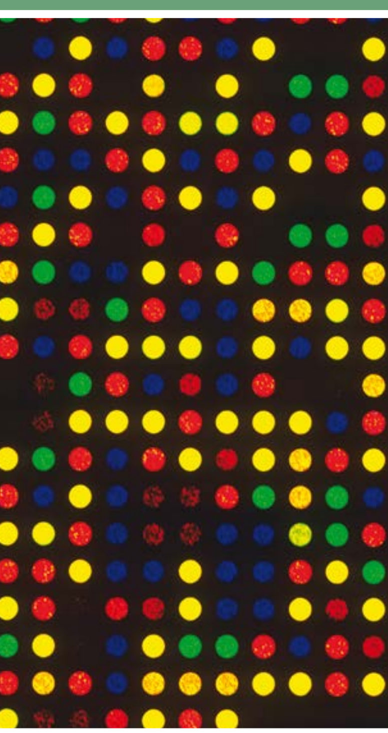
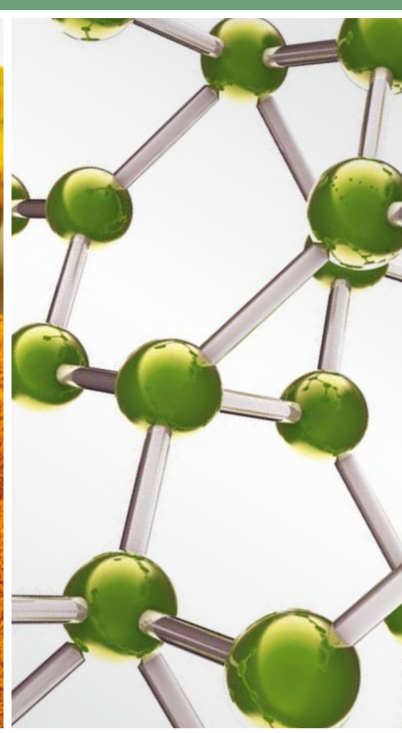
eCAM Evidence-Based Complementary and Alternative Medicine

Tai Chi, Yoga, and Qigong as Mind-Body Exercises

Guest Editors: Yong Tai Wang, Guoyuan Huang, Gloria Duke, and Yi Yang






Tai Chi, Yoga, and Qigong as Mind-Body Exercises

Tai Chi, Yoga, and Qigong as Mind-Body Exercises

Guest Editors: Yong Tai Wang, Guoyuan Huang, Gloria Duke, and Yi Yang

Editorial Board

Michael Weber, Germany
Silvia Wein, Germany
Janelle Wheat, Australia
Jenny M. Wilkinson, Australia
Darren Williams, Republic of Korea
Christopher Worsnop, Australia
Haruki Yamada, Japan
Nobuo Yamaguchi, Japan
Eun J. Yang, Republic of Korea
Junqing Yang, China
Ling Yang, China
Ken Yasukawa, Japan
Albert S. Yeung, USA
Armando Zarrelli, Italy
Chris Zaslawski, Australia
Ruixin Zhang, USA

Contents

Hindawi Publishing Corporation
Evidence-Based Complementary and Alternative Medicine
Volume 2017, Article ID 8763915, 1 page
http://dx.doi.org/10.1155/2017/8763915

Editorial

Tai Chi, Yoga, and Qigong as Mind-Body Exercises

Yong Tai Wang,[1] Guoyuan Huang,[2] Gloria Duke,[1] and Yi Yang[3]

[1] *University of Texas at Tyler, Tyler, TX, USA*
[2] *University of Southern Indiana, Evansville, IN, USA*
[3] *Wuhan Sports University, Wuhan, Hubei, China*

Correspondence should be addressed to Yong Tai Wang; ywang@uttyler.edu

Received 22 December 2016; Accepted 22 December 2016; Published 5 January 2017

Mind-body interventions or exercises may improve body function and health since nervous system affects endocrine system and immune system while performing these mind-body (MB) exercises. Tai Chi, Yoga, and Qigong are considered the most popular MB exercises, ranked by the 2002–2012 National Health Interview Surveys as the top three of the 10 most common complementary health approaches in practice.

Tai Chi is a healing/martial art combining martial art movement with Qi—vital energy circulation, breathing, and stretching techniques. Tai Chi exercise consists of a series of graceful movements with deep and slow diaphragmatic breathings performed while standing. Tai Chi exercise has been shown to have both physical and psychosocial benefits for the different populations. Yoga, a mind-body exercise, involves a combination of muscular activity and an internally directed mindful focus on awareness of the self, the breath, and energy. Yoga integrates an individual's physical, mental, and spiritual components to improve physical and mental health, particularly stress related illnesses. Qigong exercise, similar to Tai Chi, consists of a series of breath practices with body movement and meditation to attain deep focus and relaxed state. Simply speaking, Qigong exercise is practiced/used to cultivate the balance and harmony of vital energy in the human body. Considerable scientific evidence supports the health benefits of practicing Tai Chi and Qigong in various populations with differing characteristics such as age, gender, and occupation in NIH Research Report.

In this special issue, we have focused on Tai Chi, Yoga, and Qigong as mind-body exercises. Nine research articles including human experimental studies, clinical trials, and meta-analyses have been carefully reviewed, revised, and published. These research articles explore the efficacy and effectiveness of these mind-body exercises in improving, enhancing, or strengthening integrative health and well-being in relation to functional outcomes or clinical benefits on the human body. We hope you enjoy reading these research articles on this special issue.

Yong Tai Wang
Guoyuan Huang
Gloria Duke
Yi Yang

Hindawi Publishing Corporation
Evidence-Based Complementary and Alternative Medicine
Volume 2016, Article ID 9251849, 7 pages
http://dx.doi.org/10.1155/2016/9251849

Research Article

Medical Students' Stress Levels and Sense of Well Being after Six Weeks of Yoga and Meditation

Lona Prasad, Aneesha Varrey, and Giovanni Sisti

Department of Obstetrics and Gynecology, New York Presbyterian Hospital, Weill Cornell Medical Center, 525 East 68th Street, Suite J-130, New York, NY 10065, USA

Correspondence should be addressed to Lona Prasad; lonaprasad@gmail.com

Received 16 June 2016; Revised 18 September 2016; Accepted 8 November 2016

Academic Editor: Yong Tai Wang

Objective. To determine the effect of six weeks of yoga and meditation on medical students' levels of perceived stress and sense of wellbeing prior to taking their exams. *Methods*. We conducted a prospective case-control study of first-through-third-year medical students at our academic institution, measuring levels of perceived stress and sense of wellbeing before and after a six-week yoga and meditation intervention. Questionnaires used for evaluation included the perceived stress scale (PSS) and self-assessment surveys (SAS). The postintervention surveys were completed on the day of the students' written exams. *Results*. A total of thirteen women and fourteen men participated. Median age was 28 (24 yrs–32 yrs). 48.1% were Caucasian, 7.4% Black, 11.1% Hispanic, 11.1% Asian, and 22.2% other. Paired t-tests showed a statistically significant reduction in perceived stress (18.44 versus 14.52; $p = 0.004$) after the six-week yoga and meditation program. After the yoga intervention, self-assessment survey results showed a significant improvement in feelings of peace, focus, and endurance. Improvements in happiness, positivity, personal satisfaction, and self-confidence were also seen. An improvement in unsubstantiated parameters such as patience and fatigue was observed. *Conclusion*. Yoga and meditation may be effective in reducing stress levels and improving aspects of personal wellbeing in medical students.

1. Introduction

Stress amongst medical students is experienced in response to a range of occupational stimuli. These include sacrificing time spent with loved ones, acquiring sizable financial debt, and experiencing sexual harassment or professional abuse. Dealing with issues of human suffering and mortality can be emotionally challenging. Finally, working to master increasing amounts of information in limited time periods can contribute to academic stress [1]. Investigators have reported that the need to perform well on exams and preparing for and taking exams were the most stressful situations that students experienced in medical school [2]. Beyond certain levels, however, continuous exposure to stress may negatively impact the physical and mental health of students.

It has been shown that medical students have a high rate of deterioration in quality of life due to work hours and hazardous work related behavior patterns. In the United States, approximately 50% of medical students experience burnout, 25% have depression, and many suffer from chronic anxiety [3, 4]. Perpetual distress adversely affects the development of students' knowledge, skills, and professionalism. Students' ability to establish good relationships with patients has been compromised resulting in feelings of inadequacy. This has been associated with dissatisfaction which continues into residency and future clinical practice [5].

Mind body interventions are increasingly being used in the general population to assist with stress reduction. Mental silence-oriented meditation has been shown to be a safe and effective strategy for dealing with work stress and depressive feelings in full time workers [6]. Patients undergoing IVF report high levels of depressive symptoms, anxiety, and distress. Yoga has been found to improve the overall quality of life related to infertility and to reduce general anxiety and depression over time [7]. Yoga and meditation techniques have also been found to reduce performance anxiety and mood disturbance in young professional musicians [8]. There is evidence which suggests that meditation-based stress management practices reduce stress and enhance forgiveness among college undergraduates [9].

Our study focuses on yoga, an ancient Indian system of philosophy and practice. Modern yoga practice has been influenced by the "Eight-Limbed Path" of yoga, as described by Patanjali in The Yoga Sutras in 200 CE [10]. This text along with the Hatha Yoga Pradipika written in the 15th century CE suggests that one may gain physical, emotional, and spiritual health through the practices of yoga [11]. Hatha yoga practice incorporates breath awareness with bodily postures requiring focus and improving strength, flexibility, and balance. Other aspects of yoga include pranayama or "breath control" exercises which intentionally alter one's breathing pattern to help achieve mindful concentration. Meditation is a state which enables one to focus on the present moment, leading to a state of thoughtless awareness [12].

There are limited reports of structured yoga programs used in medical schools to promote students' wellbeing and reduce stress levels. A mindfulness based stress reduction (MBSR) intervention has been shown to improve perceived stress and self-compassion and promote self-awareness, self-reflection, and self-care in first-year medical students [13, 14]. Similar to our focus on yoga, a pilot study done in Montreal showed that a sixteen-week yoga intervention may be effective in decreasing stress and improving general well-being in first-year medical students [15]. Also, a randomized controlled trial conducted in India showed that a yoga intervention reduced levels of anxiety in first-year medical students prior to taking exams [16]. The primary aim of our study was to determine whether incorporating the practice of yoga into the first-through-third-year medical school curriculum for a six-week period would enable students to reduce perceived stress and experience an improvement in personal wellbeing prior to taking their exams.

2. Materials and Methods

This was a prospective case-control study undertaken between October 2013 and June 2015 at New York Presbyterian Hospital, Weill Cornell Medical School, in New York. The study was approved by the Weill Cornell Medicine Research and Ethics Committee. First-through-third-year medical students regardless of age, gender, or ethnicity were recruited by email prior to beginning either their six-week biological sciences course (first and second years) or clinical rotation (third years). Upon response, they were asked to complete an intake form and physical activity readiness questionnaire (PAR-Q) as follows:

Physical Activity Questionnaire (PAR-Q)

Identifier Code: —

Age: —

Date: —

Please read the following questions carefully and check (X) the appropriate answer. Answer all questions honestly and to the best of your ability.

(1) Has your doctor ever said that you have a heart condition (had a stroke, heart attack, or heart surgery) and/or that you should only do physical activity recommended by a doctor?

Yes: —
No: —

(2) Do you feel pain in your chest when you do physical activity?

Yes: —
No: —

(3) In the past month, have you had chest pain when you were not doing physical activity?

Yes: —
No: —

(4) Do you lose your balance because of dizziness or do you ever lose consciousness?

Yes: —
No: —

(5) Have you ever been told by a doctor that you have bone, joint or muscle problems that could be made worse by physical activity?

Yes: —
No: —

(6) Do you have a diagnosed illness that could be made worse by physical activity?

Yes: —
No: —

(7) Is your doctor currently prescribing medication for your blood pressure or heart condition?

Yes: —
No: —

(8) Are you pregnant?

Yes: —
No: —

(9) Do you know of any other reason why you should not do physical activity?

Yes: —
No: —

Fitness Participation Agreement. I have answered the questions above to the best of my ability and affirm that my physical condition is good and I have no known conditions that would prevent me from participation. I acknowledge that participation is at my own pace and comfort level and that I may discontinue my participation at any time. Furthermore, I agree to self-determine my exertion through good judgement and to discontinue any activity that exceeds my personal limitations.

Signature of Participant: —

Date: —

Participants were excluded if they had engaged in greater than one year of weekly yoga and if they had practiced weekly in the three months preceding the start date of the study. They had to meet wellness criteria determined by the physical activity readiness questionnaire and be able to attend and participate in the classes. Consent was obtained on initial contact.

All participants were required to attend one hour biweekly Hatha yoga classes for six weeks consisting of forty minutes of asanas (postures), ten minutes of pranayama (breathing exercises), and ten minutes of meditation. Students participated for twelve hours in total. Classes took place in the medical students' lounge, in the evenings on campus. Each session was conducted by a 500-hour certified yoga instructor with over fifteen years of experience. Classes were taught at an open level providing options for modifications based on the individual's requirements.

Data was obtained from participant self-reported questionnaires, specifically the perceived stress scale (PSS) and self-assessment surveys (SAS), respectively, as follows:

Perceived Stress Scale Survey. The questions in this scale ask you about your feelings and thoughts during the last month. In each case, you will be asked to indicate by circling how often you feel or thought a certain way.

Identifier Code: —

Date: —

Age: —

Gender (Circle):

M
F

Other: —

0 = Never

1 = Almost Never

2 = Sometimes

3 = Fairly Often

4 = Very Often

(1) In the last month, how often have you been upset because of something that happened unexpectedly?

0
1
2
3
4

(2) In the last month, how often have you felt that you were unable to control the important things in your life?

0
1
2
3
4

(3) In the last month, how often have you felt nervous and stressed

0
1
2
3
4

(4) In the last month, how often have you felt confident about your ability to handle your personal problems?

0
1
2
3
4

(5) In the last month, how often have you felt that things were going your way?

0
1
2
3
4

(6) In the last month, how often have you found that you could not cope with all the things that you had to do?

0
1
2
3
4

(7) In the last month, how often have you been able to control irritations in your life?

0
1
2
3
4

(8) In the last month, how often have you felt that you were on top of things?

0
1

2
3
4

(9) In the last month, how often have you been angered because of things that were outside of your control?

0
1
2
3
4

(10) In the last month, how often have you felt difficulties were piling up so high that you could not overcome them?

0
1
2
3
4

Self Assessment Survey

Identifier Code: —

Date: —

I have:

(1) a sense of happiness (Strongly Disagree/Disagree/Neither Agree or Disagree/Agree/Strongly Agree)

(2) a peaceful feeling (Strongly Disagree/Disagree/Neither Agree or Disagree/Agree/Strongly Agree)

(3) the ability to be focused (Strongly Disagree/Disagree/Neither Agree or Disagree/Agree/Strongly Agree)

(4) increased endurance (Strongly Disagree/Disagree/Neither Agree or Disagree/Agree/Strongly Agree)

(5) a positive outlook (Strongly Disagree/Disagree/Neither Agree or Disagree/Agree/Strongly Agree)

(6) personal satisfaction (Strongly Disagree/Disagree/Neither Agree or Disagree/Agree/Strongly Agree)

(7) self confidence (Strongly Disagree/Disagree/Neither Agree or Disagree/Agree/Strongly Agree)

(8) patience (Strongly Disagree/Disagree/Neither Agree or Disagree/Agree/Strongly Agree)

(9) fatigue (Strongly Disagree/Disagree/Neither Agree or Disagree/Agree/Strongly Agree)

These were completed at baseline prior to commencing their academic and clinical rotations and at six weeks after the yoga intervention, just before taking their end of rotation written exams. The perceived stress scale is a ten-item questionnaire that poses general questions allowing users to respond according to their personal stressors. This results in a "global" measurement of stress. Questions are based on a five-point Likert scale. Scores range from zero to forty with higher scores indicating higher levels of perceived stress. Score points around thirteen are average. Twenty or higher is an indicator of moderate to high stress [17]. We created the self-assessment survey. This is a nine-item questionnaire using a five-point Likert scale to assess medical students' general sense of wellbeing. Questions included in the self-assessment survey measured happiness, peace, focus, endurance, positivity, personal satisfaction, self-confidence, patience, and fatigue. The first seven of these components are synonymous with those incorporated as part of the established fourteen-item Warwick-Edinburgh mental wellbeing scale validated on a student population [18]. The latter scale includes correlating phrases such as "I've been feeling cheerful," "I've been relaxed," "I've been thinking clearly," "I've had energy to spare," "I've been feeling optimistic about the future," "I've been feeling good about myself," and "I've been feeling confident." Although the other two components, patience and fatigue, are not used as part of the Warwick-Edinburgh mental wellbeing scale, we chose to include these parameters as part of our self-assessment survey with the interest of increasing our scope of comparison understanding that these characteristics are relevant to performance in medical school. Similar items have been previously incorporated into a subjective assessment tool used in an Indian randomized controlled yoga trial. In this study, anxiety levels and general wellbeing were measured in first-year medical students before and after a yoga intervention prior to taking their exams. Survey parameters to gain students' feedback included rating sense of wellbeing, feeling of relaxation, ability to concentrate, feeling refreshed, level of self-confidence, task efficiency, irritability levels, stamina, exhaustion, appetite, optimistic outlook, headache/body ache, and interpersonal relationships [16]. Irritability levels and exhaustion are comparable descriptive terms to patience and fatigue. The latter were included as part of our self-assessment survey and have been displayed in our graph; however, we acknowledge that these are not substantiated parameters. In order to maintain a consistent and validated measurement, only scores for items synonymous with those used in the Warwick-Edinburgh mental wellbeing scale, that is, happiness, peace, focus, endurance, positivity, personal satisfaction, and self-confidence, are reliable in our analysis. Scores of our self-assessment survey including these seven items ranged from zero to 28 with higher numbers indicating a greater sense of wellbeing.

The Statistical Program for the Social Sciences (SPSS), version 22.0 (IBM), was used for data analysis. The normality of the data was checked with the Shapiro-Wilk test. Paired samples t-test comparisons were performed on the perceived stress scale survey scores before and after the yoga intervention.

3. Results

A total of 34 medical students volunteered to participate in the study. One was excluded because of her regular yoga practice. Six dropped out before completing the six-week

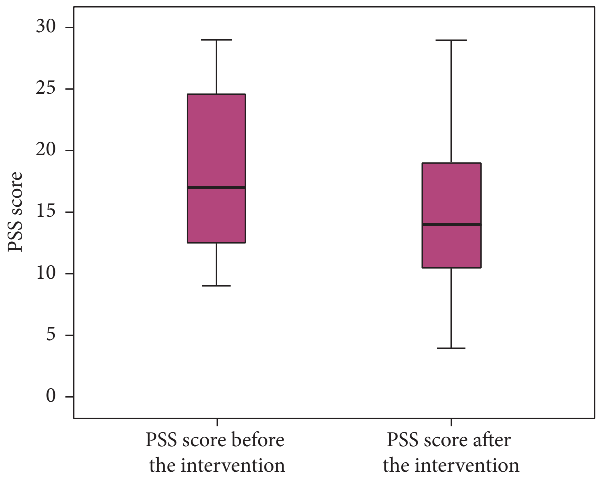


Figure 1: Perceived stress scale (PSS) graph.

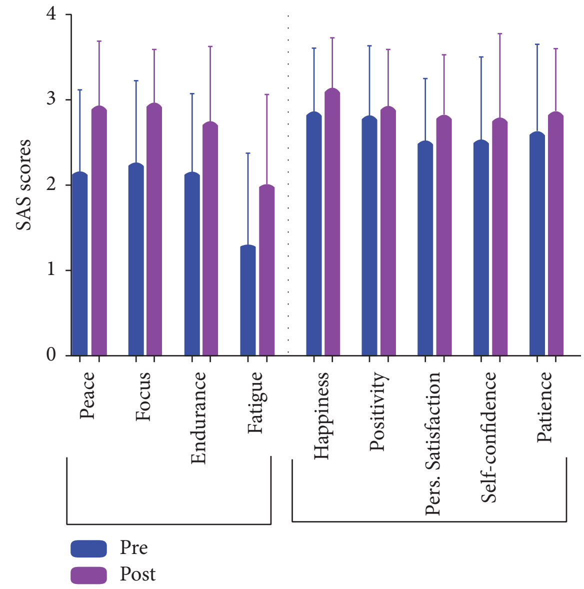


Figure 2: Self-assessment survey (SAS) graph.

yoga program. The reasons given included being too busy with medical school responsibilities or unwell. Twenty-seven medical students completed the six-week yoga program, answered all the questionnaires, and therefore were included in the analyses. A total of thirteen women and fourteen men participated. The median age was 28 years (24–32). Eight (29.6%) were in their third year. Other participants included fifteen (55.5%) second-year and four (14.8%) first-year students. Forty-eight percent of the study sample were Caucasian, 7.4% were Black, 11.1% were Hispanic, 11.1% were Asian, and 22% identified themselves as other. Twenty (74%) students had previous experience with yoga, but none had practiced regularly.

Eleven (41%) students had previous experience with meditation. Twenty-three (85%) reported involvement between one and five hours of physical exercise per week at the onset of the yoga study. Five (18.5%) participants reported taking medications.

The perceived stress scale showed a statistically significant reduction in stress levels from baseline compared to six weeks after the yoga intervention (18.44 versus 14.52; $p = 0.004$) (Figure 1). The mean baseline perceived stress score in our study population was 18.44 which is less than the scores documented in the literature for student populations (23.7 and 23.2) [17]. However, twelve of the 27 (44.4%) students were considered to be moderately to highly stressed at baseline with a score ≥20. Results of the self-assessment survey showed that there were significant improvements in feelings of peace, focus, and endurance. The increase in survey scores ranged between one and four points for each of these parameters from baseline to after the six-week yoga program. An improvement in scores was also seen for feelings of happiness, positivity, personal satisfaction, and self-confidence from baseline to the end of the intervention. Improvements in the unsubstantiated parameters of patience and fatigue were also observed after the yoga intervention (Figure 2).

Students described favorable effects. Comments received after the study included "I look forward to these evenings because I leave feeling relaxed"… "It clears my mind and helps improve my focus"… "I am more relaxed because I have become more aware of my breath"… "I feel more grounded and have noticed my posture has improved!".

4. Discussion

Our study showed that six weeks of yoga including physical postures, breathing exercises, and meditation may be effective in reducing stress levels and improving aspects of personal wellbeing in medical students prior to taking their exams. Paired t-tests showed a statistically significant reduction in perceived stress (18.44 versus 14.52; $p = 0.004$) after the six-week intervention. Similar results have been reported. A pilot study carried out in Montreal evaluated the efficacy of a yoga intervention in first-year female medical students with a mean age of 22 and showed a significant reduction in PSS scores from baseline to the end of the intervention (22.15 versus 13.38) [15].

