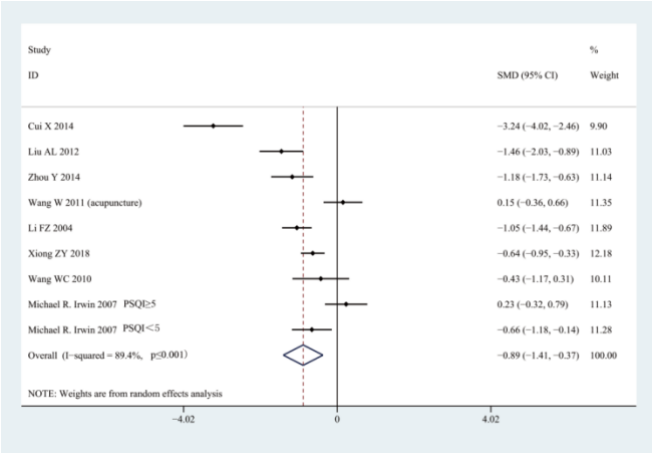

Fig.3b Sleep quality

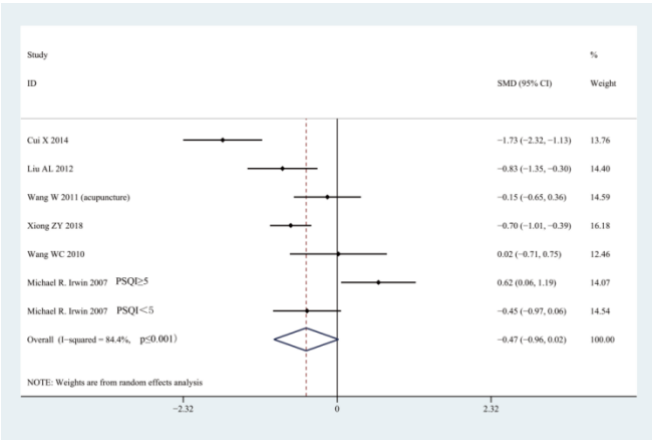

Fig.3c Sleep latency

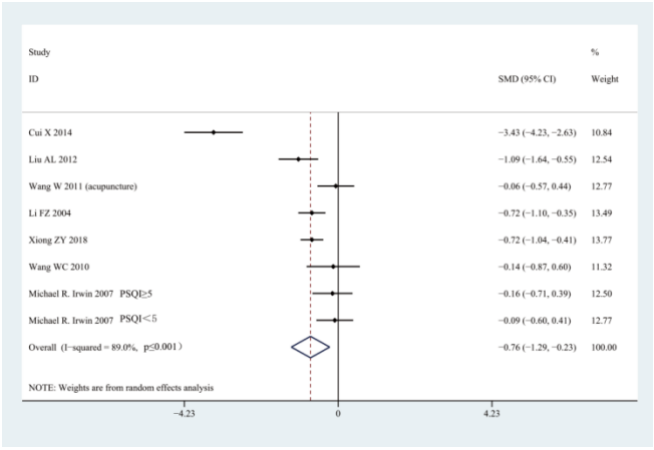

Fig.3d Habitual sleep efficiency

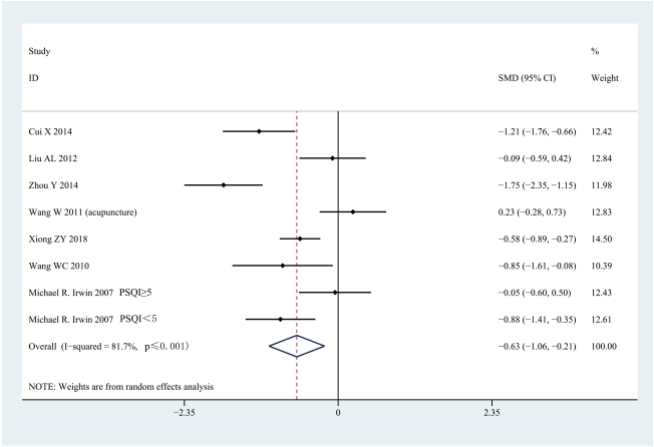

Fig.3e Sleep duration

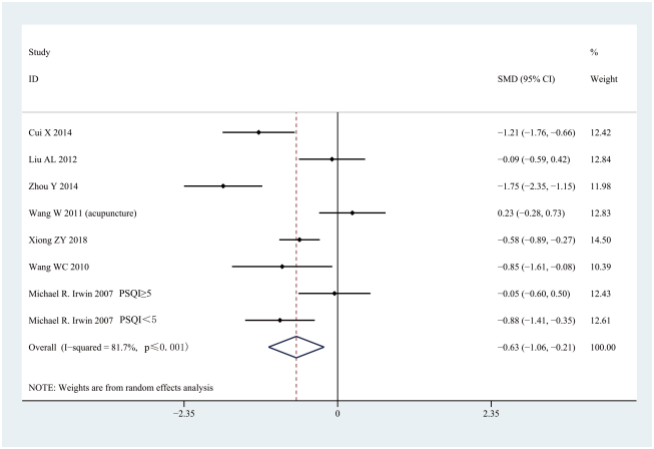

Fig.3f Sleep disturbance

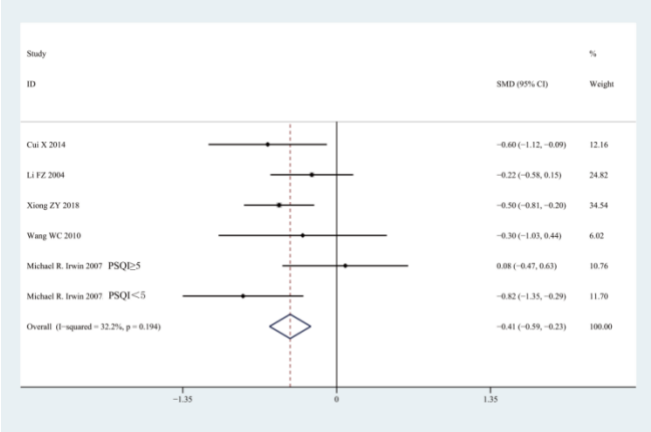

Fig.3g Use of sleep medications

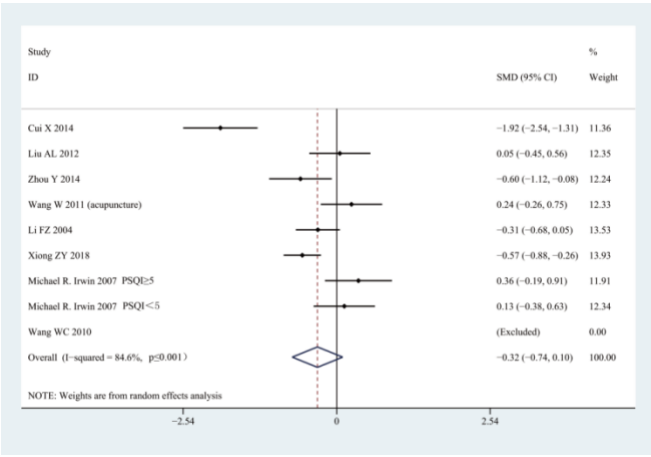

Fig.3h Daytime dysfunction

Fig. 3 Forest plot of the main outcomes for the effects of interventions on global sleep quality and the seven factors of the PSQI.

Subgroup analysis

The subgroup analysis was used to estimate whether the type of intervention affected sleep quality: Tai Chi and Qi Gong program significantly improved sleep quality (SMD=-0.601,95% CI (-1.159, -0.043); P=0.004) with high heterogeneity (I^2=58.7%, P=0.089), as did Tai Chi (SMD=-0.568, 95% CI (-1.008, -0.128); P=0.001) with high heterogeneity (I^2=80.3%, p⩽0.001), but there was not a significant difference for the Qi Gong group (SMD=-0.356,95% CI (-0.786, -0.074); P=0.105) with high heterogeneity (I^2=83.2%, p⩽0.001) (Fig. 4a).

The subgroup analysis for the duration of the intervention was based on the following groups: <8 weeks; 8-12 weeks; and >12 weeks. Interventions lasting 8-12 weeks significantly improved sleep quality (SMD=-0.517,95% CI (-0.839, -0.196); P=0.002) with high heterogeneity (I^2=71.4%, P=0.001), but sleep quality was not significantly improved for interventions lasting <8 weeks (SMD=-0.468,95% CI (-1.206, 0.390); P=0.317) with high heterogeneity (I^2= 84.0%, P = 0.002) and >12 weeks (SMD=-0.544, 95% CI (-1.122, 0.034); P=0.065) with high heterogeneity (I^2= 84.3%, p ⩽0.001) (Fig. 4b).

The subgroup analysis for the weekly duration of the intervention was based on the following groups: 120-180 min and 181-300 min. In interventions lasting 120-180 mins every week, sleep quality significantly improved (SMD=-0.595,95% CI 95% CI (-1.054, -0.135); P=0.031) with high heterogeneity (I^2=80.2%, p ⩽0.001). In interventions lasting 181-300 mins every week, there was a more significant change in sleep quality (SMD=-0.517, 95% CI (-0.986, -0.048); P=0.011) with high heterogeneity (I^2=82.4%, p⩽0.001) (Fig. 4c). Because the sample size requirement for subgroup analyses, the two studies were not statistically analyzed.[40,49]

The results indicated that traditional Chinese exercise improved sleep quality in clinical patients (SMD=-0.638, 95% CI (-0.977, -0.299); p⩽0.001) with high heterogeneity (I^2=78%, p⩽0.001), but they did not improve health and insomnia (SMD=-0.221, 95% CI (-0.561, -0.119); P=0.202) with high heterogeneity (I^2=64.9%, P=0.023) (Fig. 4d).

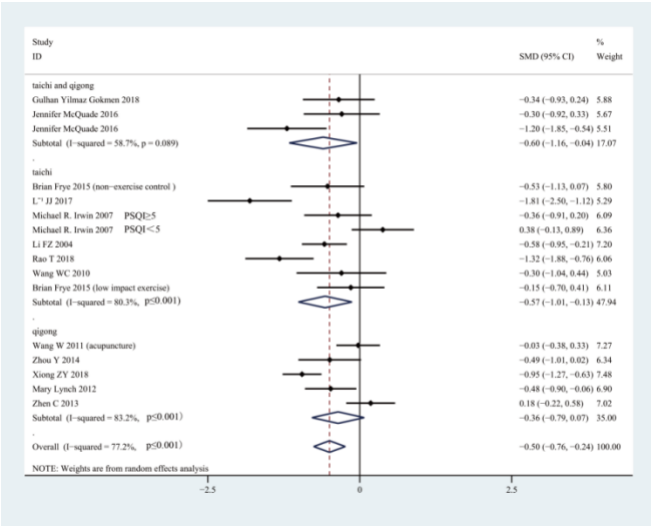

Fig. 4a Different intervention types

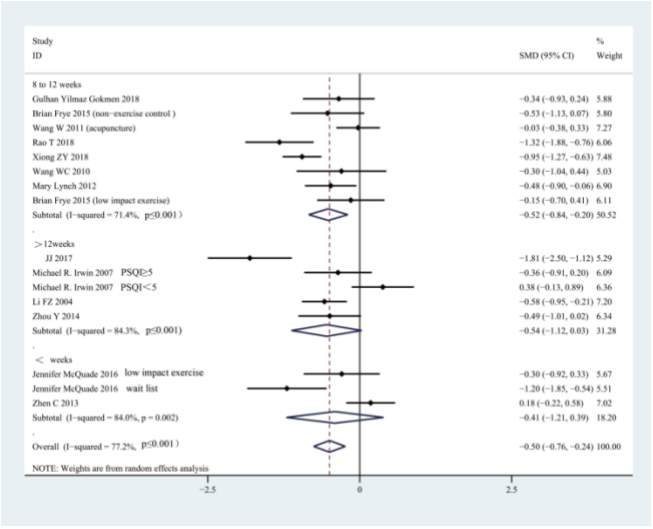

Fig. 4b Different intervention durations

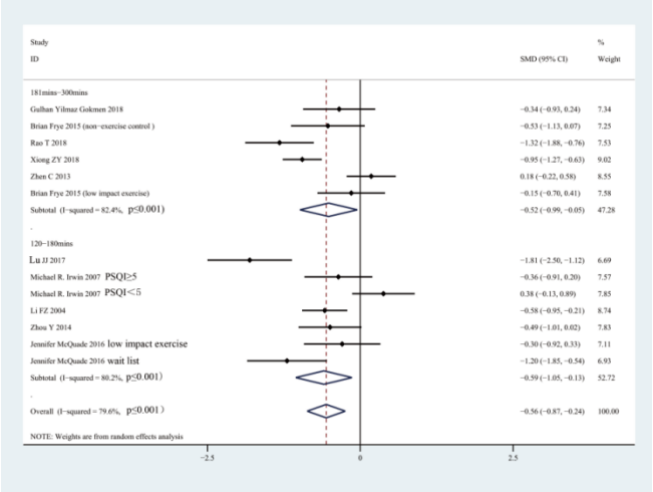

Fig. 4c Different intervention frequencies.