The results of our self-assessment survey showed a significant improvement in participants' levels of peace, focus, and endurance with an increase in points ranging between one and four from baseline to after six weeks of yoga and meditation. Improvements in happiness, positivity, personal satisfaction, and self-confidence were also seen after the intervention. Although not validated by the Warwick-Edinburgh mental wellbeing scale, the parameters of patience and fatigue also showed improvements after the six-week yoga program. A randomized control study conducted in India observed the effects of a yoga intervention on stress levels in first-year medical students aged eighteen to nineteen prior to taking exams and showed comparable results to our findings. A subjective assessment form incorporating wellness parameters was used as part of their evaluation. Their participants showed a statistically significant improvement in relaxation and calmness, in the ability to concentrate, and in stamina and exhaustion. These findings directly correlated with a greater number of yoga classes attended over time ($p < 0.01$) [16]. Despite similarities, neither of these studies may be generalizable to the American population because of cultural distinctions and variations in the medical training programs.

Limitations of our study include the small number of participants. Invariably, this reduces the power in determining significant differences seen in perceived stress and self-assessment scores from baseline to after the intervention. The absence of a control group did not allow us to discern our participant outcome from one that may have been influenced by other factors such as the natural history of stress and wellbeing over time. On the intake form, one student reported using Wellbutrin and Lexapro for anxiety and depression and another was taking sertraline for OCD management: both preexisting conditions could be confounded with reports of perceived stress.

Of this self-selected group, twenty (74%) students had previously practiced yoga and 11 (41%) had experience with meditation suggesting a possible bias in favor of this mind body intervention. Twenty (85%) students were involved in other regular exercise activities at the beginning of the yoga classes and may have continued this throughout the six-week intervention possibly impacting survey scores. However, considering the sporadic experience of yoga and meditation reported and the notable variation in hours of weekly exercise amongst this group of students, this sample could be representative of a randomly selected population. As this was a pre- and postdesigned study without a control group, the limitations of this study are acknowledged.

5. Conclusion

A future study with a larger sample size and separate yoga, exercise, and control groups should be included. In an effort to minimize the potentially detrimental psychological burden on medical students, the addition of a yoga program to the medical school curriculum could be a feasible option. Yoga is inexpensive, potentially rewarding, and safe when taught by experienced certified trainers.

Disclosure

This abstract was presented as a poster at the Annual Clinical Meeting of the American College of Obstetricians and Gynecologists, May 14–17, 2016, Washington, DC. This abstract was also presented at the Annual Academy of Integrative Health and Medicine Conference, October 30–November 3, 2015, San Diego, California.

Competing Interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

Acknowledgments

The authors would like to thank Weill Cornell Medical College for their financial support. The authors are grateful to the yoga instructors, Rebecca Cheeks Soule and Cynthia Moss, for their valuable time and teaching.

References

[1] S. Rosenzweig, D. K. Reibel, J. M. Greeson, G. C. Brainard, and M. Hojat, "Mindfulness-based stress reduction lowers psychological distress in medical students," *Teaching and Learning in Medicine*, vol. 15, no. 2, pp. 88–92, 2003.

[2] M. T. Edwards and C. N. Zimet, "Problems and concerns among medical students—1975," *Journal of Medical Education*, vol. 51, no. 8, pp. 619–625, 1976.

[3] L. N. Dyrbye, M. R. Thomas, F. S. Massie et al., "Burnout and suicidal ideation among U.S. medical students," *Annals of Internal Medicine*, vol. 149, no. 5, pp. 334–341, 2008.

[4] L. N. Dyrbye, M. R. Thomas, and T. D. Shanafelt, "Systematic review of depression, anxiety, and other indicators of psychological distress among U.S. and Canadian medical students," *Academic Medicine*, vol. 81, no. 4, pp. 354–373, 2006.

[5] S. L. Shapiro, G. E. Schwartz, and G. Bonner, "Effects of mindfulness-based stress reduction on medical and premedical students," *Journal of Behavioral Medicine*, vol. 21, no. 6, pp. 581–599, 1998.

[6] R. Manocha, D. Black, J. Sarris, and C. Stough, "A randomized, controlled trial of meditation for work stress, anxiety and depressed mood in full-time workers," *Evidence-Based Complementary and Alternative Medicine*, vol. 2011, Article ID 960583, 8 pages, 2011.

[7] G. Oron, E. Allnutt, T. Lackman, T. Sokal-Arnon, H. Holzer, and J. Takefman, "A prospective study using Hatha Yoga for stress reduction among women waiting for IVF treatment," *Reproductive BioMedicine Online*, vol. 30, no. 5, pp. 542–548, 2015.

[8] S. B. S. Khalsa, S. M. Shorter, S. Cope, G. Wyshak, and E. Sklar, "Yoga ameliorates performance anxiety and mood disturbance in young professional musicians," *Applied Psychophysiology Biofeedback*, vol. 34, no. 4, pp. 279–289, 2009.

[9] D. Oman, S. L. Shapiro, C. E. Thoresen, T. G. Plante, and T. Flinders, "Meditation lowers stress and supports forgiveness among college students: a randomized controlled trial," *Journal of American College Health*, vol. 56, no. 5, pp. 569–578, 2008.

[10] M. Govinda, *Kriya Yoga Sutras of Patanjali and the Siddhas*, Kriya Yoga, St Etienne de Bolton, Quebec, Canada, 2001.

[11] S. Muktibodhananda, *Hatha Yoga Pradipika*, Bihar School of Yoga, 3rd edition, 1998.

[12] G. Feuerstein, *Yoga: An Essential Introduction to the Principles and Practice of an Ancient Tradition*, Shambala Publications, Boston, Mass, USA, 1996.

[13] M. Erogul, G. Singer, T. McIntyre, and D. G. Stefanov, "Abridged mindfulness intervention to support wellness in first-year medical students," *Teaching and Learning in Medicine*, vol. 26, no. 4, pp. 350–356, 2014.

[14] P. A. Saunders, R. E. Tractenberg, R. Chaterji et al., "Promoting self-awareness and reflection through an experiential Mind-Body Skills course for first year medical students," *Medical Teacher*, vol. 29, no. 8, pp. 778–784, 2007.

[15] A.-A. Simard and M. Henry, "Impact of a short yoga intervention on medical students' health: a pilot study," *Medical Teacher*, vol. 31, no. 10, pp. 950–952, 2009.

[16] A. Malathi and A. Damodaran, "Stress due to exams in medical students—role of yoga," *Indian Journal of Physiology and Pharmacology*, vol. 43, no. 2, pp. 218–224, 1999.

[17] S. Cohen, T. Kamarck, and R. Mermelstein, "A global measure of perceived stress," *Journal of Health and Social Behavior*, vol. 24, no. 4, pp. 385–396, 1983.

[18] R. Tennant, L. Hiller, R. Fishwick et al., "The Warwick-Edinburgh Mental Well-being Scale (WEMWBS): development and UK validation," *Health and Quality of Life Outcomes*, vol. 5, article 63, 2007.

Hindawi Publishing Corporation
Evidence-Based Complementary and Alternative Medicine
Volume 2016, Article ID 9710941, 9 pages
http://dx.doi.org/10.1155/2016/9710941

Research Article

Tai Chi Can Improve Postural Stability as Measured by Resistance to Perturbation Related to Upper Limb Movement among Healthy Older Adults

Jiahao Pan,[1] Cuixian Liu,[1] Shuqi Zhang,[2] and Li Li[1,3]

[1] *Key Laboratory of Exercise and Health Sciences of Ministry of Education, Shanghai University of Sport, Shanghai 200438, China*
[2] *Kinesiology and Physical Education Department, Northern Illinois University, Dekalb, IL 60115, USA*
[3] *School of Health & Kinesiology, Georgia Southern University, Statesboro, GA 30460, USA*

Correspondence should be addressed to Li Li; lili@georgiasouthern.edu

Received 29 May 2016; Revised 11 October 2016; Accepted 14 November 2016

Academic Editor: Yong Tai Wang

Purpose. The aim of the study was to examine the effects of Tai Chi (TC) training on postural control when upright standing was perturbed by upper limb movement. *Methods*. Three groups, TC, Brisk walk (BW), and sedentary (SE), of thirty-six participants aged from 65 to 75 years were recruited from local community centers. Participants performed static balance task (quiet standing for 30 s with eyes open and closed) and fitting task (two different reaching distances X three different opening sizes to fit objects through). During tasks, the COP data was recorded while standing on the force plate. Criteria measures calculated from COP data were the maximum displacement in anterior-posterior (AP) and medial-lateral (ML) directions, the 95% confidence ellipse area (95% area), and the mean velocity. *Results*. No significant effect was observed in the static balance task. For fitting tasks, the group effect was observed in all directions on COP 95% area ($p < 0.05$) and the TC group showed reduced area. The tests of subject contrasts showed significant trends for reaching different distances and fitting different openings conditions in all directions, the 95% area, and the mean velocity ($p < 0.05$). *Conclusion*. Compared to the other two groups, long-term TC exercise helps in reducing the effects of upper body perturbation as measured by posture sway.

1. Introduction

Postural control is the ability to control the body's position and is important for daily living activities [1]. When performing daily activities, such as walking, talking, and cleaning [2], people mostly maintain upright posture. Postural control ability decreases with ageing [3, 4]. For example, Prieto and colleagues observed that center of pressure (COP) movement decreased in increments of 3 to 5 years in the young adult group but increased in the elderly group [4]. Furthermore, postural control has been more relevant to the risk of falling in older adults as compared to younger people since the elderly experience elevated fall risks [5, 6].

Therefore, decreasing postural stability presents a serious challenge to elderly people with increasing risk of falls. By the middle of 21st century, China will become the country with mostly elderly population [7]. In 2011, the Chinese Health Organization reported that, compared with other major epidemics, the highest mortality rate correlated to falls for people 65 years and older, 49.65/100 thousands for men and 52.80/100 thousands for women (Chinese Health Organization projections, 2011). The most common fall-related injuries include abrasions, open wounds, fractures, and brain damage [8]. Although no official document reported annual medical costs directly associated with falls in China, it should be very high on an estimation with no doubt. The data reported in the literature that spending was nearly 20 billion dollars in the US [9].

Falls most likely occur when elderly people engage in multitask activities [2]. Upright stance with an additional concurrent task that could be associated with motor, sensory, or cognitive function leads to the increased the risk of falls.

Standing with upper body movement (grabbing, reaching, fitting, etc.) is an important activity in daily life which is closely associated with fall risks among elderly people [10]. Ten years of age appears to be the transition period when children have greater adaptability and reach a degree of freedom similar to adults when performing standing with upper body movement [11]. No significant difference is observed in COP patterns between 10-year-olds and adults [11, 12]. However, the ability of postural control appears to develop, be maintained, and decline throughout life [13]. Consequently, standing with upper body movements may contribute to reduced stability, mobility, and quality of life in elderly people. Overstall and coworkers have demonstrated that rapid arm movements may induce falls in the older adults [14].

Physical activity is an effective strategy for improving postural control and decreasing fall risks among the elderly. For example, Brisk walk (BW) is a cyclic and aerobic exercise which could improve mobility, strength, and endurance [15, 16]. Walking can improve triceps surae muscle strength [15] and improve maximal oxygen uptake (V_{O2} max) [16] for ageing populations. However, research demonstrates that although elderly walking group showed significantly better postural stability during static conditions, no difference in postural limit test was observed comparing to nonwalking group [17]. Postural limit test asks the participants to actively explore the boundaries of their own postural control capacity which is very different from quiet standing where stability boundaries are not challenged.

Tai Chi (TC) is a traditional Chinese martial art which emphasizes slow and smooth movement accompanied with rhythmic weight shifting and limb coordination. During Tai Chi practice, stability boundaries are constantly challenged. Long-term TC exercise leads to a significantly smaller passive motion detection threshold than that observed in the SE comparison group [18]. Therefore, it could improve strength, proprioception, psychological well-being, and balance [18–22]. In addition, many researches also demonstrated the effectiveness of TC in reducing the risk of falls for elderly people [19, 20]. For example, Guan and Koceja observed that the postural sway of the TC group was less significant than the control group during standing [19]. For another example, Li and Manor indicated that TC exercise increased functional gait and leg strength performance among people with peripheral neuropathy [21].

Much research has demonstrated that postural control could be influenced by ageing [3, 4]. In contrast, physical activities improved posture stability [18, 22, 23]. Many studies reported better postural control after TC exercise in the elderly population. However, majority studies measured lower limb performances when evaluating balance abilities. In real world situations, the perturbation of upper body motion is a particularly challenging task for elderly people when maintaining postural stability. The purpose of this paper is to explain that (1) upper extremity motion affects postural stability measured through COP, (2) postural stability of both long-term exercise groups should be perturbed by upper body motion less than the control group, and (3) TC group should perform better than the BW group.

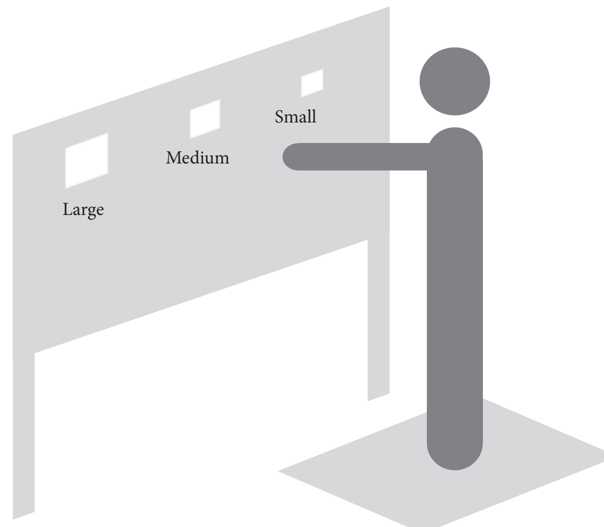


Figure 1: Experimental setup: instrumented fitting board and force platform.

2. Materials and Methods

2.1. Participants. Thirty-six apparently healthy participants aged 65 to 75 years were recruited from local community centers using snowball method. They were accordingly classified into three groups: Tai Chi (TC), sedentary (SE), and Brisk walk (BW). The TC group regularly practiced Tai Chi and the BW group took regular Brisk walks for more than 5 years (more than 3 times per week and more than 1 hour at a time); the SE group did not participate in regular exercise (less than 1 hour of purposed exercise per week). The subjects signed the informed consent which was approved by the Institutional Review Board of the Shanghai University of Sport.

Exclusion criteria were (1) lower extremity and/or dominant arm/hand surgery; (2) cardiovascular pathologies, diabetes, or hepatorenal syndrome; (3) coordination function disorders such as peripheral neuritis, Meniere disease, Parkinson's disease, and Alzheimer's disease; and (4) BMI > 30.

2.2. Instrumentation Setup. A self-manufactured instrument was used in the study (illustrated in Figure 1). The instrument had a large object placement board (1200 ∗ 600 mm) that contained three side by side openings and a fixed space between each opening of 300 mm. The sizes of the openings were large (130 ∗ 130 mm), medium (115 ∗ 115 mm), and small (100 ∗ 100 mm), respectively. The board could be adjusted, according to the participant's shoulder height and arm length, and three optical gate sensors were attached to the back of the placement board and the upper edge of each opening. Another sensor was attached to the basement that supported the fitting block (90 ∗ 90 mm) on the table. A cylindrical handle with a length of 20 mm and diameter of 20 mm was attached to the block to allow for comfortable grasp. The sensors were used to record fitting time during the fitting task. Additionally, a recessed Kistler force plate (60 ∗

90 cm) (Kistler 9287c, Kistler Corporation, Switzerland) was sampled at 1000 Hz to obtain the force data. The optical gate sensors and force plate were synchronized.

2.3. Testing Protocol. Participants performed two different tests including the static balance task (quiet standing) and the fitting task (standing with upper body movement). Prior to the data collection, height, mass, dominant arm length, and shoulder height were recorded for each participant. Through the entire tests, participants were wearing uniform socks.

In the static balance task, participants were required to stand at the center of the force plate with their feet forming a 30° angle and their heels 8% body height apart [24] for 30 s with eyes open (EO) and 30 s with eyes closed (EC). In the EO test, each participant was instructed to focus on a target positioned in the individual's line of vision at a distance of 3 meters. Each trial was repeated 3 times, and participants took a 2-minute break after each trail.

Prior to the fitting task, the experimental operator explained the test to each participant instructing them to align their middle line with the opening's center using the same foot position as in the static balance task and to maintain this foot position during the entire fitting task. If the subject's hand or the block contacted the sides of the opening or their feet moved, this condition was discarded and the task was repeated. The testing was closely monitored by the experimenters for quality purposes.

During the fitting task, participants were required to fit the block into either a small, medium, or large opening (fitting different openings condition) on the board while maintaining a stand position either an arm's length or 1.3 times an arm's length from the board (reaching different distances condition) (Figure 1). Therefore, there were six conditions as follows: (1) large opening with arm's length; (2) medium opening with arm's length; (3) small opening with arm's length; (4) large opening with 1.3 times arm's length; (5) medium opening with 1.3 times arm's length; and (6) small opening with 1.3 times arm's length. All of the conditions were randomized and executed in consecutive trials until five successful fits were achieved. Experimental operators adjusted the placement of the board based on the shoulder height and the length of the dominant arm before each condition. Otherwise, the table was adjusted to the subject's waist height so the blocks could be comfortably picked up. Each trail was accompanied by 2 short beeps to signal the start and end of the fitting task for participants. After the second beep, the experimenter would take the block and put it back on the basement as soon as possible. To prevent fatigue, there were no time constraints between each of the six conditions, so the participants can take their time to finish the protocol.

2.4. Data Analysis. All data were recorded and stored on a PC. Force plate data was used to calculate center of pressure (COP) of foot for all trails. The COP data was low-pass filtered with a Butterworth digital filter of fourth-order and cut-off frequency of 50 Hz. Only a third of the static balance task and a fifth of the fitting task data were processed by Excel (Microsoft, Washington, USA). The posture sway was quantified using maximum displacement in both the anterior-posterior (AP) and mediolateral (ML) directions, the 95% confidence ellipse area (95% area), and the mean velocity. For the static balance task, 30-second COP of foot was analyzed. For the fitting task, we analyzed the total fitting time that was recorded by optical gate sensors of COP for each condition.

2.5. Statistical Analysis. Two-way ANOVA with repeated measures was used to identify the association between dependent variables (COP variables) and independent variables (group, vision) for static balance test. Three-way ANOVA with repeated measures was used to identify the association between dependent variables (COP variables) and independent variables (group, size, and distance) for the fitting task. Then significant associations were examined further using univariate analysis and post hoc Tukey's test. All statistical analysis was conducted in SPSS system (19.0, SPSS Inc., Chicago, IL, USA). Significant level was set at 0.05.

3. Result

3.1. Demographic. Table 1 shows the demographic characteristics for the three groups. No significant group effects were observed.

3.2. Maximum Displacement of COP in the AP and ML Direction. The quiet standing condition showed less displacement than the reaching different distances and fitting different opening conditions for both directions. There were no significant group X vision interactions observed. There were no significance effects for the quiet standing condition between the EC and EO conditions, nor between groups. However, significance effects were observed for the group in the upper body movement condition in the AP direction ($F_{2,33} = 11.551$, $p < 0.0001$) (Figure 2) and ML direction ($F_{2,33} = 4.170$, $p = 0.024$) (Figure 4). The TC group had less maximum displacement in both directions for upper body movement condition than the SE and BW groups. The reaching far distance condition led to greater maximum displacement than the reaching close distance condition in the AP ($F_{1,33} = 462.072$, $p < 0.0001$) (Figure 3) and ML directions ($F_{1,33} = 22.057$, $p < 0.0001$) (Figure 5). Furthermore, the fitting different openings condition had significant effects observed in the AP ($F_{2,33} = 15.136$, $p < 0.0001$) (Figure 3) and ML directions ($F_{2,33} = 8.044$, $p = 0.003$) (Figure 5). The fitting small opening condition created greater maximum displacement than the reaching medium and larger openings condition in both directions. The distance by group also showed statistical significance in the AP ($F_{2,33} = 14.489$, $p < 0.0001$) (Figure 3) and ML directions ($F_{2,33} = 8.044$, $p = 0.003$) (Figure 5). Post hoc testing showed that the TC group had less maximum displacement than the SE and BW groups in both directions. The tests of within subject contrasts showed significant linear trends for the reaching different distances condition (AP: $F_{1,33} = 462.072$, $p < 0.0001$; ML: $F_{1,33} = 22.057$, $p < 0.0001$) and fitting different openings condition (AP: $F_{1,33} = 23.688$, $p < 0.0001$; ML: $F_{1,33} = 8.044$, $p = 0.003$) in both directions (Figures 3 and 5). This indicates increased

Table 1: Demographic information of three groups (TC: male = 8, female = 4; SE: male = 7, female = 5; BW: male = 8, female = 4).

	Mass (kg)	Height (cm)	BMI (kg/m^2)
TC	63.43 ± 9.34	162.51 ± 6.87	23.98 ± 2.91
SE	68.28 ± 7.01	163.94 ± 7.01	25.41 ± 2.96
BW	62.78 ± 6.59	163.48 ± 6.36	23.54 ± 2.74

Note. Each parameter stands for mean ± standard deviation (M ± SD). TC = Tai Chi; SE = sedentary; BW = Brisk walk.

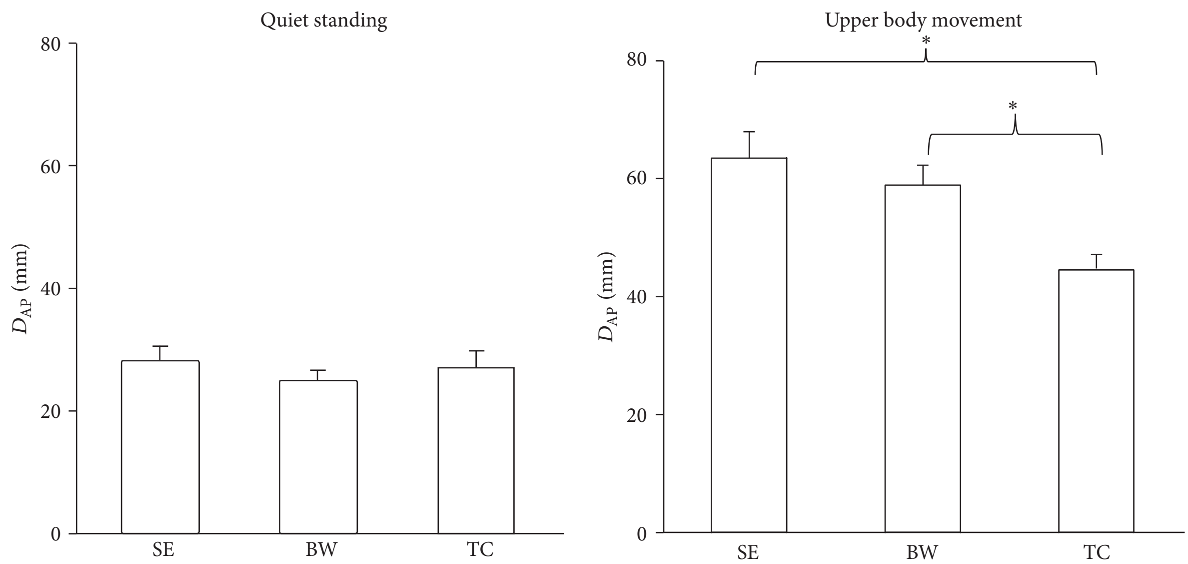


Figure 2: The maximum displacement of COP in the AP direction was collected in the quiet standing and standing with upper body movement. The TC group had better postural control than the SE and BW groups when standing with upper body movement. Values are group means ± SE, with "∗" representing significant differences (where TC group were significantly different from the other groups).