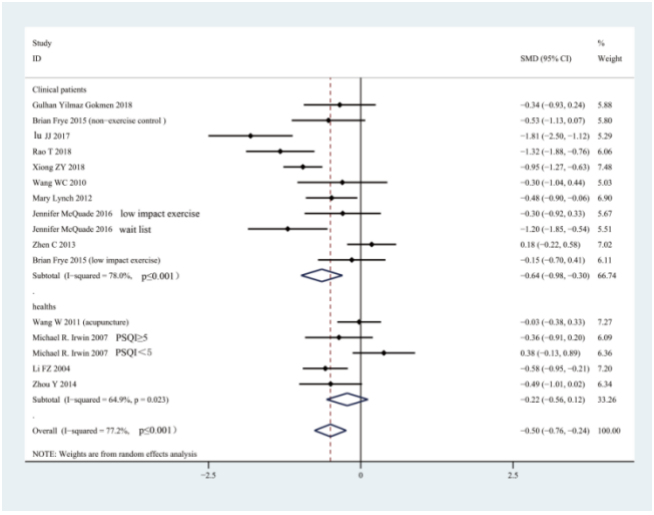

Fig. 4d Different kinds of subjects.

Fig. 4 Forest plot of the subgroup analysis of interventions for sleep quality based on different types, duration, frequencies, and kinds of subjects.

Sensitivity analysis

The sensitivity analysis revealed that exclusion of any single study did not materially alter the overall SMD, which ranged from -0.42 (95% CI, -0.66 to -0.18) to -0.55 (95% CI, -0.80 to -0.30). This means that this study has good stability.

Risk of bias across studies

A funnel plot was drawn to investigate whether there was publication bias. Funnel plot symmetry means there is no publication bias. The funnel plot is as follows:

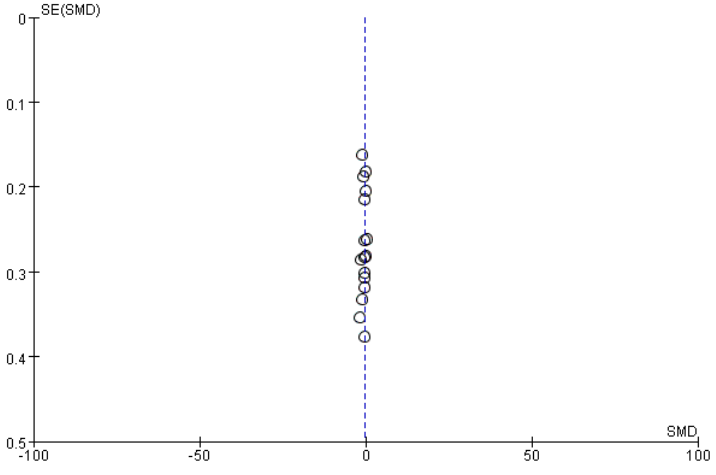

Fig. 5 Funnel plot for the estimation of publication bias. SE, standard error; SMD, standardized mean difference.

Discussion

The 13 included studies suggested that traditional Chinese exercises were beneficial in improving sleep quality.

This systematic review and meta-analysis also revealed that the benefits of traditional Chinese exercise on global sleep quality manifest in significant improvements in subjective sleep quality with high heterogeneity, habitual sleep efficiency with high heterogeneity, sleep duration with high heterogeneity and use of medication with low heterogeneity.

Considering the subgroup analysis, the results showed that subjects with illness may obtain more benefit than healthy subjects and those with insomnia. The same results were also found in another review about the effects of Tai Chi on sleep quality in healthy adults and patients with chronic conditions.[54] The results showed that a combined Tai Chi and Qi Gong program and Tai Chi alone improved sleep quality but that the combined Tai Chi and Qi Gong program had a larger effect size than Tai Chi only. At the same time, Qi Gong did not significantly improve sleep quality. In this review, we classified Baduanjin, Wuqinxi, Liuzijue, and Yijinjing Daoyin as Qi Gong. Compared to other exercise programs, Tai Chi and Qi Gong training programs are more targeted and detailed.[35,52] Tai Chi training programs were followed; however, most of the exercise programs for Qi Gong were a complete set of Qi Qong Exercises, such as Yijinjing, Wuqinxi, and Baduanjin.[40,45,48] Based on our analysis, it seems likely that more integrated, individualized, and detailed intervention programs may be more efficient for addressing sleep problems. The results showed that in terms of the duration of the intervention, those lasting 8-12 weeks were the most suitable, and subgroup analysis revealed that those lasting fewer than 8 weeks or more than 12 weeks did not significantly improve sleep quality. The results also indicated that studies involving an intervention lasting more than 180 min a week had a larger effect size than those that performed the intervention for 120-180 min. It seems that the higher the frequency of practicing traditional Chinese exercise, the more positive the effect on sleep quality. This is consistent with the recommendation of the Health Organization physical activity guidelines.[55]

In the qualitative analysis, we included one study comparing Tai Chi with cognitive behavioral therapy and found that Tai Chi, a mindful movement meditation, was found to be statistically noninferior to CBT-I, the gold standard for behavioral therapy.[44] This study indicated that traditional Chinese mind-body interventions may be a useful therapy for insomnia.

Although the exact biological mechanisms remain unknown, insomnia can impinge upon several biological pathways, such as those for cardiovascular autonomic control, oxidative stress, inflammatory responses, and endothelial function. All these pathophysiological mechanisms are likely candidates for the link between insomnia and increased risk of cardiovascular diseases, such as hypertension, congestive heart failure, coronary artery disease and arrhythmias, and metabolic disorders.[2] It is possible that the effect of traditional Chinese exercise on sleep quality can be attributed to changes in biological pathways, such as cardiovascular autonomic control, oxidative stress, inflammatory response and endothelial function.

Strengths and limitations

There are several limitations to this meta-analysis. First, we analyzed only the subjective outcomes that were easily influenced. Second, the heterogeneity among studies was significant, which may be explained by the subjects, type of intervention, duration of intervention, and frequency of intervention. Third, the follow-up for the interventions was short in most included studies, and the number of studies included in the follow-up data was small. Fourth, there were different control groups, including an active group (low-impact exercise, acupuncture, home exercise program, and health education) and a negative group (wait-list, normal care, and normal physical activity). Five of the included studies did not provide a detailed description of the random allocation method and the subject blinding method, which may have impacted the quality of this review.

Conclusion

In conclusion, this systematic review and meta-analysis showed that traditional Chinese exercise can be effective in improving sleep quality, and subjects with illness may receive more benefit than healthy subjects and those with insomnia. The results showed that integrated, individualized, and detailed traditional Chinese exercise programs (Tai Chi and Qi Gong) may be efficient for addressing sleep problems.

Appendix

Authors

The authors' full names and affiliations are as follows: Yameng Li, Shaojun Lyu, Qiuyang Wei, Meize Cui, Jianwei Zhang, College of P.E. and Sports, Beijing Normal University, Beijing, China; Fang Peng, Department of PE, Peking University, Beijing, China

Author contributions

Yameng Li, Fang Peng, Shaojun Lyu had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. Study concept and design: Yameng Li, Fang Peng, Shaojun Lyu. Extracted the information from the eligible studies: Yameng Li, Qiuyang Wei, Meize Cui. Analyzed data: Yameng Li, Qiuyang Wei, Meize Cui. Critical revision of the manuscript for key intellectual content: Shaojun Lyu, Qiuyang Wei, Jianwei Zhang. All authors read and approved the final manuscript.

Ethics approval and consent to participate

This article does not contain any studies with human participants or animals performed by any of the authors.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interest.

Funding

Research was supported by the following projects: National Key R&D Program of China (2018YFC2000600), Finance Department of the State Administration of Traditional Chinese Medicine (GZY-GCS-2018-011), and the Wushu Research Institute of the General Administration of Sport of China (WSH2018A00).