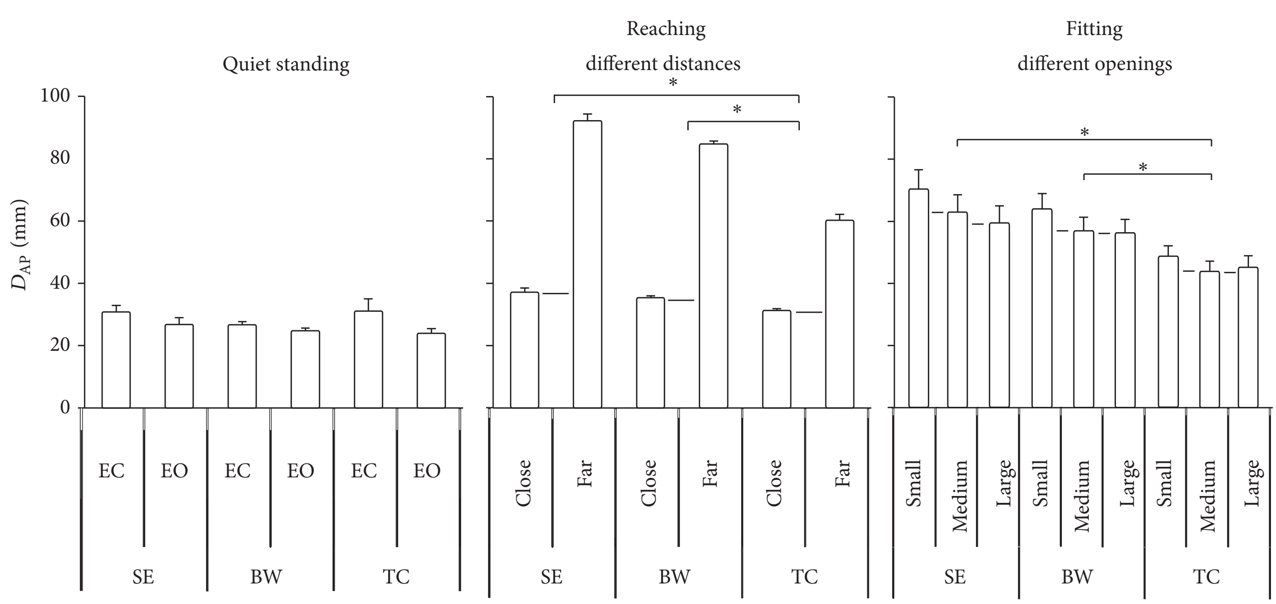


Figure 3: The maximum displacement of COP in the AP direction of quiet standing, reaching different distances, and fitting different openings. The slope of TC group was less than the BW and SE groups. Values are group means ± SE, with "∗" representing significant differences (where TC group were significantly different from the other groups for both distances and openings).

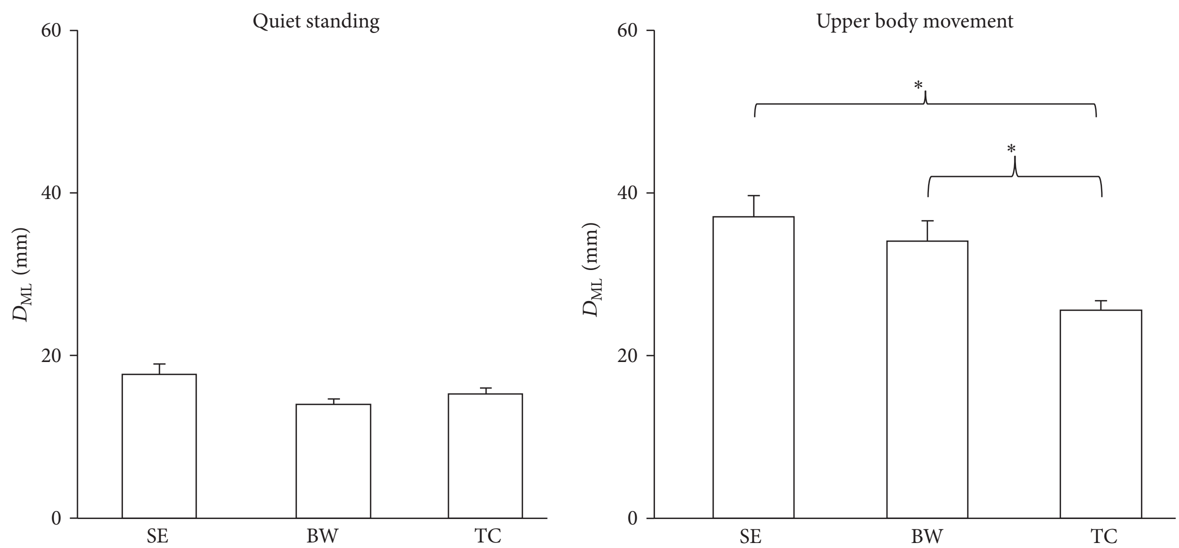


Figure 4: The maximum displacement of COP in the ML direction as collected in the quiet standing and standing with upper body movement. The TC group had better postural control than the SE and BW groups when standing with upper body movement. Values are group means ± SE, with "∗" representing significant differences (where TC group were significantly different from the other groups).

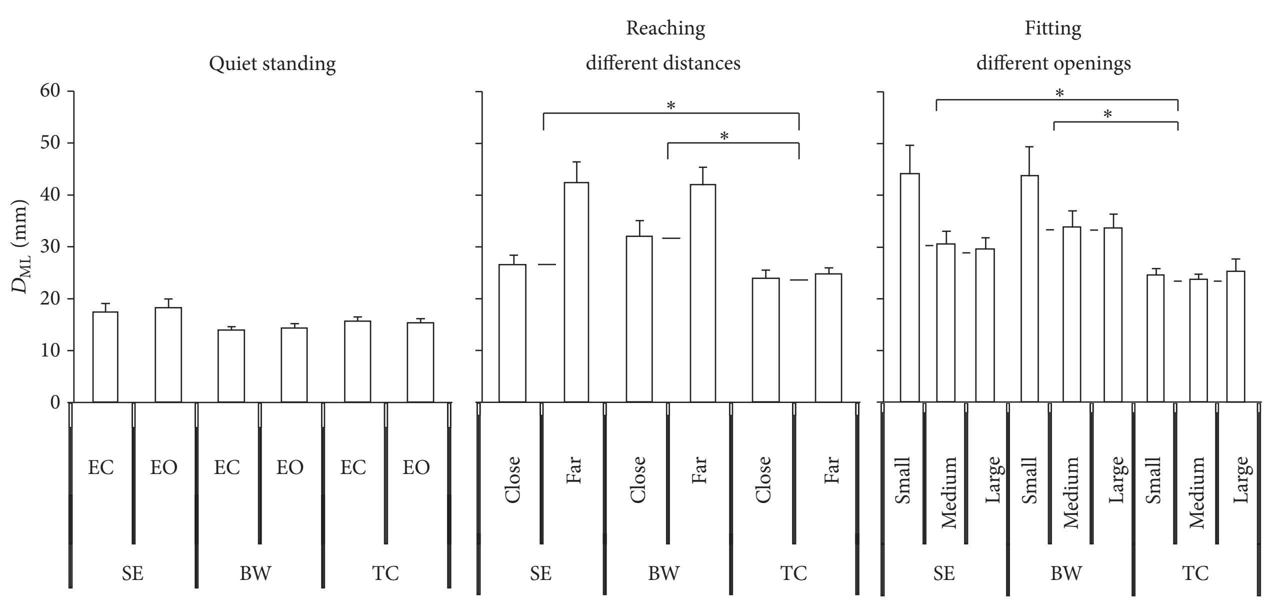


Figure 5: The maximum displacement of COP in the ML direction of quiet standing, reaching different distances, and fitting different openings. The slope of the TC group was less than the BW and SE groups. Values are group means ± SE, with "∗" representing significant differences (where TC group were significantly different from the other groups for both distances and openings).

maximum displacement for increased reaching distance or decreased fitting opening. Also, the tests showed significant quadratic trends for the fitting different openings condition in the ML direction ($F_{1,33} = 7.010$, $p = 0.012$) (Figure 5). The distance by group interaction also showed significant linear trends in AP ($F_{2,33} = 14.489$, $p < 0.0001$) (Figure 3) and ML ($F_{2,33} = 4.954$, $p = 0.013$) (Figure 5) direction which means the slope of maximum displacement of the TC group is less than the SE and BW groups with decreased reaching distance. There was no significant group by distance by opening three-way interaction having been observed.

3.3. The 95% Confidence Ellipse Area. The result indicated that the quiet standing condition showed a smaller area than the upper body movement condition. In the quiet standing condition, no statistically significant difference was found between the EC and EO conditions. In the upper body movement condition, different groups had significant effects detected on the 95% area ($F_{2,33} = 10.63$, $p < 0.0001$) (Figure 6). The TC group showed less area than the SE and BW groups. The reaching different distances condition also had significant effects detected ($F_{1,33} = 96.467$, $p = 0.000$) (Figure 7). And the distance by group interaction

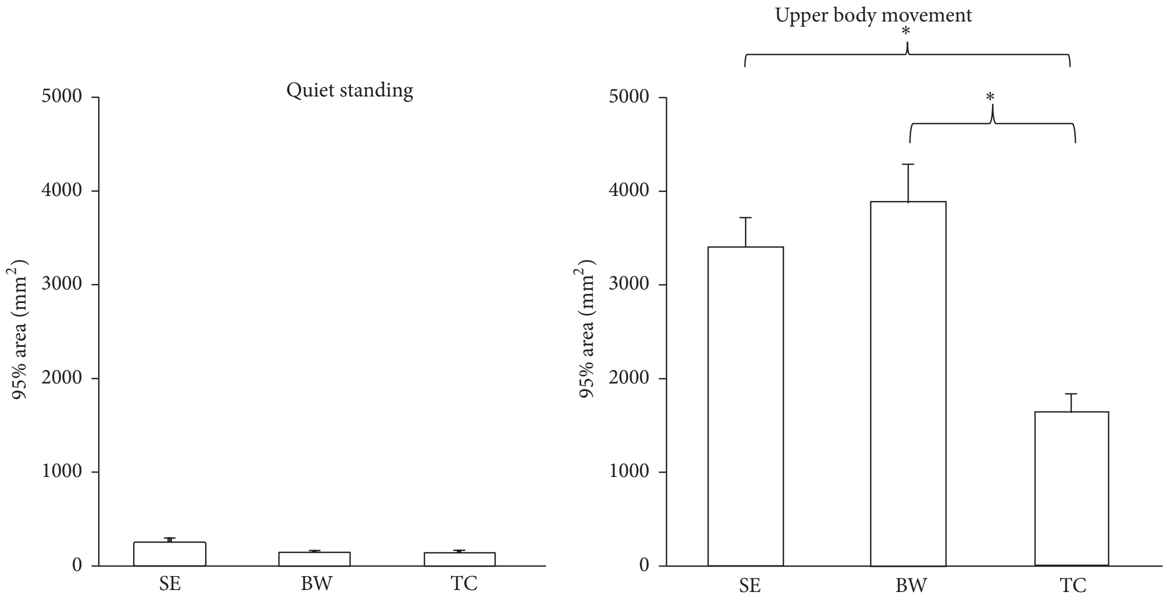


Figure 6: The 95% confidence ellipse area of COP was collected in the quiet standing and standing with upper body movement tests. The TC group had better postural control than the SE and BW groups when standing with upper body movement. Values are group means ± SE, with "∗" representing significant differences (where TC group were significantly different from the other groups).

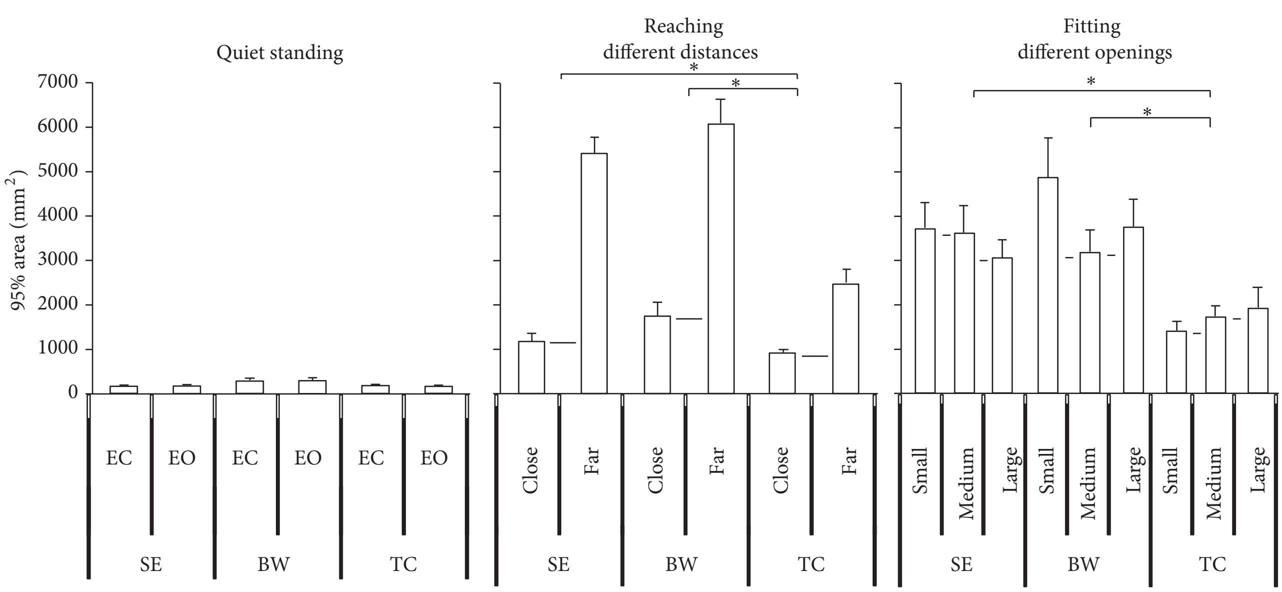


Figure 7: The 95% confidence ellipse area of COP of quiet standing, reaching different distances, and fitting different openings. The slope of TC group was less than BW and SE. Values are group means ± SE, with "∗" representing significant differences (where TC group were significantly different from the other groups for both distances and openings).

($F_{2,33} = 13.643$, $p = 0.003$) (Figure 7) was observed for the fitting task. Post hoc test showed that the TC group had less area than the BW group in the fitting close distance condition and had less area than the SE and BW groups in the fitting far distance condition. Otherwise, the tests within subject contrasts showed significant linear trends for reaching different distances ($F_{1,33} = 96.467$, $p < 0.0001$) (Figure 7) where an increase in 95% area was observed for increased distance. In addition, distance by group interaction ($F_{2,33} = 6.822$, $p = 0.003$) (Figure 7) was observed. When the reaching distance was shortened, it was observed that the slope of the TC group was less than the sedentary and BW groups. Furthermore, the tests showed significant quadratic trends for opening by group interaction ($F_{2,33} = 3.278$, $p = 0.05$) (Figure 7) which indicates that increasing the opening size leads to different change between three groups.

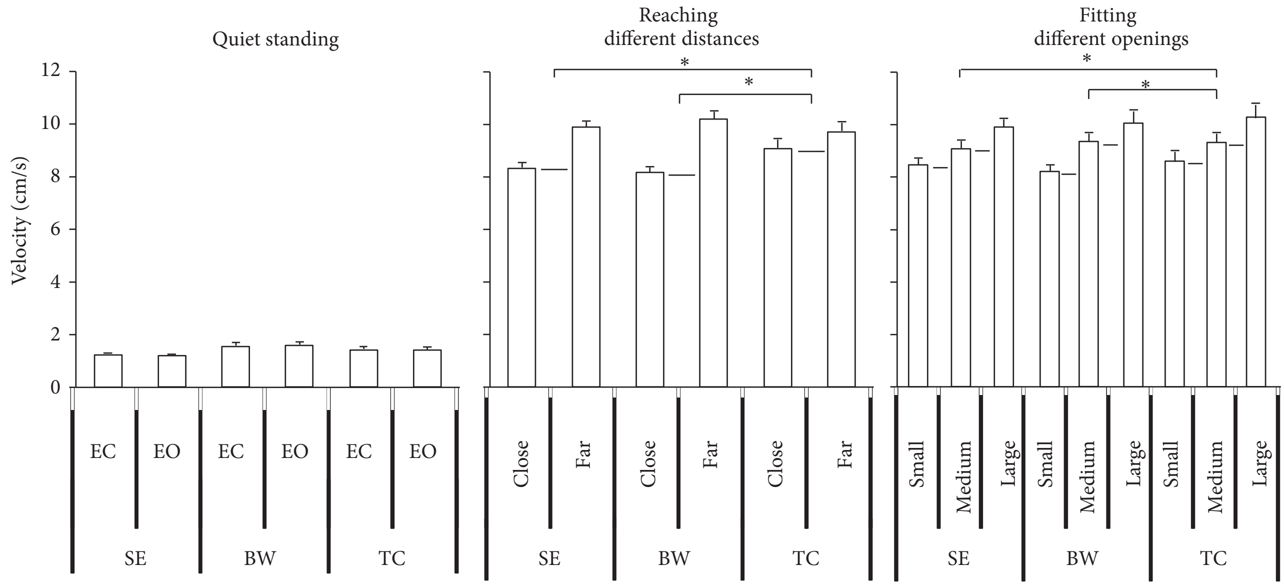


Figure 8: The mean velocity of COP of quiet standing, reaching different distances, and fitting different openings. The slope of TC group was less than BW and SE. Values are group means ± SE, with "∗" representing significant differences (where TC group were significantly different from the other groups for both distances and openings).

3.4. *Mean Velocity.* The mean velocity for the upper body movement condition was greater than for the quiet standing condition. But, there were no statistically significant differences for the quiet standing condition between the EC and EO conditions. Significant effects were observed for the reaching different distances condition ($F_{1,33} = 67.585$, $p < 0.0001$) (Figure 8) which means an increase in velocity was observed for decreased reaching distance. The fitting different openings also had significant effects ($F_{2,33} = 41.306$, $p < 0.0001$) (Figure 8) with an increase in velocity for an increased opening size. In addition, the distance by group ($F_{2,33} = 41.306$, $p < 0.0001$) (Figure 8) interaction was observed in the fitting task. Post hoc test observations revealed that the TC group demonstrated less velocity than the BW group in close distances. The tests of within subject contrasts showed significant linear trends for reaching different distances ($F_{1,33} = 67.585$, $p < 0.0001$) (Figure 8) which indicates an increase in velocity for decreased distance. Fitting different openings ($F_{1,33} = 63.961$, $p = 0.000$) (Figure 8) also had significance linear effects on velocity with an increase in velocity for larger openings. The distance by group interaction ($F_{2,33} = 5.716$, $p = 0.007$) (Figure 9) showed statistically significance linear trends. The performance of the TC group slopes of the velocity was less than for the SE and BW groups with decreased reaching distance. In addition, the distance by opening by group interaction ($F_{2,33} = 3.597$, $p = 0.039$) also showed significant linear trends which indicates the slope of velocity of the TC group is less than the SE and BW groups with change distances and opening sizes.

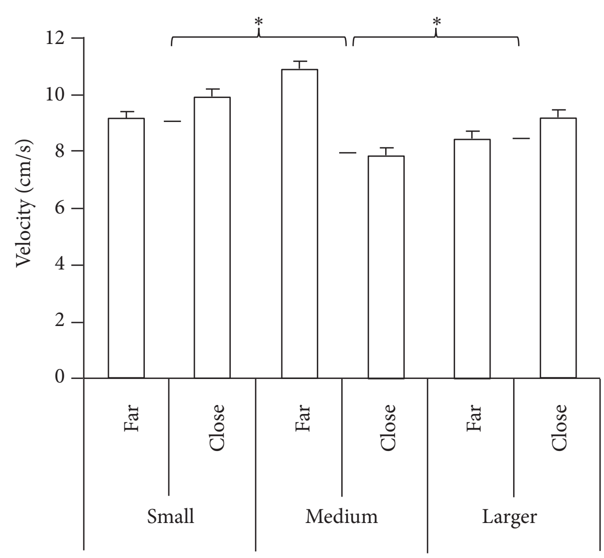


Figure 9: The mean velocity of COP of standing with upper body movement. The distance by opening interaction showed statistical significance. Values are group means ± SE.

4. Discussion

The purpose of this study was to examine the effect of TC training on postural control with additional upper limb movement. We found that although regularly practiced TC and BW, as compared with SE, were not effective in improving posture stability during static balance task, the positive influence was observed during fitting task as upper limb movement was required. The current data support our hypothesis.

4.1. *Quiet Standing Condition.* Previous studies demonstrated that visual input [25] and physical activity [19, 20] play an important role for static balance control. For example, Guan observed less COP sway area in the TC group than in the control group under four standing conditions (standing still with eyes open; standing still with eyes closed; standing and turning head to the left and right with eyes open; standing and turning head to the left and right with eyes closed) [19]. In our study, statistical results showed no significant effects among the three groups which means no effect on static balance was detected. Hence, in all of the groups, there was no obvious difference in balance control during quiet standing. Many researchers have demonstrated that the elderly people suffer more risks of falls when performing dual task [2]. In summary, the result of quiet standing condition cannot prove the distinction of postural control among the three groups. In other words, static balance control was consistent with quiet standing.

4.2. Reaching Different Distances. Theoretically, as people age, difficult manual tasks have more constraints [26, 27]. The reaching near distance condition encountered less balance perturbations than the reaching far distance condition. All of the outputs supported this standpoint. Further analysis showed that the TC group exhibited less perturbation from a reaching near distance condition than from a far distance condition compared to the BW and SE groups. However, the SE and BW groups demonstrated the same difficulty in the reaching different distances condition.

The result suggests that when the perturbation of trunk movement was more difficult, the TC group had better postural stability than the SE and BW groups. In comparison to the fitting near target, the far target approach focuses on the interaction among hip, ankle, and orientation [28]. Previous studies on fitting tasks have reported evidence in support of movement and modulating strategy for adults and older children [11]. That is, a more robust and adaptable movement and modulating strategy replaced the movement and stabilization strategy for adults. In our study, TC exercise may be more valid to maintain or promote movement and modulating strategy. The possible mechanism may be the hand movement accompanied with weight shifting in TC performance which reduces the perturbation of balance when fitting far target.

4.3. Fitting Different Openings. In general, arm movement generates perturbations of balance when upright standing [29]. Otherwise, in the block through the small opening, hand precision of the endpoint becomes important [11]. We observed a small magnitude of deviations of outputs in the fitting different openings condition by the TC group compared with the BW and SE groups. Additionally, there was no difference in stability between the BW and SE groups.