References

1. B. Rybarczyk, H. G. Lund, A. M. Garroway, L. Mack, "Cognitive behavioral therapy for insomnia in older adults: background, evidence, and overview of treatment protocol," *Clinical Gerontologist*, vol. 36, no. 1, pp. 70–93, 2013.
2. E. Tobaldini, G. Costantino, M. Solbiati, et al., "Sleep, sleep deprivation, autonomic nervous system and cardiovascular diseases," *Neuroscience and Biobehavioral Review*, vol. 74, no. B, pp. 321–329, 2017.
3. K. Ackermann, R. Plomp, O. Lao, et al., "Effect of sleep deprivation on rhythms of clock gene expression and melatonin in humans," *Chronobiology International*, vol. 30, no. 7, pp. 901–909, 2013.
4. C. M. Morin, R. R. Bootzin, D. J. Buysse, J. D. Edinger, C. A. Espie, K. L. Lichstein, "Psychological and behavioral treatment of insomnia: update of the recent evidence (1998–2004)," *Sleep*, vol. 29, no. 11, pp. 1398–1414, 2006.
5. M. M. Ohayon, "Epidemiology of insomnia: what we know and what we still need to learn," *Sleep Medicine Reviews*, vol. 6, no. 2, pp. 100–111, 2002.
6. Y. H. Si, C. Y. Wang, J. H. Zheng, Y. Guo, G. H. Xu, Y. Ma, "Tai Chi exercise for sleep problems in older adults: A protocol of systematic review and meta-analysis," *Medicine*, vol. 98, no. 45, pp. 1–9, 2019.
7. D. F. Kripke, L. Garfinkel, D. L. Wingard, M. R. Klauber, M. R. Marler, "Mortality associated with sleep duration and insomnia," *Arch General Psychiatry* vol.59, no. 2, pp. 131–136, 2002.
8. S. R. Patel, N. T. Ayas, M. R. Malhotra, et al., "A prospective study of sleep duration and mortality risk in women," *Sleep*, vol.27, no. 3, pp. 440–444, 2004.
9. J. K. Walsh, "Clinical and socioeconomic correlates of insomnia," *J Clin Psychiatry*, vol.65, no. 3, pp. 13–19, 2004.
10. G. E. Simon, M. PH, Sc. D. MV, "Prevalence, burden, and treatment of insomnia in primary care," *Am J Psychiatry*, vol.154, pp. 1417–1423, 1997.
11. C. M. Morin, M. LeBlanc, L. Bélanger, H. Lvers, C. Mérette, J. Savard, "Prevalence of insomnia and its treatment in Canada," *Canadian Journal of Psychiatry Revue Canadienne De Psychiatrie*, vol.56, no. 9, pp. 540–548, 2011.
12. G. D. Mellinger, M. B. Balter, E. H. Uhlenhuth, "Insomnia and its treatment. Prevalence and correlates," *Archives of General Psychiatry*, vol.42, no. 3, pp. 225–232, 1995.
13. J. D. Edinger, W. S. Sampson, "A primary care "friendly" cognitive behavioral insomnia therapy," *Sleep*, vol.26, no. 2, pp. 177–182, 2003.
14. L. Chen, J. S. Bell, R. Visvanathan, et al., "The association between benzodiazepine use and sleep quality in residential aged care facilities: a cross-sectional study," *BMC Geriatrics*, vol.16, no. 1, pp. 196, 2016.
15. D. Riemann, M. L. Perlis, "The treatments of chronic insomnia: a review of benzodiazepine receptor agonists and psychological and behavioral therapies," *Sleep Medicine Reviews*, vol.13, no. 3, pp. 205–214, 2009.
16. D. F. Kripke, "Chronic hypnotic use: deadly risks, doubtful benefit: REVIEW ARTICLE," *Sleep Medicine Reviews*, vol.4, no. 1, pp. 5–20, 2000.
17. J. Glass, K. L. Lanctot, N. Herrmann, B. A. Sproule, U. E. Busto, "Sedative hypnotics in older people with insomnia: meta-analysis of risks and benefits," *BMJ*, vol.331, no. 7526, pp. 1169–1175, 2005.
18. R. R. Tampi, D. J. Tampi, "Efficacy and tolerability of benzodiazepines for the treatment of behavioral and psychological symptoms of dementia: a systematic review of randomized controlled trials," *Am J Alzheimer's Dis Other Dement*, vol.29, no. 7, pp. 565–574, 2014.
19. D. F. Kripke, R. D. Langer, L. E. Kline, "Hypnotics' association with mortality or cancer: a matched cohort study," *BMJ Open*, vol.2, no. 1, pp. E000850, 2012.
20. J. M. Trauer, M. Y. Qian, J. S. Doyle, S. M. W. Rajaratnam, D. Connington, "Cognitive behavioral therapy for chronic insomnia: a systematic review and meta-analysis," *Annals of internal medicine*, vol.163, no. 3, pp. 191, 2015.
21. National Institutes of Health, "National Institutes of Health State of the Science conference statement on manifestations and management of chronic insomnia in adults," *Sleep*, vol.28, no. 9, pp. 1049–1057, 2005.
22. R. Neuendorf, H. Wahbeh, I Chamine, J, Yu, K. Hutchison, B. S. Oken, "The effects of mind-body interventions on sleep quality: a systematic review," *Evidence-Based*

Complementary and Alternative Medicine, vol.2015, 2015.
23. A. Vasudev, S. G. Torres-Platas, K. Kerfoot, et al., "Mind-body interventions in late-life mental illnesses and cognitive disorders: a narrative review," *The American journal of geriatric psychiatry*, vol.27, no. 5, pp. 536–547, 2019.
24. L. R. Forge, "Mind-body fitness: encouraging prospects for primary and secondary prevention," *The Journal of Cardiovascular Nursing*, vol.11, no. 3, pp. 53–65, 1997.
25. B. He, L. Zhang, J. H. Zhuang, J. Xu, P. Li, H. Peng, "The effects of different meditation exercises on sleep quality in older people: a network meta-analysis," *European Geriatric Medicine*, vol.10, no. 4, pp. 543–552, 2019.
26. M. R. Phillips, T.Y. Lin, W.S. Tseng, E.K. Yeh, "Chinese societies and mental health," *The China Journal*, vol.36, pp. 176–180, 1996.
27. Y. W. Y. Chow, H. W. H. Tsang, "Biopsychosocial effects of qigong as a mindful exercise for people with anxiety disorders: A speculative review," *Journal of Alternative and Complementary Medicine*, vol.13, no. 8, pp. 831–839, 2007.
28. T. Field, "Tai Chi research review," *Complementary Therapies in Clinical Practice*, vol.17, no. 3, pp. 141–146, 2011.
29. Y. H. Jiang, C. Tan, S. Yuan, "Baduanjin exercise for insomnia: a systematic review and meta-analysis," *Behavioral Sleep Medicine*, pp. 1–13, 2017.
30. J. J. Zhang, "The research progress of Traditional regimens in the rehabilitation of COPD patients," *Journal of External Therapy of TCM* , vol.26, no. 6, pp. 54–56, 2017.
31. H. P. Zhang, X. G. Bao, W. Bai, Y. Gao, "Traditional health exercises and hypertension prevention," *Journal of Practical Chinese Internal medicine* ,vol.27, no. 13, pp. 44–46, 2013.
32. A. Furlan, A. Malmivaara, R. Chou, et al., "2015 updated method guideline for systematic reviews in the cochrane back and neck group," *Spine*, vol.40, no. 21, pp. 1660–1673, 2015.
33. J. Cohen, "Statistical power analysis for the behavioral science," *Technometrics*, vol.31, no. 4, pp. 499–500, 1988.
34. D. Mavridis, G. Salanti, "How to assess publication bias: funnel plot, trim-and-fill method and selection models," *Evidence-Based Mental Health*, vol.17, no. 1, pp. 30, 2014.
35. G. Y. Gokmen, M. E. Akkoyunlu, L. Kilic, C. Algun, "The effect of T'ai Chi and Qigong training on patients with obstructive sleep apnea: a randomized controlled study," *Journal of alternative and complementary medicine*, vol.25, no. 3, pp. 317-325, 2018.
36. F. Brian, S. Stephen, K Tatyana, P. Rachell, "Tai Chi and low impact exercise: effects on the physical functioning and psychological well-being of older people," J*ournal of Applied Gerontology*, vol.26, no. 5, pp. 433-453, 2007.
37. X. Cui, Z. G. Bai, "Study on the effects of Liuzijue exercise on sleeping quality of college students," *Guangming journal of Chinese medicine*, vol.29, no. 5, pp. 953-954, 2014.
38. J. J. Lü, L. Y. Huang, X. Wu, W. J. Fu, Y. Liu, "Effect of Tai Ji Quan training on self-reported sleep quality in elderly Chinese women with knee osteoarthritis: a randomized controlled trail,". *Sleep medicine*, vol.33, pp. 70-75, 2017.
39. A. L. Liu, B. Q. Lu, Y. Y. Zheng, "The study on sleep quality and physique of undergraduates induced by Eight-section brocade," *Journal of Henan university (medical edition)*, vol.31, no. 04, pp. 286-289, 2012.
40. W. Wang, Q. LI，S. X. MA, J. Zhang, S. W. Sun, R. J. Mei, "The impact of massage Gong"Yi Jin Jing" on college students with Insomnia," *Information on Traditional Chinese Medicine*, vol.28, no. 5, pp. 91-93, 2011.
41. M. R. Irwin, R. Olmstead, S. J. Motivala, "Improving sleep quality in older adults with moderate sleep complaints: a randomized controlled trial of Tai Chi Chih," *Sleep*, vol.31, no. 7, pp. 1001-1008, 2008.
42. F. Z. Li, K. J. Fisher, P. Harmer, D. Irbe, R. G. Tearse, C. Weimer, "Tai Chi and self-rated quality of sleep and daytime sleepiness in older adults: a randomized controlled trial," *J Am Geriatr Soc*, vol.52, no. 06, pp. 892-900, 2004.
43. M. Lv, Y. M. LYU, G. M. Zhang, Y. Wang, "Observation for the curative effect of the Tai Chi Stake Exercise on insomnia," *Jilin Journal of Chinese Medicine*, vol.37, no. 4, pp. 367-369, 2017.
44. M. R. Irwin, R. Olmstead, C. Carrillo, N. Sadeghi, P. Nicassio, P. A. Ganz, J. E. Bower, "Tai Chi compared with cognitive behavioral therapy for the treatment of insomnia in