Many researches demonstrated that intervention techniques can improve fine manual performance in older adults [29, 30]. However, BW and SE appear to impact whole body postural functions the same. Bernstein detected that the hammer's trajectories were exhibited without competition when striking a nail; however, the endpoint was competition [31]. He suggested that the release of the redundant degree of freedom was a central issue in motor control. BW exercise is a simple, optionally cyclical movement which means the coordination among the segments was not critically important, whereas TC exercise is coordinated, precise movement. There is variability in the trajectory of the arm movement, but the endpoint is consistent. Haddad et al. speculated that it is easier for young children to freeze the trunk to control hand precision than it is for older children and adults [11]. Therefore, it is possible that the mechanism of TC exercise that reduces redundant degrees of freedom [31] may make standing with reaching different openings easier to control [11].

One limitation of this study is that the design is a cohort study rather than a randomized controlled trail. Therefore, there may be unavoidable selection bias that may interfere with results. Therefore, future study should be designed by randomized controlled trail. Another limitation of this study is that we had not recruited a daily function group: the participants only engaged in long-term housework, such as cooking, sweeping, and folding laundry, without other physical activities. The upper body perturbation should improve the postural control during daily life. Therefore, the daily function group that requires both quiet standing task and fitting task should be tested in future study.

This study observed the postural control of long-term TC, BW, and SE during quiet standing and fitting conditions. With the quantification of COP data during these tasks, we recognized that rhythmic weight shifting with upper body motion might decrease the risk of fall and improve the quality of daily life for older adults. This observation can be used to design balance training where upper extremity can be used as self-generated perturbation in a safe environment for more effective postural control rehabilitation exercise.

5. Conclusion

In this study, the result showed that long-term TC practitioners effectively decreased their posture sway during upper body movements comparing to the BE and SE groups. Hence, long-term, regular TC exercise could link to decreased risk of falls for older people. This potential benefit could be due to the fact that TC exercise demands highly accurate movements and the upper limb movements effectively serve as challenges for lower extremity movements during Tai Chi practice. The interaction between upper and lower extremity movements during Tai Chi practice and its benefit for postural control should be further examined in the future using well designed intervention studies.

Competing Interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

References

[1] B. I. Bertenthal and R. K. Clifton, "Perception and action," in *Handbook of Child Psychology (Cognition, Perception, and Language)*, vol. 2, pp. 51–102, Wiley Online Library, Hoboken, NJ, USA, 1998.

[2] N. M. Nachreiner, M. J. Findorff, J. F. Wyman, and T. C. McCarthy, "Circumstances and consequences of falls in community-dwelling older women," *Journal of Women's Health*, vol. 16, no. 10, pp. 1437–1446, 2007.

[3] K. M. Newell, S. M. Slobounov, E. S. Slobounova, and P. C. M. Molenaar, "Stochastic processes in postural center-of-pressure profiles," *Experimental Brain Research*, vol. 113, no. 1, pp. 158–164, 1997.

[4] T. E. Prieto, J. B. Myklebust, R. G. Hoffmann, E. G. Lovett, and B. M. Myklebust, "Measures of postural steadiness: differences between healthy young and elderly adults," *IEEE Transactions on Biomedical Engineering*, vol. 43, no. 9, pp. 956–966, 1996.

[5] K. O. Berg, B. E. Maki, J. I. Williams, P. J. Holliday, and S. L. Wood-Dauphinee, "Clinical and laboratory measures of postural balance in an elderly population," *Archives of Physical Medicine and Rehabilitation*, vol. 73, no. 11, pp. 1073–1080, 1992.

[6] M. E. Tinetti, M. Speechley, and S. F. Ginter, "Risk factors for falls among elderly persons living in the community," *The New England Journal of Medicine*, vol. 319, no. 26, pp. 1701–1707, 1988.

[7] F. Chen and G. Liu, "Population aging in China," in *International Handbook of Population Aging*, P. Uhlenberg, Ed., pp. 157–172, Springer, Dordrecht, The Netherlands, 2009.

[8] S. R. Lord, D. McLean, and G. Stathers, "Physiological factors associated with injurious falls in older people living in the community," *Gerontology*, vol. 38, no. 6, pp. 338–346, 1992.

[9] J. A. Stevens, P. S. Corso, E. A. Finkelstein, and T. R. Miller, "The costs of fatal and non-fatal falls among older adults," *Injury Prevention*, vol. 12, no. 5, pp. 290–295, 2006.

[10] D. Hyndman, A. Ashburn, and E. Stack, "Fall events among people with stroke living in the community: circumstances of falls and characteristics of fallers," *Archives of Physical Medicine and Rehabilitation*, vol. 83, no. 2, pp. 165–170, 2002.

[11] J. M. Haddad, L. J. Claxton, R. Keen et al., "Development of the coordination between posture and manual control," *Journal of Experimental Child Psychology*, vol. 111, no. 2, pp. 286–298, 2012.

[12] J. M. Haddad, R. E. A. Van Emmerik, J. S. Wheat, and J. Hamill, "Developmental changes in the dynamical structure of postural sway during a precision fitting task," *Experimental Brain Research*, vol. 190, no. 4, pp. 431–441, 2008.

[13] J. M. Haddad, S. Rietdyk, L. J. Claxton, and J. E. Huber, "Task-dependent postural control throughout the lifespan," *Exercise and Sport Sciences Reviews*, vol. 41, no. 2, pp. 123–132, 2013.

[14] P. W. Overstall, A. N. Exton-Smith, F. J. Imms, and A. L. Johnson, "Falls in the elderly related to postural imbalance," *British Medical Journal*, vol. 1, no. 6056, pp. 261–264, 1977.

[15] E. J. Bassey, M. J. Bendall, and M. Pearson, "Muscle strength in the triceps surae and objectively measured customary walking activity in men and women over 65 years of age," *Clinical Science*, vol. 74, no. 1, pp. 85–89, 1988.

[16] M. H. Murphy and A. E. Hardman, "Training effects of short and long bouts of brisk walking in sedentary women," *Medicine & Science in Sports & Exercise*, vol. 30, no. 1, pp. 152–157, 1998.

[17] I. Melzer, N. Benjuya, and J. Kaplanski, "Effects of regular walking on postural stability in the elderly," *Gerontology*, vol. 49, no. 4, pp. 240–245, 2003.

[18] J. X. Li, D. Q. Xu, and Y. Hong, "Tai Chi exercise and proprioception behavior in old people," *Medicine & Sport Science*, vol. 52, no. 52, pp. 77–86, 2008.

[19] H. Guan and D. M. Koceja, "Effects of long-term Tai Chi practice on balance and H-reflex characteristics," *The American Journal of Chinese Medicine*, vol. 39, no. 2, pp. 251–260, 2011.

[20] A. Voukelatos, R. G. Cumming, S. R. Lord, and C. Rissel, "A randomized, controlled trial of tai chi for the prevention of falls: the central sydney tai chi trial," *Journal of the American Geriatrics Society*, vol. 55, no. 8, pp. 1185–1191, 2007.

[21] L. Li and B. Manor, "Long term tai chi exercise improves physical performance among people with peripheral neuropathy," *The American Journal of Chinese Medicine*, vol. 38, no. 3, pp. 449–459, 2010.

[22] J. O. Nnodim, D. Strasburg, M. Nabozny et al., "Dynamic balance and stepping versus tai chi training to improve balance and stepping in at-risk older adults," *Journal of the American Geriatrics Society*, vol. 54, no. 12, pp. 1825–1831, 2006.

[23] M. M. Schleicher, L. Wedam, and G. Wu, "Review of Tai Chi as an effective exercise on falls prevention in elderly," *Research in Sports Medicine*, vol. 20, no. 1, pp. 37–58, 2012.

[24] V. Cimolin, M. Galli, L. Vismara, G. Grugni, L. Priano, and P. Capodaglio, "The effect of vision on postural strategies in Prader-Willi patients," *Research in Developmental Disabilities*, vol. 32, no. 5, pp. 1965–1969, 2011.

[25] A. S. Edwards, "Body sway and vision," *Journal of Experimental Psychology*, vol. 36, no. 6, pp. 526–535, 1946.

[26] J. Desrosiers, R. Hébert, G. Bravo, and A. Rochette, "Age-related changes in upper extremity performance of elderly people: a longitudinal study," *Experimental Gerontology*, vol. 34, no. 3, pp. 393–405, 1999.

[27] C. D. Smith, G. H. Umberger, E. L. Manning et al., "Critical decline in fine motor hand movements in human aging," *Neurology*, vol. 53, no. 7, pp. 1458–1461, 1999.

[28] T. A. S. G. E. Ricco, "Affordances as constraints on the control of stance," *Human Movement Science*, vol. 7, no. 2–4, pp. 265–300, 1988.

[29] A. Kubicki, F. Bonnetblanc, G. Petrement, Y. Ballay, and F. Mourey, "Delayed postural control during self-generated perturbations in the frail older adults," *Clinical Interventions in Aging*, vol. 7, no. 5, pp. 65–75, 2012.

[30] M. Zimerman, M. Nitsch, P. Giraux, C. Gerloff, L. G. Cohen, and F. C. Hummel, "Neuroenhancement of the aging brain: restoring skill acquisition in old subjects," *Annals of Neurology*, vol. 73, no. 1, pp. 10–15, 2013.

[31] N. Bernstein, *The Coordination and Regulation of Movements*, Pergamon Press, Oxford, UK, 1967.

Hindawi Publishing Corporation
Evidence-Based Complementary and Alternative Medicine
Volume 2016, Article ID 7137362, 9 pages
http://dx.doi.org/10.1155/2016/7137362

Review Article

Traditional Chinese Mind and Body Exercises for Promoting Balance Ability of Old Adults: A Systematic Review and Meta-Analysis

Shihui Chen,[1] Yanjie Zhang,[2] Yong Tai Wang,[3] and Xiao Lei Liu[4]

[1]*Department of Kinesiology, Texas A&M University Texarkana, TX, USA*
[2]*Department of Physical Education, Chinese University of HK, Shenzhen, China*
[3]*College of Nursing and Health Science, University of Texas at Tyler, Tyler, TX, USA*
[4]*Department of Traditional Sports, Beijing Sports University, Beijing, China*

Correspondence should be addressed to Shihui Chen; shchen@ied.edu.hk

Received 12 June 2016; Revised 8 October 2016; Accepted 13 October 2016

Academic Editor: Carmen Mannucci

The purpose of this study was to provide a quantitative evaluation of the effectiveness of traditional Chinese mind and body exercises in promoting balance ability for old adults. The eligible studies were extensively searched from electronic databases (Medline, CINAHL, SportDicus, and Web of Science) until 10 May 2016. Reference lists of relevant publications were screened for future hits. The trials used randomized controlled approaches to compare the effects of traditional Chinese mind and body exercise (TCMBE) on balance ability of old adults that were included. The synthesized results of Berg Balance Scale (BBS), Timed Up and Go Test (TUG), and static balance with 95% confidence intervals were counted under a random-effects model. Ten studies were selected based on the inclusion criteria, and a total of 1,798 participants were involved in this review. The results of the meta-analysis showed that TCMBE had no significant improvement on BBS and TUG, but the BBS and TUG could be obviously improved by prolonging the intervention time. In addition, the results showed that TCMBE could significantly improve the static balance compared to control group. In conclusion, old adults who practiced TCMBE with the time not less than 150 minutes per week for more than 15 weeks could promote the balance ability.

1. Introduction

Today, the issue of aging is a major public concern worldwide. According to recent population census [1], Chinese aged 60 years or older were more than 220 million, about 15% of the total population by the end of 2014. The numbers of old population will continue to grow and reach 437 million by 2051. The similar situation exists in the United States; for example, the numbers of population aged over 65 will reach 85 million by 2050 and will be doubled compared with the number in 2010 [2]. Many aging related studies showed health issues which increase prevalence of chronic diseases, complex medical conditions, and even loss of their independent functions [3–5]. Issue of aging brings serious economic burden to the society, of which the elderly's health and medical related costs are the major expenditures for them [4, 6]. Participating in exercises and physical activities may have beneficial effects on the aging related chronic diseases and health conditions of elderly people. There is good evidence that appropriate physical exercise can effectively prevent the onset of noncommunicable diseases and can improve the health condition and fitness of elderly people [7]. Previous studies found that exercise therapy as non-pharmacological intervention may have beneficial effects on functional recovery, such as balance, strength, walking gait correction, and fall prevention [8–11].

Traditional Chinese mind and body exercises (TCMBE) include, for example, Tai Chi, Qigong, Baduanjin, or Yijin-jing, all developed by ancient Chinese people. TCMBE as an effective, low-cost, and safety exercise approach is widely accepted in elderly people in China and other Asian countries [12–14]. During recent years, many studies reported that motor movements of elderly people were improved by participating in Tai Chi, Qigong, and Baduanjin [10, 15, 16]. Besides, Verhagen et al. [17] and Voukelatos et al. [18] reported that practicing Tai Chi can effectively reduce the falls of elderly people. Wenneberg et al. [19] provided evidence that persons who practice Qigong exercise could significantly improve their balance control abilities. The decline of balance function is the main reason of causing fall for the elderly [13]. Therefore, the TCMBE program may be an appropriate exercise to improve elderly people's balance ability and reducing the risk of falls.

This systematic review and meta-analysis aimed to summarize the current research results of randomized controlled trials on the effectiveness of TCMBE on balance and the risk to fall in the healthy elderly. This study analyzed the effectiveness of TCMBE intervention program compared with control group (non-TCMBE) on balance ability in elderly populations.

2. Materials and Methods

2.1. Search Strategy. The Preferred Reporting Items for Systematic Reviews and Meta-Analysis guideline (PRISMA) was followed throughout this review and research processes. Four databases of literature had been used as data sources for this study from inception until 10 May, 2016 (Medline: 1946-, SportDicus: 1978-, Cinahl: 1992-, and Web of Science: 1900-). The two groups of terms were combined for the systematical search as follows: (1) "traditional Chinese exercise" OR "tai chi" OR "tai chi chuan" OR "taiji" OR "taijiquan" OR "qi gong" OR "chi kung" OR "Baduanjin" OR "Yijinjing"; AND (2) "balance" OR "balance control" OR "fall" OR "falls" OR "slip". In addition to the database search, a manual search from the reference lists of identified articles and relevant articles was also applied. Further, additional studies were also found from many experts who were in the field of traditional Chinese exercise.

2.2. Inclusion Criteria. The included studies should meet the following criteria: (1) type of studies: the current research only applied randomized controlled trials; (2) participants: the study participants were healthy humans with age over 60 years; (3) interventions: the subjects of study must be related to a treatment group that only using traditional Chinese exercise and a control group involved in no TCMBE exercises or other treatment (e.g., wellness education, and resistance training). There must be different interventions between treatment group and control group (either passive or positive); (4) outcome measures: the outcomes were related to balance performance, for instance, Berg Balance Score (BBS) and Timed Up and Go Test (TUG); (5) providing adequate information for calculating effect size; (6) the fact that traditional Chinese exercise intervention period was no less than two months (8 weeks).

2.3. Exclusion Criteria. The studies were excluded if (1) there was no randomized assignment to study groups; (2) the trial used the Chinese exercise plus additional treatments (e.g., Tai Chi and stretch training in treatment group); (3) the presence of animal models or unhealthy participants (e.g., diabetic and stroke participants); (4) there is a lack of sufficient information to calculate the effect size; (5) they were questionnaire, case study, abstract, or reviews; and (6) the studies were published in non-English journals.

2.4. Selection of Studies. The literature searches were conducted by two authors. The two reviewers independently screened the potential articles by reading the titles and abstracts and then full-text articles according to the eligible criteria. Disagreements between two reviewers were resolved in discussion. If necessary, the third reviewer was consulted to reach a consensus.

2.5. Data Extraction. The following information from each article was extracted: (1) author and year of publication; (2) characteristic of the participants: sample size, sex, and age; (3) study design; (4) interventions; and (5) standardized mean, standard deviation, or raw data for effect size calculation. There were no disparities of data abstraction.

2.6. Quality Assessment. Two reviewers independently assessed the quality of study using the Jadad scale [20]. This scale has been widely applied in assessing methodological quality in exercise field [21, 22]. The scale includes three items: randomization (0–2 points), blinding (0–2 points), and withdrawals and dropouts (0-1 point). The range scores of Jadad were 0–5. A score higher than 3 points could be considered as high-quality studies.

2.7. Statistical Analysis. The Comprehensive Meta-Analysis software was used for meta-analysis. The Q-test and the I2-coefficient were used to examine heterogeneity between studies. If there is a statistic significant Q, it indicates differences of study heterogeneity. And the I2 statistic was used to measure the effect of heterogeneity with low (25%), moderate (50%), and high (75%) respectively [23]. The fixed-effects model was conducted to pool ESs with 95% confidence interval (CI), if the heterogeneity was not found. Otherwise, the random-effects model was adopted. Eventually, the publication bias was examined through using the Egger regression asymmetry test and Begg's funnel plot.

3. Results

3.1. Search Results. Figure 1 shows the flow diagram of the study selection process. A total of 2,184 articles were found in Medline, CINAHL, SportDicus, and Web of Science. After removing duplications, 1169 articles were eliminated, and 1134 articles were further excluded after screening the titles and abstracts. The remaining studies ($n = 38$) were reviewed for eligibility through reading the full-texts. Finally, 10 studies (12 trials, two studies included two eligible trails) were included in the present review [12, 16, 24–31].

3.2. Study Characteristics. The main characteristics of eligibility studies are summarized in Table 1. All included articles

Table 1: Characteristics of eligible studies in current meta-analysis.

Author and year	Subjects	Duration	Design	Intervention		Outcome	Key findings
				Control	Experiment		
Li et al. 2005	$n = 256$ Age: 70–92 Gender: 77M, 179F	24 w	RCT	Stretching 60 minutes, 3 times per week	Tai Chi 60 minutes, 3 times per week	BBS TUG	The score of BBS and TUG was improved in the Tai Chi group compared to the stretching group
Zhang et al. 2006	$n = 49$ Age: ≥60 Gender: 25M, 24F	8 w	RCT	Continue their current level of physical activity	Tai Chi 60 minutes, 7 times per week	One-leg balance	TCC training group significantly improved in one-leg balance compared to daily activities
Pereira et al. 2008	$n = 70$ Age: 60–82 Gender: 77F	12 w	RCT	Doing their daily activities	Tai Chi 50 minutes, 3 times per week	Unipodal position test	TC had an increase in unipodal position compared to control group
Kim et al. 2009	$n = 40$ Age: 65–87 Gender: 20M, 20F	12 w	RCT	Wellness education 60 minutes, per week	Tai Chi 60 minutes, 3 times per week	Center of pressure	TC had a greater COP compared to wellness education
Logghe et al. 2009	$n = 269$ Age: ≥70 Gender: 78M, 191F	13 w	RCT	Usual care	Tai Chi + Chi Kung 60 minutes, twice per week	BBS	No difference
Taylor-Piliae et al. 2010 Trial 1	$n = 132$ Age: 60–84 Gender: 40M, 92F	24 w	RCT	Attend-control 90 minutes, once per week	Tai Chi 45 minutes, twice per week	Single-leg stance	Tai Chi had greater improvements compared to control group
Taylor-Piliae et al. 2010 Trial 2	$n = 132$ Age: 60–84 Gender: 40M, 92F	24 w	RCT	Western exercise 45 minutes, 3 times per week	Tai Chi 45 minutes, twice per week	Single-leg stance	Tai Chi had greater improvements compared to WE
Nguyen and Kruse 2012	$n = 96$ Age: 60–79 Gender: 48M, 48F	24 w	RCT	Daily activities	Tai Chi 60 minutes, twice per week	TUG	TUG in TC group is significantly improved compared to daily activities
Taylor et al. 2012 Trial 1	$n = 684$ Age: ≥65 Gender: 182M, 502F	20 w	RCT	Low-level exercise 60 minutes, once per week	Tai Chi 60 minutes, once per week	TUG	No difference
Taylor et al. 2012 Trial 2	$n = 684$ Age: ≥65 Gender: 182M, 502F	20 w	RCT	Low-level exercise 60 minutes, once per week	Tai Chi 60 minutes, twice per week	TUG	No difference
Tousignant et al. 2012	$n = 152$ Age: ≥65 Gender: 41M, 111F	15 w	RCT	Physiotherapy intervention	Baduanjin 60 minutes, twice per week	BBS TUG	No difference
Son et al. 2016	$n = 50$ Age: 65–83 Gender: 50F	12 w	RCT	Otago exercise 60 minutes, twice per week	Tai Chi 60 minutes, twice per week	TUG OLS	Otago group exhibited a greater improvement in TUG compared to TC group; TC group showed greater improvement in OLS compared to Otago group

Note: TC: Tai Chi; TUG: Timed Up and Go Test; BBS: Berg Balance Score; OLS: One-leg-standing.

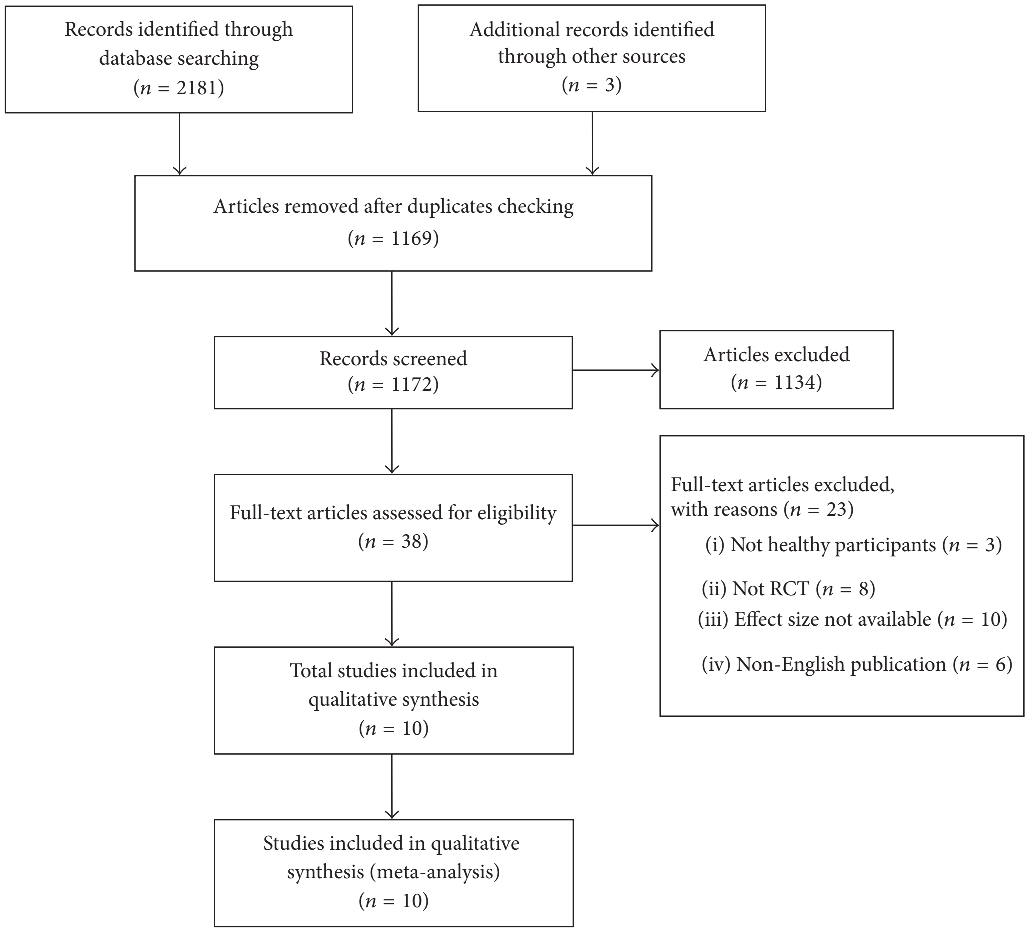


Figure 1: Flow diagram for selection of studies.

were published between 2003 and 2015, and they aimed to measure the effectiveness of traditional Chinese mind and body exercise on balance or fall prevention among healthy old adults. A total of 1,798 participants were involved in 10 studies. The sample size ranged from 40 to 702 participants. Three types of interventions were used: eight studies (10 trials) used Tai Chi, one study used Tai Chi + Qigong [27], and one study used Baduanjin [16].