survivors of breast cancer: a randomized, partially blinded, noninferiority trial," *J Clin Oncol*, vol.35, no. 23, pp. 2656-2665, 2017.
45. Y, Zhuo, L. Liang, J. LI, "An analysis on the treatment effect of Five-Animal Exercises to university students with insomnia," *Liao Ning sport science and technology*, vol.36, no. 03, pp. 69-71, 2014.
46. A. W. K. Chan, D. S. F. Yu, K. C. Choi, D. T. F. Lee, J. W. H. Sit, H. Y. L. Chan, "Tai chi qigong as a means to improve night-time sleep quality among older adults with cognitive impairment: a pilot randomized controlled trial," *Clinical Interventions in Aging*, *v*ol.11, pp. 1277-1286, 2016.
47. T. Rao, J. H. Ning, "Effects of taijiquan on sleep and mood in patients with depression-related insomnia," *Chinese primary health care*, vol.32, no. 1, pp. 66-78, 2018.
48. Z. Y. Xiong, B. Chen, Q. Y. Fang, Y. H. Zheng, B. Z. Ye, L. Zhou, M. G. Yang, G. H. Zheng, "Effect of Baduanjin exercise on the quality of sleep in community population at high risk of stroke," *Pract Geriatr*, vol.32, no. 03, pp. 259-262, 2018.
49. W. C. Wang, M. Sawada, Y. Noriyama, K. Arita, T. Ota, M. Sadamatsu, R. Kiyotou, M. Hirai, T. Kishimoto, "Tai Chi exercise versus rehabilitation for the elderly with cerebral vascular disorder: a single-blinded randomized controlled trial," *Psychogeriatrics*, vol.0, no. 3, pp. 160-166, 2010.
50. M. Lynch, J. Sawynok, C. Hiew, D. Marcon, "A randomized controlled trial of qigong for Fibromyalgia," *Arthritis Research and Therapy*, vol.14, no. 4, pp. R178, 2012.
51. M. L. Yeh, Y. C. Chung, "A randomized controlled trial of qigong on fatigue and sleep quality for non-Hodgkin's lymphoma patients undergoing chemotherapy," *European Journal of Oncology Nursing*, vol.23, pp. 81-86, 2016.
52. J. McQuade, S. Prinsloo, D. Z. Chang, et al., "Qigong/tai chi for sleep and fatigue in prostate cancer patients undergoing radiotherapy: a randomized controlled trial," *Psycho-oncology*, vol.26, no. 11, pp. 1936-1943, 2017.
53. C. E. Rutter, M. S. Moran, "Qigong Improves Quality of Life in Women Undergoing Radiotherapy for Breast Cancer: Results of a Randomized Controlled Trial," *Breast Diseases*, vol.24, no. 4, pp. 1690-1698, 2013.
54. G. Raman, Y. Zhang, V. J. Minichiello, C. M. D. Ambrosio, C. C. Wang, "Tai Chi Improves sleep quality in healthy adults and patients with chronic conditions: a systematic Review and meta-analysis," *J Sleep Disord Ther*, vol.2, no. 6, pp. 141, 2013.
55. R. Jahnke, L. Larkey, C. Rogers, J. Etnier, F. Lin, "A comprehensive review of health benefits of Qigong and Tai Chi," *American Journal of Health Promotion*, vol.24, no. 6, pp. e1-e25, 2010.