3.3. Risk of Bias within Studies. The main risks of bias of the included studies are summarized in Table 2. It indicated that six trials had a high bias risk and six trials had a low bias risk based on the Jadad scale recommendation. All of the studies used the randomized allocation, but three studies reported using appropriate randomization methods, and the rest studies used appropriate double blinding or double blinding. In addition, most trials from these studies explicitly stated the number of withdrawals or the reasons for dropout. Both passive and active control group are included in the selected studies, and the ordinary intervention (not TCMBE) or other treatment (e.g., wellness education, and resistance training) was used for the control group. Eight trials used regular daily exercise [24–26, 28–31] and four trials used the wellness education, regular daily care exercises, and regular physiotherapy intervention [12, 16, 27, 31]. The detailed conditions and activities arranged for the control group are listed in Table 1.

3.4. Synthesis of Results and Berg Balance Scale. In this meta-analysis the main outcome measures were Berg Balance Scale (BBS); Timed Up and Go Test (TUG); and static balance. Figure 2 shows the forest plot of the meta-analysis. Three trials stated the BBS for old people, and a random-effects model was used due to the high heterogeneity: $Q = 7.68$, $p = 0.02$, and $I^2 = 73.98\%$. The pooled results indicated that there was no significant improvement on BBS in favor of elderly people practicing the traditional Chinese exercise (TCMBE): ES = 0.164, 95% CI (−0.199, 0.526), $z = 0.88$, and $p = 0.38$.

3.5. Timed Up and Go Test. There were seven trials in which the TUG was conducted in this meta-analysis. According to estimating the synthesis results, significant heterogeneity was found among the eligible seven trials, $Q = 36.27$, $p < 0.01$, and $I^2 = 83.46\%$, and then a random-effects model was conducted to calculate the effect size. Figure 3 shows the forest

Table 2: Quality assessment of included studies.

Author and year	Randomization	Double blinding	Withdrawals	Appropriate randomization	Appropriate double blinding	Total
Li et al. 2005	1	0	1	1	0	3
Zhang et al. 2006	1	0	1	0	0	2
Pereira et al. 2008	1	0	1	0	0	2
Kim et al. 2009	1	0	0	0	0	1
Logghe et al. 2009	1	1	1	0	1	4
Taylor-Piliae et al. 2010 Trial 1	1	0	1	0	0	2
Taylor-Piliae et al. 2010 Trial 2	1	0	1	0	0	2
Nguyen and Kruse 2012	1	0	1	0	0	2
Taylor et al. 2012 Trial 1	1	0	1	1	1	4
Taylor et al. 2012 Trial 2	1	0	1	1	1	4
Tousignant et al. 2012	1	0	1	0	1	3
Son et al. 2016	1	0	1	1	1	4

Study name	Statistics for each study						
	Std diff in means	Standard error	Variance	Lower limit	Upper limit	Z-Value	p value
Li et al. 2005	0.446	0.127	0.016	0.198	0.694	3.522	0.000
Logghe et al. 2009	−0.059	0.136	0.018	−0.325	0.208	−0.432	0.666
Tousignant et al. 2012	0.059	0.261	0.068	−0.452	0.570	0.227	0.820
	0.164	0.185	0.034	−0.199	0.526	0.884	0.377

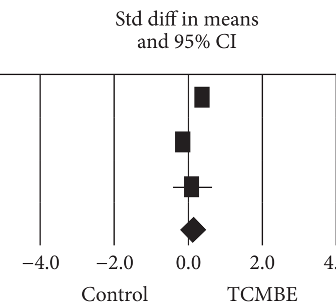


Figure 2: The effect of TCMBE versus control on BBS for the elderly.

plot of the analysis. The pooled results did not indicate any effect of TCMBE on TUG for the elderly: ES = 0.28, 95% CI (−0.01, 0.57), $z = 1.88$, and $p = 0.06$.

3.6. Static Balance. Static balance was reported in six trials in this meta-analysis. After calculating the pooled results in Figure 4, it gives a significant heterogeneity: $Q = 13.34$, $p < 0.01$, and $I^2 = 65.51\%$, so the random-effects model was suited for this analysis. It demonstrated that the static balance ability of the elderly in TCMBE group was significantly improved compared to the control group: ES = 0.70, 95% CI (0.03, 0.35), $z = 3.89$, and $p < 0.01$.

3.7. Publication Bias. In aspect of TUG and static balance, the nonsignificant results of Egger's test stated no publication bias with $p = 0.31$ and $p = 0.06$, respectively. But the two funnel plots were not symmetrical (Figures 5 and 6). The possible reason for unsymmetrical plot may be because of the heterogeneity among the included studies rather than publication bias.

3.8. Subgroup Analysis. Due to the significant heterogeneity in BBS, TUG, and static balance, three subgroup analyses were performed to compare the different intervention period (less than 15 weeks and more than 15 weeks) and different exercise time per week (≤90 minutes, around 120 minutes, and ≥180 minutes). To perform the subgroup analysis, the random-effects model was used. The forest plots of the subgroup analysis were shown in Figures 7–9.

Firstly, there was no difference in TCMBE group on BBS compared with control group in intervention period ($Q = 1.70$, $p = 0.20$). However, the potential result was longer period (≥15 weeks) and TCMBE had an effect on BBS (ES = 0.32, $p = 0.001$). Secondly, it indicated TCMBE group had no effect on TUG compared with control group based on the different duration time ($Q = 2.11$, $p = 0.15$). There also was a trend that long period (≥15 weeks) TCMBE play a positive effect on TUG. Finally, no group difference in exercise time per week ($Q = 2.53$, $p = 0.28$) was found. But the evidenced result was that if the participants took a longer time (≥150 minutes per week) to participate in TCMBE, they could improve their static balance power.

4. Discussion

This systematic review and meta-analysis was conducted to assess the effectiveness of TCMBE intervention compared with control group (non-TCMBE activity) on balance ability and risk to fall for old adults. We found that (1) there was no effect on BBS by using the TCMBE, based on the

Study name	Statistics for each study						
	Std diff in means	Standard error	Variance	Lower limit	Upper limit	Z-Value	p value
Li et al. 2005	0.631	0.128	0.016	0.380	0.882	4.927	0.000
Pereira et al. 2008	−0.093	0.228	0.052	−0.540	0.354	−0.409	0.683
Nguyen and Kruse 2012	1.307	0.258	0.067	−0.800	1.813	5.057	0.000
Taylor et al. 1 2012	0.151	0.093	0.009	−0.031	0.333	1.622	0.105
Taylor et al. 2 2012	0.026	0.094	0.009	−0.159	0.211	0.276	0.782
Tousignant et al. 2012	0.084	0.261	0.068	−0.427	0.594	0.321	0.748
Son et al. 2016	−0.124	0.299	0.089	−0.710	0.462	−0.415	0.678
	0.279	0.148	0.022	−0.012	0.570	1.878	0.060

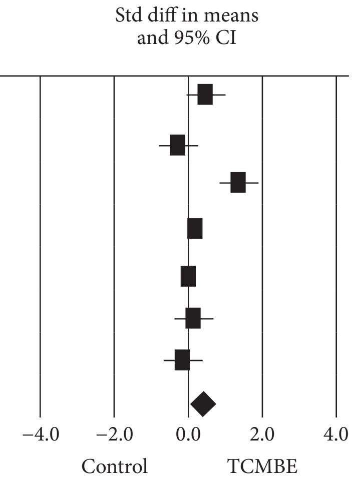


Figure 3: The effect of TCMBE versus control on TUG for the elderly.

Study name	Statistics for each study						
	Std diff in means	Standard error	Variance	Lower limit	Upper limit	Z-Value	p value
Zhang et al. 2006	1.444	0.328	0.107	0.802	20.86	4.408	0.000
Kim et al. 2009	1.233	0.345	0.119	0.557	1.909	3.574	0.000
Pereira et al. 2008	0.508	0.232	0.054	0.054	0.962	2.194	0.028
Taylor-Piliae et al. 1 2010	0.658	0.217	0.047	0.232	1.084	3.028	0.002
Taylor-Piliae et al. 2 2010	0.224	0.230	0.053	−0.227	0.675	0.972	0.331
Son et al. 2016	0.377	0.301	0.091	−0.213	0.968	1.252	0.211
	0.695	0.179	0.032	0.345	1.045	3.888	0.000

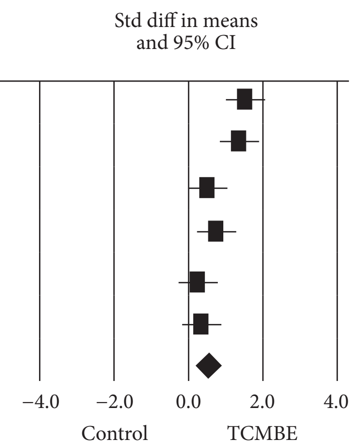


Figure 4: The effect of TCMBE versus control on static balance for the elderly.

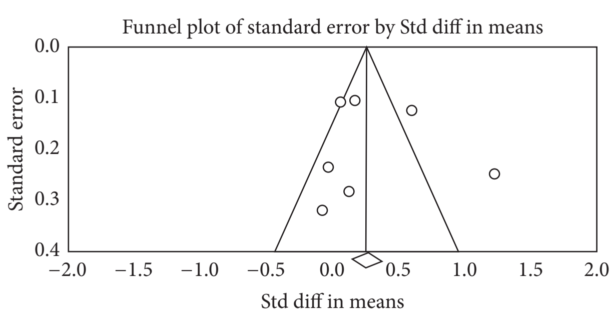


Figure 5: Funnel plot (TUG).

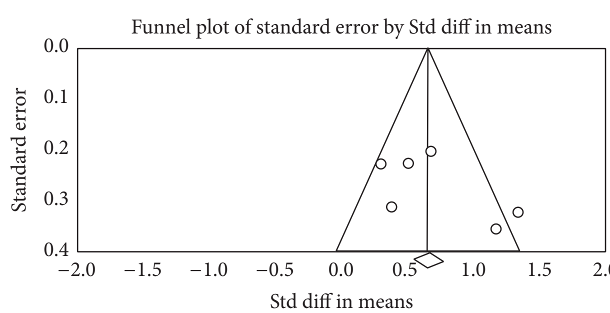


Figure 6: Funnel plot (static balance).

synthesis ESs of 3 randomized controlled trials; (2) TCMBE intervention did not significantly improve old adults' TUG though displaying the pooled ESs of seven randomized controlled trials; and (3) there was a significant improvement on static balance power, in particular, if the subjects participate in the TCMBE program for more than 150 minutes per week. These findings seem to be different from the previous meta-analysis [8, 14, 32], in which Tai Chi intervention significantly improved the BBS and TUG compared with control group. The current study includes more eligible trials using the TCMBE interventions and its characteristics are homogenous compared to previous meta-analysis, such that if one study has three different groups, we use the TCMBE group to compare with the other two groups, respectively.

Group by time point	Study name	Time	Statistics for each study						
			Std diff in means	Standard error	Variance	Lower limit	Upper limit	Z-Value	p value
<15 weeks	Logghe et al. 2009	<15 weeks	−0.059	0.136	0.018	−0.325	0.208	−0.432	0.666
<15 weeks			−0.059	0.226	0.051	−0.502	0.385	−0.259	0.795
≥15 weeks	Li et al. 2005	≥15 weeks	0.446	0.127	0.016	0.198	0.694	3.522	0.000
≥15 weeks	Tousignant et al. 2012	≥15 weeks	0.059	0.261	0.068	−0.452	0.570	0.227	0.820
≥15 weeks			0.320	0.181	0.033	−0.036	0.675	1.762	0.078

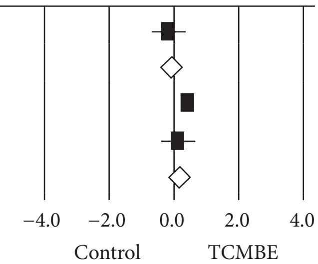


Figure 7: Subgroup meta-analysis: the effect of TCMBE versus control on BBS for elderly TUG.

Group by time point	Study name	Time	Statistics for each study						
			Std diff in means	Standard error	Variance	Lower limit	Upper limit	Z-Value	p value
<15 weeks	Pereira et al. 2008	<15 weeks	−0.093	0.228	0.052	−0.540	0.354	−0.409	0.683
<15 weeks	Son et al. 2016	<15 weeks	−0.124	0.299	0.089	−0.710	0.462	−0.415	0.678
<15 weeks			−0.105	0.181	0.033	−0.460	0.251	−0.577	0.564
≥15 weeks	Li et al. 2005	≥15 weeks	0.631	0.128	0.016	0.380	0.882	4.927	0.000
≥15 weeks	Nguyen and Kruse 2012	≥15 weeks	1.307	0.258	0.067	−0.800	1.813	5.057	0.000
≥15 weeks	Taylor et al. 1 2012	≥15 weeks	0.151	0.093	0.009	−0.031	0.333	1.622	0.105
≥15 weeks	Taylor et al. 2 2012	≥15 weeks	0.026	0.094	0.009	−0.159	0.211	0.276	0.782
≥15 weeks	Tousignant et al. 2012	≥15 weeks	0.084	0.261	0.068	−0.427	0.594	0.321	0.748
≥15 weeks			0.250	0.056	0.003	0.140	0.359	40459	0.000

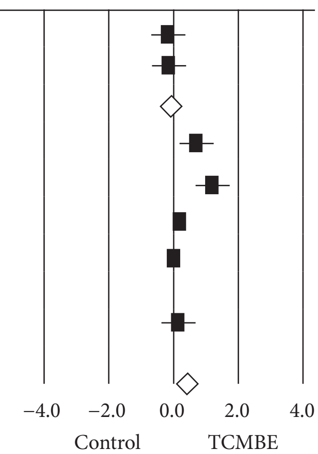


Figure 8: Subgroup meta-analysis: the effect of TCMBE versus control on TUG for the elderly.

Group by time point	Study name	Time	Statistics for each study						
			Std diff in means	Standard error	Variance	Lower limit	Upper limit	Z-Value	p value
=120 min	Son et al. 2016	=120 min	0.377	0.301	0.091	−0.213	0.968	1.252	0.211
=120 min			0.377	0.301	0.091	−0.213	0.968	1.252	0.211
≤90 min	Taylor-Piliae et al. 1 2010	≤90 min	0.658	0.217	0.047	0.232	1.084	3.028	0.002
≤90 min	Taylor-Piliae et al. 2 2010	≤90 min	0.224	0.230	0.053	−0.227	0.675	0.972	0.331
≤90 min			0.444	0.298	0.089	−0.140	1.029	1.149	0.000
≥150 min	Zhang et al. 2006	≥150 min	1.444	0.328	0.107	0.802	20.86	4.408	0.000
≥150 min	Kim et al. 2009	≥150 min	1.233	0.345	0.119	0.557	1.909	3.574	0.000
≥150 min	Pereira et al. 2008	≥150 min	0.508	0.232	0.054	0.054	0.962	2.194	0.028
≥150 min			1.009	0.269	0.072	0.481	1.536	3.749	0.000

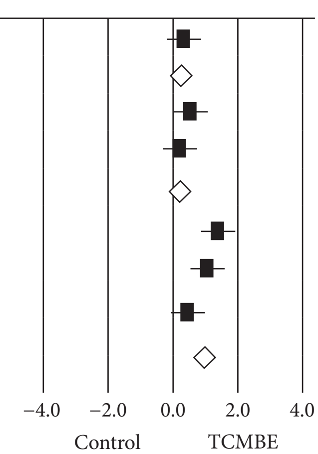


Figure 9: Subgroup meta-analysis: the effect of TCMBE versus control on static balance for the elderly.

Besides, the previous review included the participants with diseases, such as stoke, dementia, and Parkinson's. Our study used the healthy population without any disease. In addition, the current review firstly evidenced the effect of TCMBE on static balance ability for old adults though meta-analysis.

Because of the high heterogeneity in meta-analysis, we conducted subgroup meta-analysis to investigate the reasons of heterogeneity. The intervention time (≥15 weeks) of participants participating in the TCMBE showed significantly effect on BBS and TUG for old adults ($p_{\text{BBS}} = 0.001$ and $p_{\text{TUG}} = 0.02$, resp.). There was significantly improved static balance for old adults if the time they participated in the TCMBE was not less than 150 minutes per week ($p < 0.01$). Therefore, more senior people are encouraged to take part in the TCMBE program with long practicing time every week in order to achieve the benefits of the TCMBE exercise.

This meta-analysis study has few limitations that may influence the findings; for example, there are 50 percent of trials that are classified as high bias risk based on the Jadad scale. The present review only consists of English publications. The varied TCMBE sessions per week and the different measurement parameters were used in original studies. Moreover, in original studies some participants dropped out the experiment at the end of the trial; the number of participants at the postintervention was used to assess the ESs. This systematic review and meta-analysis did not evaluate the long-term beneficial effects of TCMBE on balance for the elderly after the end of intervention. It is expected that more studies are needed to confirm the findings in the future.

5. Conclusion

In summary, the time old adults participated in the TCMBE program more than 150 minutes per week for more than 15 weeks can promote their balance ability. Therefore, the traditional Chinese mind and body exercise training program can be introduced to the public as an alternative rehabilitation treatment for old adults to promote their balance ability.

Competing Interests

The authors declare that they have no competing interests.

References

[1] NBC, *China Aged Care Industry Report, 2014–2017*, 2015, http://www.prnewswire.com/news-releases/china-aged-care-industry-report-2014-2017-300089774.html.

[2] L. A. Jacobsen, M. Kent, M. Lee, and M. Mather, America's aging population, Population Bulletin, 2011, http://www.prb.org/pdf11/aging-in-america.pdf.

[3] D. J. Macfarlane, K. L. Chou, and W. K. Cheng, "Effects of Tai Chi on the physical and psychological well-being of Chinese older women," *Original Article*, vol. 3, no. 2, pp. 87–94, 2004.

[4] X. Z. Lan, *The Aging Problem of China*, 2007, http://www.bjreview.com.cn/lianghui/txt/2007-03/14/content_59110.htm.

[5] T. M. Dall, P. D. Gallo, R. Chakrabarti, T. West, A. P. Semilla, and M. V. Storm, "An aging population and growing disease burden will require a large and specialized health care workforce by," *Health Affairs*, vol. 32, no. 11, pp. 2013–2020, 2013.

[6] J. Zhang and J. Chaaban, "The economic cost of physical inactivity in China," *Preventive Medicine*, vol. 56, no. 1, pp. 75–78, 2013.

[7] E. G. Lakatta and D. Levy, "Arterial and cardiac aging: major shareholders in cardiovascular disease enterprises: part II: the aging heart in health: links to heart disease," *Circulation*, vol. 107, no. 2, pp. 346–354, 2003.

[8] B.-L. Chen, J.-B. Guo, M.-S. Liu et al., "Effect of traditional Chinese exercise on gait and balance for stroke: a systematic review and meta-analysis," *PLoS ONE*, vol. 10, no. 8, article e0135932, 2015.

[9] P. Scuffham, S. Chaplin, and R. Legood, "Incidence and costs of unintentional falls in older people in the United Kingdom," *Journal of Epidemiology and Community Health*, vol. 57, no. 9, pp. 740–744, 2003.

[10] M. S. Lee, K. W. Chen, K. M. Sancier, and E. Ernst, "Qigong for cancer treatment: a systematic review of controlled clinical trials," *Acta Oncologica*, vol. 46, no. 6, pp. 717–722, 2007.

[11] T. Zhang, "Chinese stroke rehabilitation guide," *Chinese Journal of Rehabilitation Theory and Practice*, vol. 4, pp. 301–318, 2012.

[12] H.-D. Kim, J.-T. Han, and Y.-H. Cho, "The effectiveness of community-based Tai Chi training on balance control during stair descent by older adults," *Journal of Physical Therapy Science*, vol. 21, no. 4, pp. 317–323, 2009.

[13] P. A. Harmer and F. Li, "Tai Chi and falls prevention in older people," *Medicine and Sport Science*, vol. 52, pp. 124–134, 2008.

[14] Y. Zhao and Y. Wang, "Tai Chi as an intervention to reduce falls and improve balance function in the elderly: a meta-analysis of randomized controlled trials," *Chinese Nursing Research*, vol. 3, no. 1, pp. 28–33, 2016.

[15] A. I. Greenspan, S. L. Wolf, M. E. Kelley, and M. O'Grady, "Tai chi and perceived health status in older adults who are transitionally frail: a randomized controlled trial," *Physical Therapy*, vol. 87, no. 5, pp. 525–535, 2007.

[16] M. Tousignant, H. Corriveau, P.-M. Roy et al., "The effect of supervised Tai Chi intervention compared to a physiotherapy program on fall-related clinical outcomes: a randomized clinical trial," *Disability and Rehabilitation*, vol. 34, no. 3, pp. 196–201, 2012.

[17] A. P. Verhagen, M. Immink, A. van der Meulen, and S. M. A. Bierma-Zeinstra, "The efficacy of Tai Chi Chuan in older adults: a systematic review," *Family Practice*, vol. 21, no. 1, pp. 107–113, 2004.

[18] A. Voukelatos, R. G. Cumming, S. R. Lord, and C. Rissel, "A randomized, controlled trial of tai chi for the prevention of falls: the central Sydney tai chi trial," *Journal of the American Geriatrics Society*, vol. 55, no. 8, pp. 1185–1191, 2007.

[19] S. Wenneberg, L.-G. Gunnarsson, and G. Ahlström, "Using a novel exercise programme for patients with muscular dystrophy—part II: A Quantitative Study," *Disability and Rehabilitation*, vol. 26, no. 10, pp. 595–602, 2004.

[20] A. R. Jadad, R. A. Moore, D. Carroll et al., "Assessing the quality of reports of randomized clinical trials: is blinding necessary?" *Controlled Clinical Trials*, vol. 17, no. 1, pp. 1–12, 1996.

[21] A. R. Aladro-Gonzalvo, M. Machado-Díaz, J. Moncada-Jiménez, J. Hernández-Elizondo, and G. Araya-Vargas, "The effect of Pilates exercises on body composition: a systematic review," *Journal of Bodywork and Movement Therapies*, vol. 16, no. 1, pp. 109–114, 2012.

[22] M. S. Lee, M. H. Pittler, and E. Ernst, "Tai chi for osteoarthritis: a systematic review," *Clinical Rheumatology*, vol. 27, no. 2, pp. 211–218, 2008.

[23] J. P. T. Higgins, S. G. Thompson, J. J. Deeks, and D. G. Altman, "Measuring inconsistency in meta-analyses," *British Medical Journal*, vol. 327, no. 7414, pp. 557–560, 2003.

[24] F. Li, P. Harmer, K. J. Fisher et al., "Tai Chi and fall reductions in older adults: a randomized controlled trial," *Journals of Gerontology—Series A Biological Sciences and Medical Sciences*, vol. 60, no. 2, pp. 187–194, 2005.

[25] J.-G. Zhang, K. Ishikawa-Takata, H. Yamazaki, T. Morita, and T. Ohta, "The effects of Tai Chi Chuan on physiological function and fear of falling in the less robust elderly: an intervention study for preventing falls," *Archives of Gerontology and Geriatrics*, vol. 42, no. 2, pp. 107–116, 2006.

[26] M. M. Pereira, R. J. de Oliveira, M. A. F. Silva, L. H. R. Souza, and L. G. Vianna, "Effects of Tai Chi Chuan on knee extensor muscle strength and balance in elderly women," *Revista Brasileira de Fisioterapia*, vol. 12, no. 2, pp. 121–126, 2008.

[27] I. H. J. Logghe, P. E. M. Zeeuwe, A. P. Verhagen et al., "Lack of effect of tai chi chuan in preventing falls in elderly people living at home: a randomized clinical trial," *Journal of the American Geriatrics Society*, vol. 57, no. 1, pp. 70–75, 2009.

[28] M. H. Nguyen and A. Kruse, "The effects of Tai Chi training on physical fitness, perceived health, and blood pressure in elderly Vietnamese," *Open Access Journal of Sports Medicine*, vol. 3, pp. 7–16, 2012.

[29] D. Taylor, L. Hale, P. Schluter et al., "Effectiveness of Tai Chi as a community-based falls prevention intervention: a randomized controlled trial," *Journal of the American Geriatrics Society*, vol. 60, no. 5, pp. 841–848, 2012.

[30] N. Son, Y. U. Ryu, H. Jeong, Y. Jang, and H. Kim, "Comparison of 2 different exercise approaches: Tai Chi Versus Otago, in Community-Dwelling Older Women," *Journal of Geriatric Physical Therapy*, vol. 39, no. 2, pp. 51–57, 2016.

[31] R. E. Taylor-Piliae, K. A. Newell, R. Cherin, M. J. Lee, A. C. King, and W. L. Haskell, "Effects of Tai Chi and Western exercise on physical and cognitive functioning in healthy community-dwelling older adults," *Journal of Aging and Physical Activity*, vol. 18, no. 3, pp. 261–279, 2010.

[32] Y. Huang and X. Liu, "Improvement of balance control ability and flexibility in the elderly Tai Chi Chuan (TCC) practitioners: a systematic review and meta-analysis," *Archives of Gerontology and Geriatrics*, vol. 60, no. 2, pp. 233–238, 2014.

Hindawi Publishing Corporation
Evidence-Based Complementary and Alternative Medicine
Volume 2016, Article ID 5867810, 6 pages
http://dx.doi.org/10.1155/2016/5867810

Research Article

Simplified Tai Chi Program Training versus Traditional Tai Chi on the Functional Movement Screening in Older Adults

Huiru Wang,[1] Ankui Wei,[2] Yingzhi Lu,[2] Bo Yu,[3] Wenhua Chen,[3] Yang Lu,[2] Yang Liu,[4] Dinghai Yu,[5] and Liye Zou[6]

[1]*Department of Sport and Physical Education, Shanghai Jiao Tong University, Shanghai, China*
[2]*School of Kinesiology, Shanghai University of Sport, Shanghai, China*
[3]*Department of Rehabilitation Medicine, Shanghai First People's Hospital, Shanghai Jiao Tong University, Shanghai, China*
[4]*School of Physical Education and Sport Training, Shanghai University of Sport, Shanghai, China*
[5]*School of Chinese Wushu, Shanghai University of Sport, Shanghai, China*
[6]*Department of Health Education and Physical Education, Springfield College, Springfield, MA 01109, USA*

Correspondence should be addressed to Yang Liu; docliuyang@hotmail.com and Dinghai Yu; yudinghai_shs@163.com

Received 3 June 2016; Revised 22 September 2016; Accepted 19 October 2016

Academic Editor: Yi Yang

Background. The present study aimed to evaluate and compare the effect of two different types of Tai Chi programs on the Functional Movement Screening (FMS) in older adults. *Methods*. Ninety older adults (65.5 ± 4.6 years old) who met the eligibility criteria were randomized into three different groups based on a ratio of 1 : 1 : 1: a traditional Tai Chi exercise (TTC), a simplified Tai Chi exercise (TCRT), or a control group (routine activity). The FMS consisted of the deep squat, hurdle step, in-line lunge, shoulder mobility, active straight leg rise, trunk stability push-up, and rotatory stability, which was used to measure physical function before the present study and after six months of Tai Chi interventions. *Results*. Seventy-nine participants completed the present study (control = 27, TTC = 23, and TCRT = 29). Significant improvement on the FMS tests between the baseline and after the six-month intervention was observed in both Tai Chi programs, whereas no significant improvement was observed in the control group. In addition, participants in the TCRT group demonstrated greater improvement than those in the TTC group. *Conclusions*. The TCRT is more effective in improving the physical function in older adults when compared to the traditional Tai Chi modality, particularly for improving balance.

1. Background

Falls are one of the most devastating problems that emerge in more than 30% of older adults, leading to high morbidity and death rates. In particular, not only does fall-related morbidity significantly reduce the quality of life in older adults, but also it challenges the national healthcare system [1]. Potential risk factors have been identified in association with falls, including weak lower extremity, unstable gait, and limited mobility [2]. Researchers emphasize that older adults should pay attention to improving their muscular strength and mobility to help stabilize the body (balance), ultimately reducing rates of falling [3].

In recent years, exercise has been recommended as one of the most effective and cost-effective methods for fall prevention in older adults [4]. Traditional Chinese Qigong exercises (TCQG) (e.g., Taichi, Baduanjin, and Daoyishu), characterized by gracefulness, softness, mindfulness, and gentleness, were proven to have a positive impact on flexibility and functional balance contributing to fall reduction in older adults [5]. Two systematic reviews consistently support the effectiveness of Tai Chi on reducing the frequency of falls and fear of falling [6, 7]. For instance, a research group designed a randomized controlled study and found that a six-month Tai Chi intervention protocol positively affected the total number of falls and psychological fear of falling in older adults (aged 70 or above) with sedentary lifestyle [8].

Although people of different ages and health status received benefits from practicing Tai Chi, the complexity of moves of traditional Tai Chi has become a big challenge to

Table 1: Demographic information of participants at the baseline (mean ± SD).

Variables	TCRT, $n = 30$	TTC, $n = 30$	Control group, $n = 30$
Height (cm)	162.3 ± 4.9	161.2 ± 6.1	162.3 ± 5.5
Weight (kg)	62.3 ± 7.4	59.6 ± 7.1	63.3 ± 8.1
Age (years)	65.3 ± 4.3	65.2 ± 5.0	65.3 ± 4.4
BMI (kg/m^2)	23.6 ± 2.3	22.9 ± 2.6	23.7 ± 2.7

Note. SD: standard deviation; BMI: body mass index.

Tai Chi practitioners, especially for those novice older adults. More specifically, the complex and lengthy traditional Tai Chi form does not simply challenge motor memory capability in older adults that could discourage them, but relatively large space is demanded for home-based practice. A simplified Tai Chi form is therefore needed for older adults to strengthen their balance for fall prevention.

We therefore developed a simplified Tai Chi resistance training protocol consisting of 32 moves, which focus on improving physical function (e.g., balance, flexibility, and agility) and circulating flow of internal energy. Prior to the present study, the researchers designed a randomized controlled study to investigate the effectiveness of this simplified Tai Chi form in alleviating bone loss in menopausal women and found that the simplified Tai Chi form is as effective as the traditional Tai Chi form in slowing bone loss [9]. Whether this simplified Tai Chi could improve balance in older adults still remains unclear; therefore, the present study aimed to compare the effectiveness of the 8-minute Tai Chi form versus the traditional Tai Chi form on the Functional Movement Screen (FMS) in older adults when compared to a control group [10].

2. Materials and Methods

2.1. Participants. Participants in the present study were recruited from Shanghai City of China, through advertisements placed in local newspapers and in community centers. The demographic information of participants at the baseline is presented in Table 1. The study was approved by the Scientific Research Ethics Committee of Shanghai Sport University. Participants were included in the present study if they met the following eligibility criteria: (1) they were aged between 60 and 70 years; (2) they were employed in jobs without substantial physical demands; (3) they were currently not participating in any other supervised exercise program or did not attend any exercise program for the last three months; (4) they did not have any major diseases and/or physical illnesses (as measured by Manual Muscle Test) [11] that limit their practice of Tai Chi exercise; (5) they were not involved with any mental disorders (as measured by the Mini-Mental State Examination) [12] that may negatively affect understanding Tai Chi moves.

Medical history and health status were checked by a medical doctor from the Department of Rehabilitation, Shanghai First People's Hospital. The Manual Muscle Test for muscular strength, Goniometer for range of motion on both hips and knees, and the Mini-Mental State Examination for cognitive function were administered by another two medical doctors from the same hospital. All abovementioned screening took place prior to the beginning of randomized assignment. All eligible participants signed consent forms prior to being randomly placed into three groups (TTC = 30, TCRT = 30, and control = 30) based on computer-generated numbers.

2.2. Exercise Interventions. Four Tai Chi instructors (males = 2 and females = 2) were recruited from Shanghai Sport University. Taking into account the performance bias (standardized instruction), prior to the present study, the four instructors received three months of official training together, given by a Tai Chi grandmaster who was familiar with both TTC and TCRT. After the three months of the training, all instructors reached the standard of the effectiveness of instruction and then were equally assigned into the two Tai Chi groups based on mixed gender.

Participants in the control group were asked to keep their original lifestyles. Participants in the traditional Tai Chi group experienced four 60-minute Yang Style Tai Chi (85 moves) sessions weekly for six months. Of the four sessions weekly, two sessions were conducted by two experienced Tai Chi instructors and home-based practice for the remaining two sessions took place through watching a Tai Chi video. Participants in the TCRT had a similar protocol, involving frequency and duration of simplified Tai Chi program, and exercise modes (supervised and home-based). The exercise routine included a 10-minute warm-up, subsequent 40-minute Tai Chi form, and 10-minute relaxation at the end. The four instructors took attendance and reported it to researchers. Participants in the TCC group spent their first months learning and refining their moves before they practiced the entire routine. When compared to the 85-move TTC, participants in the TCRT group only spent their first two weeks in their learning stage because it included only 32 moves. The similarities and differences between simplified Tai Chi and traditional Tai Chi are presented in Table 2.

2.3. Functional Movement Measurement. Physical function was measured using the FMS consisting of seven tasks before and after the six-month Tai Chi intervention period. The seven tasks included deep squat (assessing bilateral, symmetrical, and functional mobility of the hips, knees, and ankles), hurdle step (assessing the bilateral functional mobility and stability of the hips, knees, and ankles), in-line lunge (assessing torso, shoulder, hip, and ankle mobility and stability, quadriceps flexibility, and knee stability), shoulder mobility (assessing bilateral shoulder range of motion, combining internal rotation with adduction and external rotation with abduction), active straight leg rise (assessing active hamstring and gastric-soleus flexibility while maintaining stable pelvis and active extension of the opposite leg), trunk stability push-up (assessing trunk stability in the sagittal plane while a symmetrical upper extremity motion is performed), and rotary stability (assessing multiplane trunk stability during a combined upper and lower extremity motion) [10–13]. Two high-resolution cameras located in the sagittal and frontal planes (Sony HXR-NX3, China) were used to record the quality of movement while performing the FMS tasks.

Table 2: The similarities and differences between simplified Tai Chi exercise (TCRT) and traditional Tai Chi (TTC).

Variables	Name of Tai Chi routine	
	TCRT	TTC
Origin	It was developed by a Qigong master at Shanghai Sport University in a recent year, simplified resistance Tai Chi	It was created by Chinese martial artists and has a history of more than 100 years, Traditional Yang Style 85-form Tai Chi.
Number of moves	32	85
Element of routine	Movements focus on weight shift, muscle stretching, cultivating internal energy, and fall-prevention training. In particular, pushing hands as a key element is added in which two practitioners place their dominant hands together and apply their force or action to make the opponent lose balance.	Hand movements are characterized by circulation, spiral, slowness, smoothness. low limbs are involved with weight-shift training while maintaining core stability.
Duration of routine	28 min, 30 seconds	28 min, 16 seconds
Exercise intensity	Moderate	Moderate
Strengths and Weaknesses	Relatively short routine is suitable for older adults due to age-related memory decline. Practitioners can carry out home-based practice, instructed by watching a video. Pushing hand provides practitioners with the opportunity to socialize with each other.	Lengthy routine is a challenge for older adults. Additionally, complex moves not only require supervised practice, but also could discourage novice practitioners (discontinue Tai Chi training).

All tests took place in the indoor sport hall of Shanghai University of Sport.

Each task has specific score criteria for the rater to determine among 0, 1, 2, and 3. Any pain reported while performing the movement in each test automatically resulted in a score of 0. The participant received a score of 3 if the performance meets all the standards delineated in the manual. Each test was scored from 0 to 3, and the maximum total score is 21. The secondary author who is a certified FMS expert recruited two graduate students and gave them official training before the present study. In order to avoid detection bias, the two assessors were blinded to the purpose of the present study. First of all, the two assessors independently evaluated the quality of movement of each task. If any disagreement existed between the two assessors, the certified FMS expert intervened to resolve the disagreement. The interrater reliability for assessing each task of the FMS was 92% or above.

2.4. Statistical Analysis. A statistician who was blinded to the outcome measures performed data analysis. For the total score, an intention-to-treat analysis was performed to compare among the three groups. The effects of the interventions were assessed by using analysis of covariance (ANOVA) for repeated measures within 3 (group: TCRT group, TTC group, and control group) × 2 (time: before and after). The effect was localized by using LSD's correction for multiple comparisons. Other than the repeated measure, the percentage differences (0–6 months) were calculated from duration between baseline and the end of the measurements for each individual. Furthermore, for each individual FMS test, crosstab was used to calculate the population percentage of improving, remaining, and descent. All analyses were done using SPSS version 20, and $p < 0.05$ was considered a statistically significant difference.

3. Results

The research group had received responses from 114 participants who were interested in participating in the present study. Based on the eligibility criteria, 24 volunteers were excluded (age = 12, disease = 9, and schedule conflict = 3). A final number of 90 participants (65.5 ± 4.6 years) were included in the present study. Seventy-nine participants completed the six-month Tai Chi intervention period: 3 (schedule conflict = 1 and dropout = 2) in the control group, 7 (dropout = 2 and low attendance = 5) in the TTC, and 1 with schedule conflict in the TCRT group. Figure 1 presents screening, randomization, and completion of the 6-month intervention.

For the total score, the main effect of time was significant ($F(1,76) = 17.726$; $p < .001$; $\eta_p^2 = .189$), and a significant improvement in both Tai Chi groups was observed before and after the six-month Tai Chi intervention period (14.284 ± 1.417 versus 14.871 ± 1.522; $p < .001$). The main effect of group was also significant ($F(2,76) = 3.640$; $p = .031$; $\eta_p^2 = .087$), and pairwise comparisons showed that TCRT had higher scores than the control group (15.034 ± 1.395 versus 14.111 ± 1.489; $p = .009$). Finally, the interaction between time and group was found ($F(2,76) = 3.514$; $p = .013$; $\eta_p^2 = .109$), with further analysis showing that both the TCRT (14.655 ± 1.289 versus 15.414 ± 1.500; $p = .001$) and the TTC (14.087 ± 1.443 versus 15.087 ± 1.276; $p < .001$) groups had improved total score, while no difference was found in the control group (14.111±1.502 versus 14.111±1.476; $p = 1.000$) (Figure 2).

Table 3 presents the percentage of improvement, maintenance, and declining on each task of the FMS across three groups.

With respect to each individual task of the FMS, the percentage of change in the TCRT group was observed in

Table 3: Changing conditions of the 7 FMS movement modes before and after the intervention.

Variables	TCRT			TTC			Control		
	Improve%	Keep%	Decline%	Improve%	Keep%	Decline%	Improve%	Keep%	Decline%
Deep squat	6.90	89.66	3.45	4.35	91.30	4.35	3.70	85.19	11.11
Hurdle step	37.93	58.62	3.45	26.09	69.57	4.35	14.81	81.48	3.70
In-line lunge	10.34	68.97	20.69	13.04	82.61	4.35	3.70	77.78	18.52
Shoulder mobility	24.14	68.97	6.90	52.17	43.48	4.35	18.52	66.67	14.81
Leg rise	10.34	86.21	3.45	8.70	82.61	8.70	18.52	62.96	18.52
Push-up	6.90	89.66	3.45	8.70	86.96	4.35	7.41	77.78	14.81
Rotary	13.79	86.21	0.00	13.04	82.61	4.35	18.52	77.78	3.70

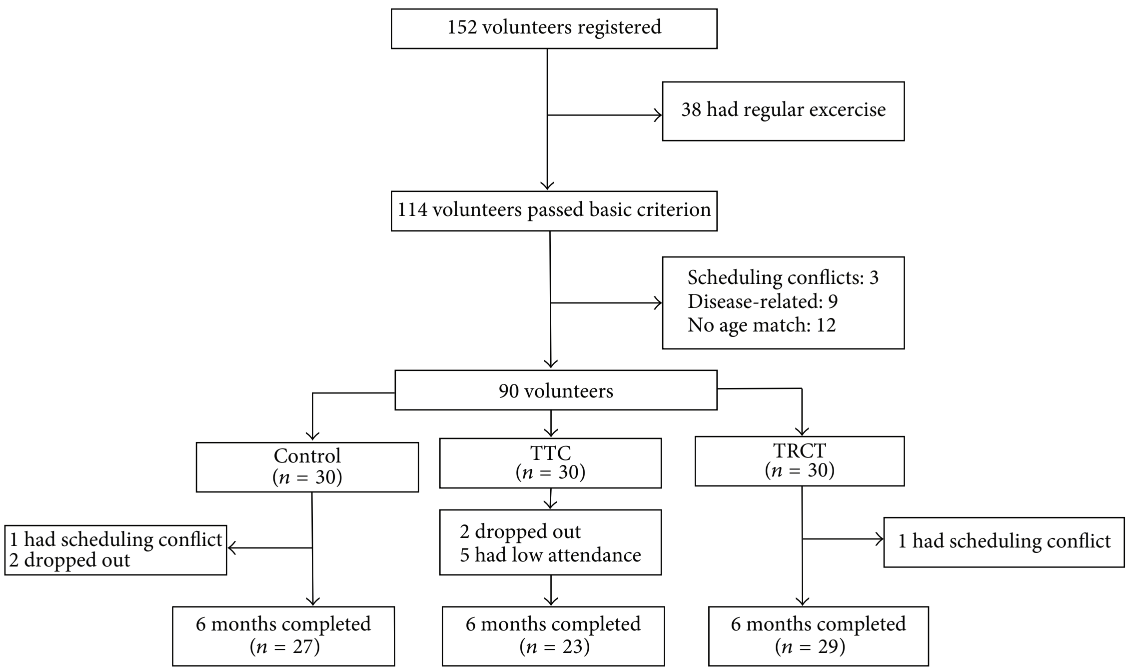


Figure 1: The entire process of screening, randomization, and completion of the 6-month intervention.

hurdle step (improvement: 37.93%, decline: 4.35%), leg rise (improvement: 10.34%, decline: 4.35%), push-up (improvement: 6.90%, decline: 4.35%), and rotary (improvement: 13.79%, decline: 0.00%) test with the least decline percentage and relative high improvement percentage, compared with the TTC and control group (Figure 3). The change of percentage at the baseline and after the six-month Tai Chi intervention period is reported in Table 3.

4. Discussion

The present study was to evaluate and compare the effect of two different types of Tai Chi training programs on the Functional Movement Screening (FMS) in older adults: a simplified Tai Chi resistance training program and traditional Tai Chi. Older adults who experienced either Tai Chi program experienced significant improvement on balance performance after the six-month intervention period.

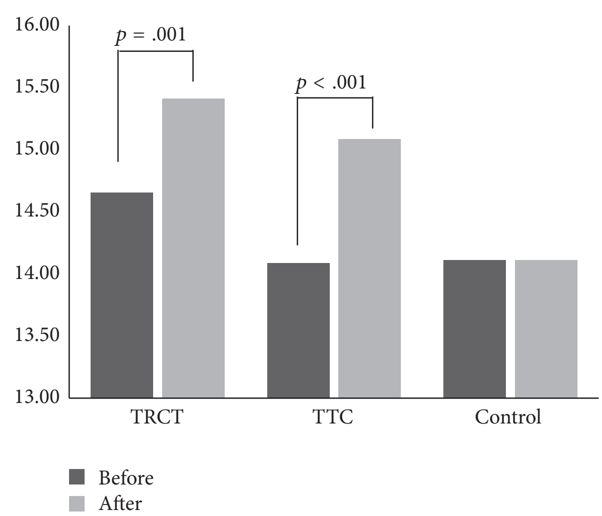


Figure 2: The interaction between the time and groups.

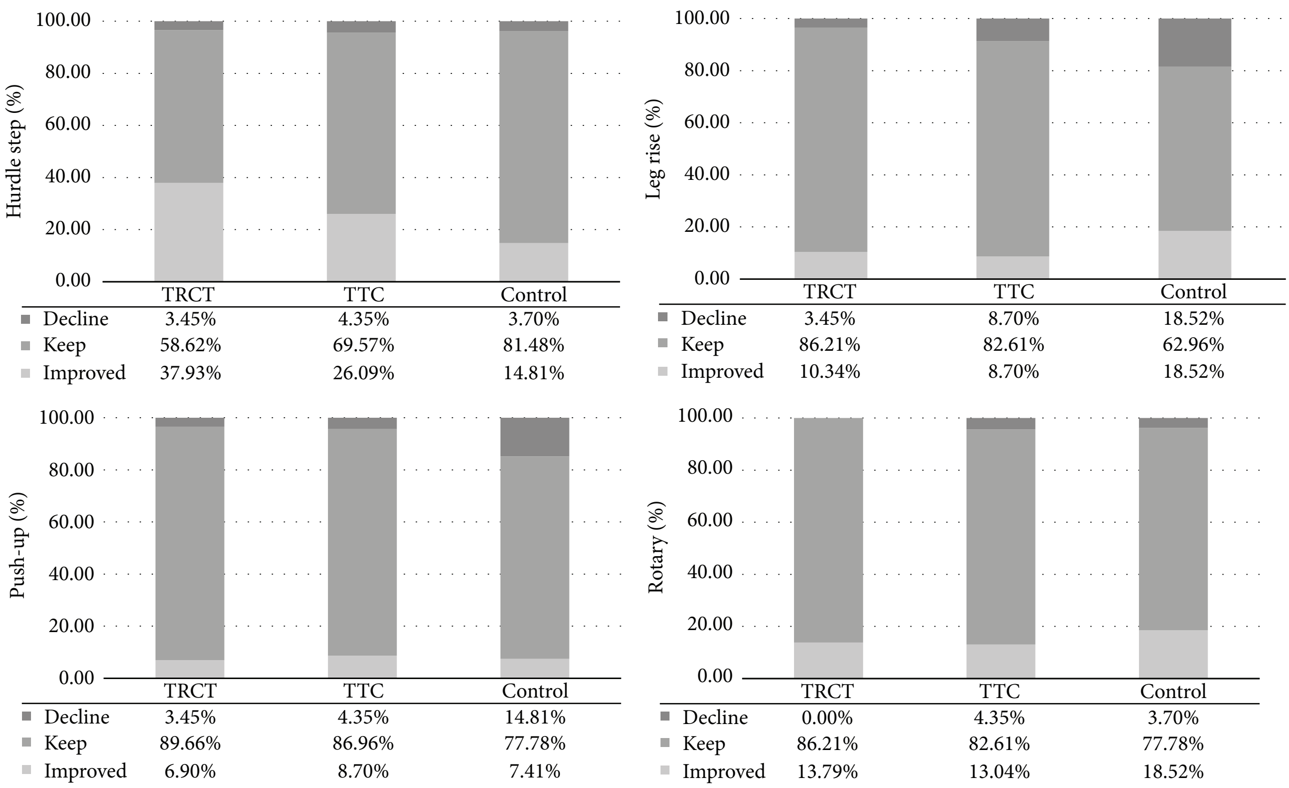


Figure 3: The percentage of change for the four tasks of the FMS across three groups.

Although many factors may contribute to falls, it has been documented that weak muscular strength in the lower extremities and balance ability due to aging are the main risk factors. Physical exercise has been proven to improve muscular strength and balance ability for fall prevention in older adults [14, 15]. Tai Chi is a safe, health-enhancing exercise and is suitable for older adults due to the features of gentleness and softness [16]. Tai Chi has been extensively studied and its positive impact includes improving postural stability and alleviating degeneration of muscular strength in older adults [17]. Shih [18] found that, after 16 weeks of Tai Chi training, the dynamic sway velocity as an indicator of balance became significantly lower among older people. After a 16-week Tai Chi practice, researchers found that older adults demonstrated significant improvement on the postural stability test due to decreasing displacement of center of pressure under the feet [19].

Tai Chi practice is effective in strengthening the limb muscle groups that contribute to initiating voluntary, goal-directed, and coordinative movements for postural stability [20]. The traditional Tai Chi routine is lengthy and complex, which restricts those people who lack the time, commitment, or mobility to exercise in groups under the supervision of an instructor. The simplified Tai Chi exercise not only keeps the original essence of the traditional Tai Chi improving physical function, but also is more easily accessible to older adults [16]. The resistance training in the simplified Tai Chi exercise has been proven to have a positive impact on alleviating bone mass loss [16]. The present study also showed that the simplified Tai Chi improved the FMS scores, which may be attributed to its main function improving physical function. Among the seven FMS functional tests, the hurdle step and leg rise tests are two main indictors of physical balance. In the present study, we found that the simplified Tai Chi exercise had a greater impact on the hurdle step and leg rise than the traditional Tai Chi routine. The leg rise test reflects the flexibility of the posterior femoral muscle group, as well as the strength of quadriceps femurs, the condition of lumbar vertebrae, and the stability of the pelvis. The muscle-stretching exercise, the second series of the new Tai Chi exercise, is specialized in improving flexibility. The hurdle step test is used to evaluate the ability of lifting up the lower limb and striding over the obstacle (hurdle) while stabilizing the torso. It reflects the static stability of the torso, stability of the supporting leg, and the agility of the striding leg. Accidental falls in older adults are mainly attributed to weak lower extremity (e.g., single leg and double leg support and the difficulty to initiate a voluntary and coordinated movement due to nerve degeneration).

The present study supports the notion that the simplified Tai Chi exercise is as effective as the traditional Tai Chi routine in improving physical function, particularly for balance. When compared to the traditional Tai Chi routine, the simplified Tai Chi exercise is more accessible to different skill levels of people (from novice to advanced level) and is more user-friendly, which is seemingly reflected by greater adherence (29 in the TCRT versus 23 in the TTC). When the traditional 85-form Tai Chi requires supervised practice because of the complex and lengthy routine, the simplified Tai Chi form can also be practiced at home because large space is not required. In addition, pushing hand in the simplified Tai Chi resistance training program provides practitioners with the opportunity to interact with each other, which makes the routine become more interesting and enjoyable.

5. Conclusions

Both the traditional and the simplified Tai Chi routines are effective in improving physical function in older adults, especially for physical balance. In the present study, the simplified Tai Chi outperforms the traditional Tai Chi. The simplified Tai Chi exercise may be an effective alternative method to strengthen physical function in older adults. Future studies should recruit a large number of participants with a mixed method to examine whether the effect of the simplified Tai Chi on health outcomes is superior to the traditional Tai Chi when comparing dropout rates and compliance and learnability.

Competing Interests

The authors declare that they have no competing interests.

Acknowledgments

This study was financially supported by Shanghai Municipal Education Commission (no. 12ZZ169), Shuguang Program by Shanghai Education Development Foundation and Shanghai Municipal Education Commission (14SG46), Science and Technology Commission of Shanghai Municipality (16080503400), Shanghai Pujiang Program (16PJC075), and Shanghai Key Lab of Human Performance (Shanghai University of Sport, no. 11DZ2261100).

References

[1] L. Z. Rubenstein, "Falls in older people: epidemiology, risk factors and strategies for prevention," *Age and Ageing*, vol. 35, no. 2, pp. ii37–ii41, 2006.

[2] S. Studenski, P. W. Duncan, J. Chandler et al., "Predicting falls: the role of mobility and nonphysical factors," *Journal of the American Geriatrics Society*, vol. 42, no. 3, pp. 297–302, 1994.

[3] W. Dite and V. A. Temple, "A clinical test of stepping and change of direction to identify multiple falling older adults," *Archives of Physical Medicine and Rehabilitation*, vol. 83, no. 11, pp. 1566–1571, 2002.

[4] L. D. Gillespie, M. C. Robertson, W. J. Gillespie et al., "Interventions for preventing falls in older people living in the community," *Cochrane Database of Systematic Reviews*, no. 2, Article ID CD007146, 2009.

[5] J. X. Li, Y. Hong, and K. M. Chan, "Tai chi: physiological characteristics and beneficial effects on health," *British Journal of Sports Medicine*, vol. 35, no. 3, pp. 148–156, 2001.

[6] S. Low, L. W. Ang, K. S. Goh, and S. K. Chew, "A systematic review of the effectiveness of Tai Chi on fall reduction among the elderly," *Archives of Gerontology and Geriatrics*, vol. 48, no. 3, pp. 325–331, 2009.

[7] M. M. Schleicher, L. Wedam, and G. Wu, "Review of Tai Chi as an effective exercise on falls prevention in elderly," *Research in Sports Medicine*, vol. 20, no. 1, pp. 37–58, 2012.

[8] F. Li, P. Harmer, K. J. Fisher, and E. Mcauley, "Tai Chi: improving functional balance and predicting subsequent falls in older persons," *Medicine and Science in Sports & Exercise*, vol. 36, no. 12, pp. 2046–2052, 2004.

[9] G. Wu, "Evaluation of the effectiveness of Tai Chi for improving balance and preventing falls in the older population—a review," *Journal of the American Geriatrics Society*, vol. 50, no. 4, pp. 746–754, 2002.

[10] K. I. Minick, K. B. Kiesel, L. Burton, A. Taylor, P. Plisky, and R. J. Butler, "Interrater reliability of the functional movement screen," *The Journal of Strength and Conditioning Research*, vol. 24, no. 2, pp. 479–486, 2010.

[11] C. T. Wadsworth, R. Krishnan, M. Sear, J. Harrold, and D. H. Nielsen, "Intrarater reliability of manual muscle testing and hand-held dynametric muscle testing," *Physical Therapy*, vol. 67, no. 9, pp. 1342–1347, 1987.

[12] M. F. Folstein, L. N. Robins, and J. E. Helzer, "The mini-mental state examination," *Archives of General Psychiatry*, vol. 40, no. 7, p. 812, 1983.

[13] D. S. Teyhen, S. W. Shaffer, C. L. Lorenson et al., "The functional movement screen: A Reliability Study," *Journal of Orthopaedic and Sports Physical Therapy*, vol. 42, no. 6, pp. 530–540, 2012.

[14] L. Day, B. Fildes, I. Gordon, M. Fitzharris, H. Flamer, and S. Lord, "Randomised factorial trial of falls prevention among older people living in their own homes," *British Medical Journal*, vol. 325, no. 7356, pp. 128–131, 2002.

[15] A. Barnett, B. Smith, S. R. Lord, M. Williams, and A. Baumand, "Community-based group exercise improves balance and reduces falls in at-risk older people: a randomised controlled trial," *Age and Ageing*, vol. 32, no. 4, pp. 407–414, 2003.

[16] H. Wang, B. Yu, W. Chen, Y. Lu, and D. Yu, "Simplified Tai Chi resistance training versus traditional Tai Chi in slowing bone loss in postmenopausal women," *Evidence-Based Complementary and Alternative Medicine*, vol. 2015, Article ID 379451, 6 pages, 2015.

[17] N. M. Sjösten, M. Salonoja, M. Piirtola et al., "A multifactorial fall prevention programme in home-dwelling elderly people: a randomized-controlled trial," *Public Health*, vol. 121, no. 4, pp. 308–318, 2007.

[18] J. Shih, "Basic Beijing twenty-four forms of T'ai Chi exercise and average velocity of sway," *Perceptual and Motor Skills*, vol. 84, no. 1, pp. 287–290, 1997.

[19] W. R. Forrest, "Anticipatory postural adjustment and T'ai Chi Ch'uan," *Biomedical Sciences Instrumentation*, vol. 33, pp. 65–70, 1997.

[20] S. Vaapio, M. Salminen, T. Vahlberg et al., "Effects of risk-based multifactorial fall prevention on health-related quality of life among the community-dwelling aged: a randomized controlled trial," *Health and Quality of Life Outcomes*, vol. 5, article 20, 2007.

Hindawi Publishing Corporation
Evidence-Based Complementary and Alternative Medicine
Volume 2016, Article ID 5935782, 11 pages
http://dx.doi.org/10.1155/2016/5935782

Research Article

Effects of Health Qigong Exercises on Relieving Symptoms of Parkinson's Disease

Xiao Lei Liu,[1] Shihui Chen,[2] and Yongtai Wang[3]

[1] *Department of Traditional Sports, Beijing Sport University, Beijing, China*
[2] *Department of Kinesiology, Texas A&M University-Texarkana, Texarkana, TX, USA*
[3] *College of Nursing and Health Science, University of Texas at Tyler, Tyler, TX, USA*

Correspondence should be addressed to Shihui Chen; shchen@ied.edu.hk

Received 4 June 2016; Revised 19 September 2016; Accepted 4 October 2016

Academic Editor: Karin Kraft

The purpose of this study was to investigate the effects of Health Qigong on the treatment and releasing symptoms of Parkinson's disease (PD). Fifty-four moderate PD patients ($N = 54$) were randomly divided into experimental and control groups. Twenty-eight PD patients were placed in the experimental group in which the prescribed medication plus Health Qigong exercise will be used as intervention. The other 26 PD patients as the control group were treated only with regular medication. Ten-week intervention had been conducted for the study, and participants completed the scheduled exercises 5 times per week for 60 minutes each time (10 minutes for warm-up, 40 minutes for the exercise, and 10 minutes for cooldown). Data which included the muscle hardness, one-legged blind balance, physical coordination, and stability was collected before, during, and after the intervention. Comparisons were made between the experimental and control groups through the Repeated Measures ANOVA. The results showed that PD patients demonstrate a significant improvement in muscle hardness, the timed "up and go," balance, and hand-eye coordination (the turn-over-jars test). There were no significant differences between the two groups in gender, age, and course of differences ($P < 0.05$). The study concluded that Health Qigong exercises could reduce the symptoms of Parkinson's disease and improve the body functions of PD patients in both the mild and moderate stages. It can be added as an effective treatment of rehabilitation therapy for PD.

1. Introduction

Parkinson's disease (PD) is a progressive chronic disorder of the central nervous system characterized by impaired muscular coordination and tremors, and it is an age-related disease that afflicts a large number of patients globally. Individuals with PD typically have movement impairment, such as resting tremors, bradykinesia, and rigid muscles, resulting from the lack of dopamine in the extrapyramidal system [1, 2]. According to the recent statistics on Parkinson's disease, there are approximately 6.3 million people with PD in the world and more than 1.7 million people with PD in China, affecting approximately 1.7% of the Chinese population aged over 65 years (European Parkinson's Disease Association). Parkinson's disease is a painful chronical disease because it limits muscle capacity, sense of balance, motor skills, language, sleep, and daily living abilities. It may also cause psychological and sociological problems such as depression and fatigue, reducing the quality of life, and lowering self-esteem [3, 4].

People with PD need extensive rehabilitation because current medication can do little for motor function deterioration. It is crucial for PD patients to do physical therapy because they need a medical treatment and a positive influence on both body and mind. Over the past few years, achievements had been made in the therapy formulations of PD including drug therapy, gene therapy, and operative treatment. Treatment options now include rehabilitation, symptomatic treatment, protective treatment, deep-brain stimulation, and reconstruction treatment. Despite the fact that movement disorders are a main symptom of Parkinsonism, few studies use exercise therapy as an integrative approach for the prevention and treatment of PD. According to recent research studies, physical exercise helps improve clinical symptoms of

PD such as postural instability, rigidity, muscle tremors, and the slowness of movement, as well as physical abilities such as muscle functions and the sense of balance [5], and more physical activity programs have been integrated into therapy treatments of PD [6, 7].

According to the statistics, falling is one of the most common and serious problems for Parkinson's patients. 66% of PD patients fall once a year and 46% encounter repeating falls [8]. This is mainly caused by symptoms such as freezes, muscle weakness, and balance problems [9, 10]. Scholars had made joint efforts to explore new methods for the treatment of PD. It had been found that physical treatments as a complement to medications could achieve superior results [11]. These physical exercises aimed to develop balance, gait, mobility, muscle control, and the capacity for independent living. Some items had been tested before and after the intervention, including akinetic symptoms, posture capacity, balance, pain evaluations, gait, rigidity, and a posture analysis. The physical treatments were mainly meant for the improvement of the patients' motor capacity, daily living ability, and muscle control [7].

Different types of physical exercise had been designed for Parkinson's patients aiming to improve patient mobility [12], balance [13], muscle control and power [14], aerobic capacity [15], and gait [16]. For instance, aerobic exercises had been widely applied to increase a PD patient's cardiac respiratory function and muscle capacity. Aerobic gait and step exercises such as walking and using a treadmill helped renew the daily life capacity, because they could develop behavioral functions and improved life quality [17]. In addition, when combining aerobic exercise with drug therapy, the effect was improved. Muhlack et al. [18] found that the efficiency of levodopa was improved after practicing aerobic exercise. Other studies had found that aerobic exercises could also protect the patients' neuro- and neural pathways [19, 20]. Aerobic exercise was found to provide patients with improved movement capacity and physical functions and ease PD symptoms [21]. Both intensive and adaptive exercise programs had been shown to improve balance and mobility in patients with PD [22].

PD patients' muscle strength is lower than that in normal people; this might be because of a loss in central stimulation [23]. According to some research, physical capacity was concerned with lower leg strength and could be improved by regular exercise [24]. For individuals with PD, immobility might also cause problems in bone density, and doing more muscle exercises could relieve this situation [25]. Lima et al. [26] suggested that mild- and medium-level PD patients undergo progressive resistance training during rehabilitation, which could increase their walking capacity and reduce the risk of falls. Hunot and Hirsch's studies [13] also found that performing strength and balance exercises could reduce the risk of falls, and patient strength and balance could be obviously increased. Oguh et al. [21] found in their research on 4,866 Parkinson's patients that regular exercise provided superior mobility and physical functioning, slowed the advancement of the disease, and reduced cognitive loss as well as nursing costs. Hove et al.'s studies [27] also showed that rhythmic exercise could significantly benefit the movement and coordination of PD patients.

In 2008, Lan et al. [28] claimed that muscle-strengthening exercises could raise patients' muscle power but that the effect on balance, gait, and movement capacity was limited. As such, the potential effectiveness of traditional mind and body harmony exercises, Tai Chi, Health Qigong, and Yoga, on treating PD was studied by some of researchers [29, 30]. The characteristics of Tai Chi and Health Qigong are slow, coherent, and aerobic low-intensity exercises that can relax body and mind. Tai Chi and Qigong are treated as a style of Chinese martial arts incorporating meditation, breathing, and physical movement. Exercising Tai Chi and Qigong serves many functions: relaxing body and mind, inducing pleasure and satiety, recharging metabolism, improving heart functions and slowing heart rates, and reducing blood pressure. Used as physiotherapy, they have always been an essential part of Chinese traditional herbal medicine [31]. Some scholars think that Qigong emerged from methods used by the ancient Chinese and, actually, it was developed on the basis of traditional Chinese medicine by controlling the movement of Qi through meridian system in the body [32]. As people in the early stages of PD can still dance, run, and walk smoothly and can also do complex movements for several minutes when they are given appropriate emotional or visual cues, Health Qigong appears to be an appropriate exercise for PD patients to improve their symptoms.

Among different types of balance exercises, Tai Chi is one of the most effective interventions that can be used by recreational therapists to improve balance and postural stability in older adults with PD [29]. Morris [33] showed that Tai Chi could improve balance, kinesthetic sense, and strength; hence, it may be prescribed as a sensorimotor agility program for patients with PD. Because Qigong and Tai Chi share many similar characteristics, the effects of Qigong on PD may resemble those functions of Tai Chi. Tai Chi and Qigong are exercises that both require the unification of the body and soul as their philosophical basis. Both are the two most popular Chinese medical exercises in improving balance, flexibility, relaxation, and postural stability worldwide [34]. Tai Chi and Qigong had been shown to improve health-related quality of life indicators and psychological health [35]. This type of exercise can relieve anxiety and depression and contribute to a sense of calm. There is growing evidence that physical and mental therapy helps eliminate negative emotions, reduce the symptoms of depression, and promote mental health. The use of mind-body therapies, such as Tai Chi, Yoga, Health Qigong, and meditation, is frequently reported as a means of coping with anxiety and depression [36].

In summary, Health Qigong is a traditional Chinese exercise that builds the practitioners mind and body by controlling the flow of Qi, comforting the body, and releasing pressure through movement. To PD patients, exercising Health Qigong is superior to taking medication because of its fewer side effects and a longer honeymoon effect. Although different traditional exercises had been attempted as treatments for the PD patients, few people use them as an alternative approach for the treatment of PD disease which the present study is trying to focus on. As one of the Chinese traditional mind and body exercises which share similar functions with Tai Chi, Health Qigong as an alternative therapy exercise integrated into regular medical treatment of PD is receiving greater attention. In order to analyze the effectiveness of Chinese Health Qigong exercises on relieving symptoms of Parkinson's disease, the purposes of this study were to conduct an experiment to investigate the effects of Health Qigong on the treatment and releasing symptoms of Parkinson's disease. The main aims of this study were (1) to design a Health Qigong exercise program for mild-to-moderate stages of PD, (2) to examine the effects of 10 weeks of Health Qigong exercise on PD, (3) to investigate the effects of Health Qigong on function of shaking, muscle hardness and elasticity, balance, and activity of daily living on PD, and (4) to specially design/modify a Health Qigong exercise form for PD.

2. Materials and Methods

2.1. Participants. Fifty-four patients diagnosed with PD, from YT Mountain Hospital, were selected as participants for this study. The inclusion criteria for the recruitment of participants were as follows: (1) mild or moderate PD, (2) ability to walk independently, (3) normal state of mental health, (4) ability to follow instructions, (5) absence of other complications, and (6) ability to participate in physical exercise. The exclusion criteria included any previous practical experience with Health Qigong, a recent or planned change in medication, and signs of a central nervous system disease other than PD, such as aphasia or dementia (as defined by the mini mental status examination). Selected participants were randomly divided into two groups. The Health Qigong experiment group included 28 patients (11 men and 17 women and average age of 65.84 ± 5.45), and the control group included 26 patients (14 men and 12 women with average age of 62.5 ± 3.13). The two groups showed no statistically significant differences in gender, age, and course of differences ($P > 0.05$).

2.2. Instruments. Four instruments were used to measure the outcomes of the 10-week Health Qigong program. They included the muscle hardness, the physical stability (9-holed instrument) test, and the physical coordination test (TUG and turn-over-jars tests). This study is mainly concerned with the effect of Health Qigong on PD treatment; thus, the items such as muscle hardness and elasticity, balance capacity, and physical coordination (the most common and main symptoms of PD) all needed to be measured and analyzed. The following instruments were used for collecting data: myometry (Myoton-3) for muscle hardness and elasticity and the BDW-85-II to test physical stability. In addition, balance and physical coordination were measured through (a) TUG test, (b) eye-hand coordination *(turn-over-jars)* test, and (c) one-legged blind balance test. All data was collected by the lab technicians and the project assistants.

2.3. Experimental Design. The participants were randomly divided into two groups. The control group received only drug therapy and participated in regular daily activities, and the experimental group participated in the Health Qigong program in addition to the drug therapy. Three measurements were conducted for the entire experiment period: pretest was conducted one week before starting the intervention of the Health Qigong exercise program, interim test was conducted four to five weeks after the intervention started, and the posttest was conducted immediately after the intervention. All instruments were reliable and were operated and recorded by the experienced technicians.

2.4. Intervention and Procedures

2.4.1. Intervention Procedures. Ten Health Qigong movements targeted for Parkinsonism symptoms and movement patterns were selected and compiled as the Health Qigong program by the principle researcher of this study who has more than 12 years of teaching and research experiences in Qigong. She selected 10 Qigong movements from a Health Qigong program based on the nature of these movements to match the characteristics of PD condition. The 10 movements' program then was sent to five well-renowned Qigong experts in the nation for consultation. The movement selection and compilation were examined and evaluated by the distinguished Health Qigong experts, who analyzed the feasibility and potential effectiveness of the 10 movements in relieving the symptoms of PD, and were confirmed by the five experts with minor changes. The 10 Health Qigong movements are holding the hands high with palms up to regulate the internal organs (Shuang Shou Tuo Tian Li San Jiao), thrusting the fists and making the eyes glare to enhance strength (Cuan Quan Nu Mu Zeng Qi Li), and looking backwards to prevent sickness and strain (Wu Lao Qi Shang Wang Hou Qiao) from Baduanjin exercise; the "XU" and "XI" exercises from Liuzijue exercise; the bird exercise (Niao Xi) from Wuqinxi exercise; the showing talons and spreading wings (Chu Zhao Liang Chi Shi) from Yijinjing; the beginning of Heaven's creation (Qian Yuan Qi Yun) and the white crane flies high in the clouds (Yun Duan Bai He) from 12-step daoyin health preservation exercise; the dragon flying (Long Deng) from Mawangdui Daoyinshu exercise.

Each movement was to be practiced three times, taking approximately 14-15 minutes for the entire form, to improve PD's physical coordination, stability, balance, and muscle control. The Health Qigong exercise program was conducted for 10 weeks, 5 days per week, with each session lasting for 60 minutes. Each session included 10 minutes of warm-up, 40 minutes of Health Qigong practice, and 10 minutes of relaxation at the end.

2.5. Statistics and Data Analysis. Because PD patients were a special group, it became difficult to control the number of participants from both control and experiment groups. For different reasons, we lost some participants in the muscle hardness, action control capacity, one-legged blind balance, TUG, and hand-eye coordination (turn-over-jars) tests. According to the experiment design, the same test items between the control and experimental groups were tested during the pretest, interim test, and posttest, and

Table 1: The muscle hardness testing of the pronator teres on left and right sides during pretest, interim test, and posttest between the two groups (N/m).

	Control group (n = 18)			Experimental group (n = 23)		
	Pre	Interim	Post	Pre	Interim	Post
Left	257.28 ± 39.08	256.72 ± 38.59	252.67 ± 40.05	280.00 ± 55.30	251.17 ± 38.29**	217.48 ± 26.35**
Right	263.39 ± 57.23	270.78 ± 62.83	262.17 ± 61.54	284.35 ± 61.33	245.39 ± 40.72**	229.96 ± 35.73**

Note: ∗∗ is represented as $P < 0.01$, very significant.

Table 2: The hand-eye coordination test results on the right and left sides (s).

	Control group (n = 18)			Experimental group (n = 23)		
	Pre	Interim	Post	Pre	Interim	Post
Left	9.00 ± 4.90	8.68 ± 4.39	8.51 ± 3.50	8.05 ± 2.90	6.94 ± 3.38*	6.45 ± 3.46*
Right	7.26 ± 2.19	7.51 ± 2.24	7.66 ± 1.93	8.19 ± 4.34	6.49 ± 1.42*	6.22 ± 2.35*

Note: ∗ is represented as $P < 0.05$, significant.

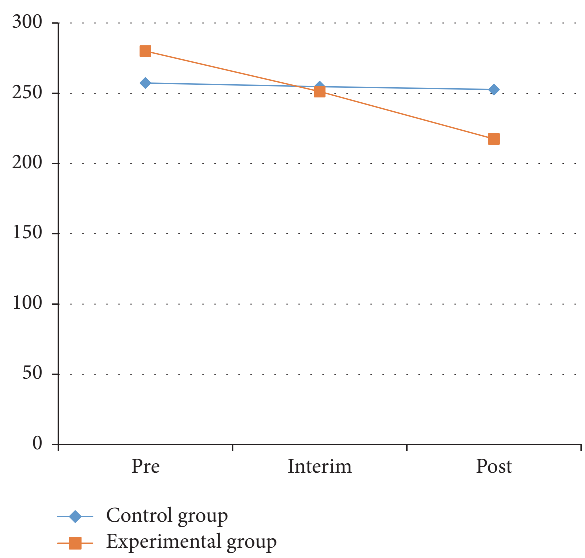


Figure 1: The value of left muscle hardness between control and experimental groups.

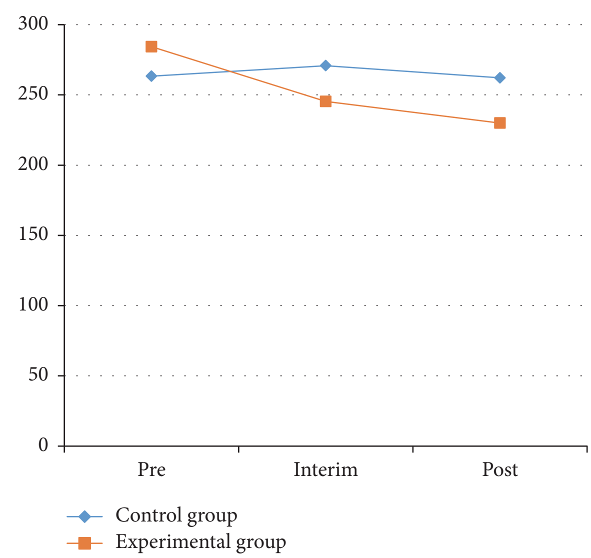


Figure 2: The value of left hand-eye coordination test between control and experimental groups.

the Repeated Measures ANOVA was used for the statistical analysis.

3. Results

3.1. Effect of 10 Weeks of Health Qigong on Muscle Hardness. The muscle hardness was measured on the left and right pronator teres during the pretest, interim test, and posttest, and the results were shown in Tables 1 and 2.

As shown in Table 1 and Figures 1 and 2, the muscle hardness index of the left pronator teres decreased significantly. Compared with the muscle hardness index of the left pronator teres measured in the 2 groups at pretest, the interim test decreased from 280.00 ± 55.30 to 251.17 ± 38.29 N/m. The range declined from 284.35 ± 61.33 to 245.39 ± 40.72 N/m for the right side, with a significant level at $P < 0.01$. The range declined from 280.00 ± 55.30 to 217.48 ± 26.35 N/m from the pretest to the posttest in the left side; for the right side, the index dropped from 284.35 ± 61.33 to 229.96 ± 35.73 N/m, with a significant difference at the level $P < 0.01$.

Figures 1 and 2 indicated that after 10 weeks of Health Qigong intervention, the muscle hardness levels of the left and right pronator teres were decreased, and the muscle hardness levels declined significantly with the extension of the intervention. Health Qigong exercise can improve the muscle hardness of the pronator teres in PD patients. The data provides the evidence that Health Qigong relaxes the body and relieves stiff muscles in PD patients.

3.2. Effects of Health Qigong on Physical Coordination, Stability, and Balance

3.2.1. Evaluating Physical Coordination in PD Patients

(1) Hand-Eye Coordination (Turn-over-Jars) Test. To test the participants' upper-body control, we placed five jars (250 mL

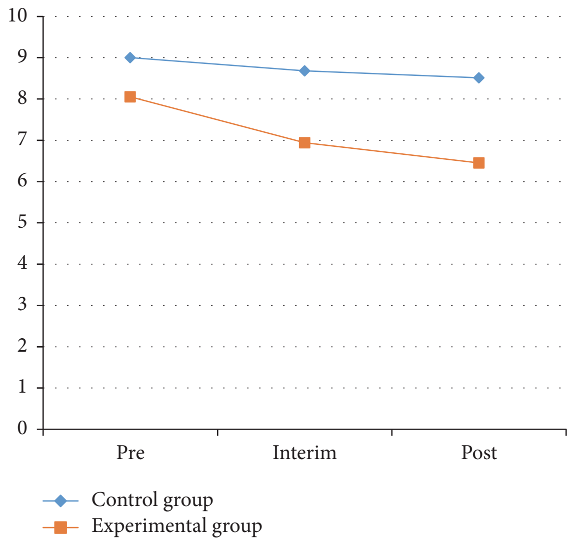


Figure 3: The value of left hand-eye coordination test between control and experimental groups.

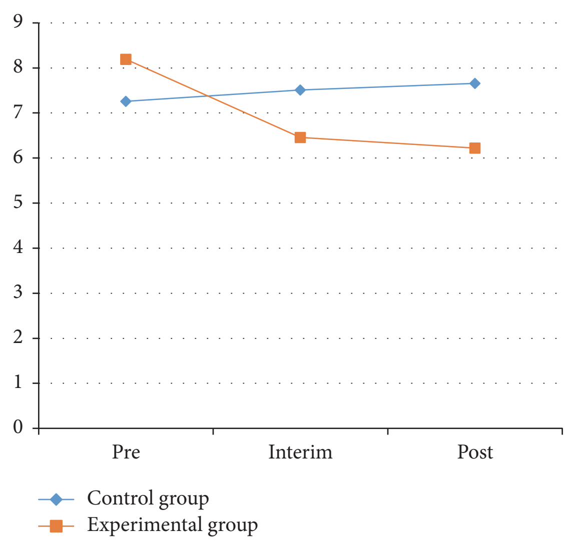


Figure 4: The value of right hand-eye coordination test between control and experimental groups.

in size) in a line on a table. Each patient had to flip the jars, one at a time, as fast as they could. The test was timed with a stopwatch. The patients observed how to perform the action and complete the specifications when the time was recorded. The hand-eye coordination test results for the experimental and the control groups from the pretest, interim test, and posttest are shown in Table 2 and Figures 3 and 4.

As shown in Table 2 and Figures 3 and 4, the right-side and left-side results for the hand-eye coordination test on the control group showed no significant effect between the pretest and posttest ($P > 0.05$). The index of the left side for both groups was also not statistically significant difference ($P > 0.05$). However, the index for both groups on the right side showed significant effects between the pretest and posttest ($P < 0.05$). In the experimental group, the index

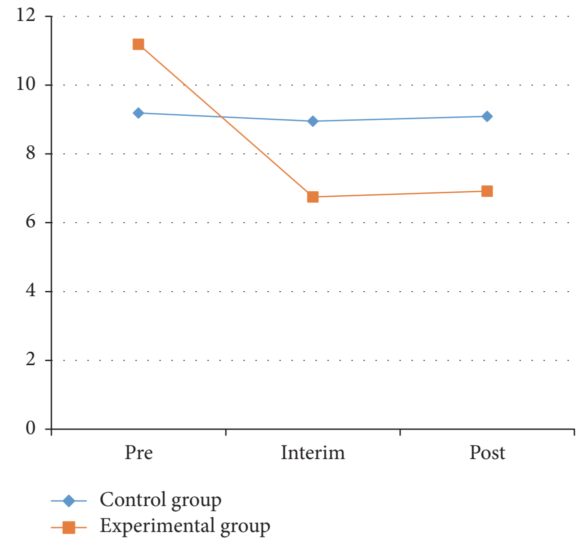


Figure 5: The results of right timed "up and go" test between the control and experimental groups.

decrease from the pretest to the posttest for both the left and right sides was significant ($P < 0.05$). On the left side for the experimental group, the average declined from 8.05 ± 2.90 to 6.45 ± 3.46 s; on the right side, the average dropped from 8.19 ± 4.34 to 6.22 ± 2.35 s.

The index for the experimental group before and after the hand-eye coordination test on the left side showed significant effects. Significant differences were also shown for the right side of the 2 groups between the pretest and interim test and for the left side of the experimental group between the pretest and posttest. These results illustrate that Health Qigong exercise could significantly improve the hand-eye coordination of PD patients.

(2) TUG Test. A timed TUG test was used to test patient's balance, gait, and stride while walking. A chair was placed against a wall, and a distance of 3 m from the chair was marked. The patient sits on the chair, and the timer is started once the patient stands up. The patient must walk to the 3 m mark, then turn around, walk back to the chair, and sit down again. The timer is stopped at this point. In the experiment, the testers recorded the completed time and observed the patient's balance, gait, and stride while walking. The results of the TUG test for both the experimental and control groups were shown in Tables 3 and 4 and Figure 5.

As shown in Table 3, the results of TUG test for the 2 groups between the pretest and the interim test and between the pretest and posttest were statistically significant ($P < 0.01$). The average TUG test index for all patients at the pretest, interim test, and posttest was 10.19 ± 0.45, 7.68 ± 0.40, and 8.00 ± 0.31 s, respectively. The pretest TUG results showed significant differences ($P < 0.05$) between the 2 groups. Significant differences were found between the interim test and posttest ($P < 0.01$) for both groups.

Table 4 and Figure 5 show that the TUG test results in the experimental group were significant between the pretest and

Table 3: The timed "up and go" test results on the right and left sides (s).

Group	Pre	Interim	Post
Experimental	11.19 ± 0.60	$6.40 \pm 0.53^{**}$	$6.91 \pm 0.41^{**}$
Control	9.19 ± 0.68	8.96 ± 0.60	9.09 ± 0.46
Experimental and control	10.19 ± 0.45	$7.68 \pm 0.40^{*}$	$8.00 \pm 0.31^{*}$

Note: $*$ is represented as $P < 0.05$, significant; $**$ is represented as $P < 0.01$, very significant.

Table 4: The timed "up and go" test results between the control and experimental group (s).

	Control group (n = 18)			Experimental group (n = 23)		
	Pre	Interim	Post	Pre	Interim	Post
Time	9.19 ± 2.97	8.95 ± 2.81	9.09 ± 2.51	11.19 ± 2.78	$6.40 \pm 2.27^{**}$	$6.92 \pm 1.38^{**}$

Note: $**$ is represented as $P < 0.01$, very significant.

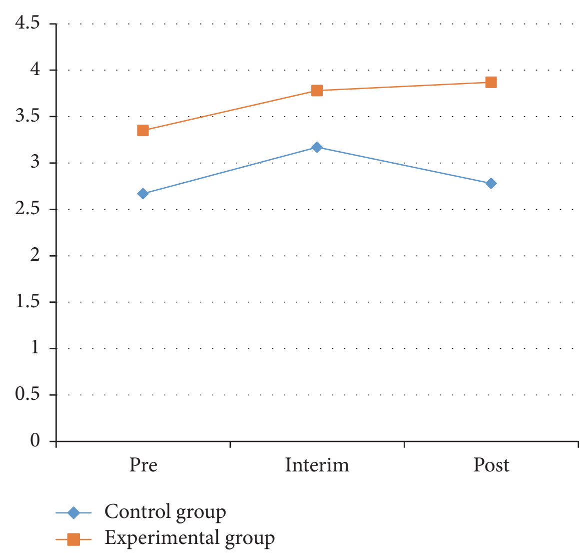


Figure 6: The results of left stability between control and experimental groups.

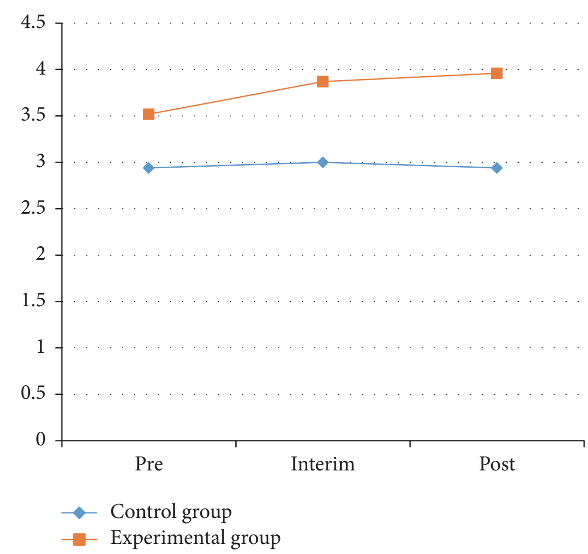


Figure 7: The results of right stability between control and experimental groups.

the interim test and between the pretest and posttest ($P < 0.01$). The TUG test results for the control group showed no significant changes. In the experimental group, the average time went from 11.19 ± 2.78 s before the experiment to 6.92 ± 1.38 s after the experiment.

These data show that the stability of the experimental group had increased significantly. This illustrates that Health Qigong exercise could significantly improve physical coordination and gait in patients with PD.

3.2.2. Physical Stability (9-Holed Instrument) Test to Evaluate Upper Limb Ability. The physical stability (9-holed instrument) test was used to evaluate upper limb ability; the results of the physical stability test for the experimental and control groups are shown in Table 5.

From Table 5 and Figures 6 and 7, the results for the left and right sides of the physical stability test in the experimental and control groups were not statistically significant ($P > 0.05$) between pretest and posttest. The left-side results for the control group at the pretest, interim test, and posttest were 2.67 ± 1.46, 1.86 ± 1.66, and 3.17 ± 2.78, respectively, and were not statistically significant. The right-side results for the control group at the pretest, interim test, and posttest were 2.94 ± 1.83, 3.00 ± 1.78, and 2.94 ± 1.76, respectively, also with no statistical significance.

The left-side results for the experimental group at the pretest, interim test, and posttest were 3.35 ± 1.77, 3.78 ± 2.88, and 3.87 ± 1.89, respectively, and for the right side they were 2.94 ± 1.83, 3.00 ± 1.78, and 2.94 ± 1.76, respectively. None of these results were statistically significant. These results showed that there was no significant effect on the stability of PD patients through Health Qigong exercise.

3.2.3. One-Legged Blind Balance Test to Evaluate Balance. The results of the one-legged blind balance test for the experimental and control groups are shown in Table 6.

As Table 6 and Figures 8 and 9 showed, the left-side results of one-legged blind balance test in the experimental group showed significant differences between the pretest and posttest ($P < 0.05$). The right-side results of the experimental

Table 5: The physical stability results on the right and left sides.

	Control group (n = 18)			Experimental group (n = 23)		
	Pre	Interim	Post	Pre	Interim	Post
Left	2.67 ± 1.46	3.17 ± 1.86	2.78 ± 1.66	3.35 ± 1.77	3.78 ± 2.88	3.87 ± 1.89
Right	2.94 ± 1.83	3.00 ± 1.78	2.94 ± 1.76	3.52 ± 1.83	3.87 ± 1.55	3.96 ± 2.03

Table 6: One-legged blind balance test on the right and left sides (s).

	Control group (n = 18)			Experimental group (n = 23)		
	Pre	Interim	Post	Pre	Interim	Post
Left	7.93 ± 4.40	7.94 ± 4.23	8.25 ± 4.27	7.21 ± 4.51	9.20 ± 5.33	11.13 ± 8.50*
Right	5.42 ± 2.83	5.29 ± 2.99	5.60 ± 2.89	6.93 ± 3.93	9.36 ± 5.44*	9.08 ± 4.19*

Note: ∗ is represented as $P < 0.05$, significant.

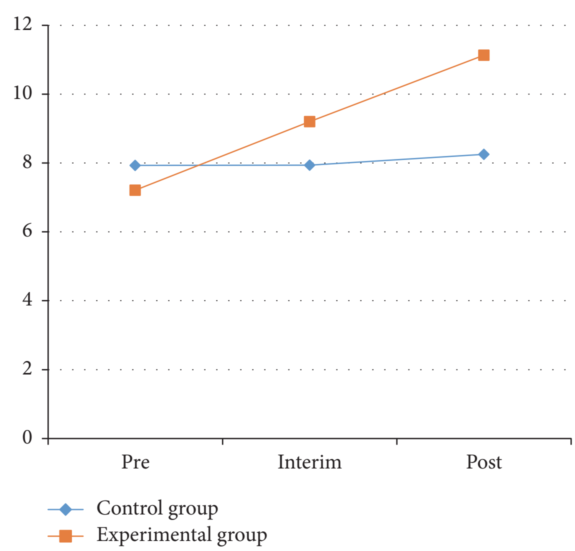


Figure 8: One-legged blind balance test on the left side between control and experimental groups.

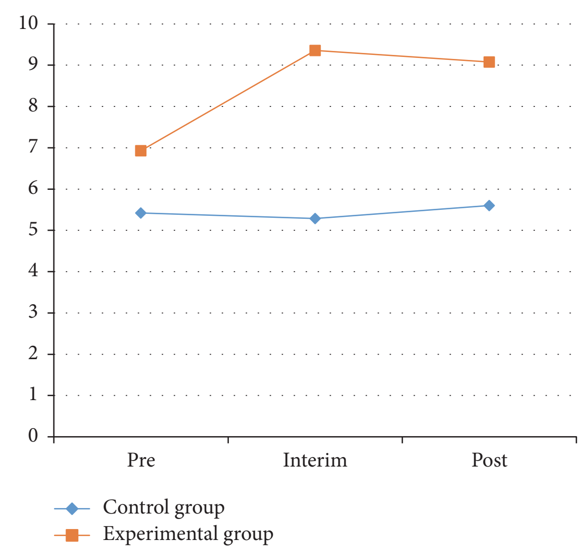


Figure 9: One-legged blind balance eyes test on the right side between control and experimental groups.

group showed significant changes in the process between the pretest and interim test and between the pretest and posttest ($P < 0.05$).

On the left side for the experimental group, the one-legged blind balance test average increased from 7.21 ± 4.51 to 11.13 ± 8.50 s after the experiment. On the right side for the experimental group, the average increased from 6.93 ± 3.93 s before the experiment to 9.08 ± 4.19 s after the experiment. From this data, the ability to stand on one foot had increased significantly for the experimental group. This illustrates that Health Qigong exercise could significantly improve balance in patients with PD.

4. Discussion

The purposes of this study were to investigate the effects of Health Qigong as a treatment on releasing symptoms of Parkinson's disease (PD). To address these purposes, four instruments or tests were used to collect data (muscle hardness, the TUG test, the turn-over-jars test, and one-legged blind balance test), and the results of measurements on muscle hardness, physical coordination, stability, and balance were examined and presented in the previous section. In the following sections, the results shown above will be further discussed item by item.

4.1. Muscle Hardness. An increase in muscle tension leads to a decrease in the range of motion and flexibility in PD patients. Therefore, lowering muscle tension is an essential rehabilitation goal for PD patients. Muscle tension disorder in PD patients may be a result of abnormal exercise, inhibiting cortical systems and reducing incoming sensory integration. PD patients should perform the correct relaxation exercises, rebuild the cortical system, and strengthen motor sensory system functions to lower muscle tension and hardness.

In this experiment, the differences in muscle hardness were statistically significant within various timings. The timings and groups reflected each other, and the timings were different between the experimental and control groups. The muscle hardness of the experimental group tended to decline. In other words, muscle tension in the right and left pronator teres decreased after 10 weeks of Health Qigong exercise; furthermore, the longer the time lasted, the faster the hardness level declined. Therefore, Health Qigong exercise significantly improved the muscle hardness of the pronator teres in PD patients. The longer the time is, the better the effects are.

The explanations of the significant results are as follows: the actions of Health Qigong exercise are slow and soft and the feature is relaxing across the whole process and tensional in special timing. Health Qigong practitioners tried to relax their body during the entire exercise process. In the experiment, Qigong relaxation exercises were included before each session. Patients sat on chairs with a backrest, closed their eyes, and followed the step-by-step suggestions of the coach to relax various parts of their body, eventually achieving full-body relaxation. Health Qigong exercise can increase brain electrical activity and amplitude. The status of Qigong is not between sleep and sanity, instead of a special exciting status. Qigong meditation leads the human cerebral cortex into a special status with a low psychological load and low energy consumption. This status is critical for lowering muscle tension.

4.2. Hand-Eye Coordination (Turn-over-Jars) Test. Hand-eye coordination refers to coordinating vision with subtle hand actions. The nerve cells of PD patients generally drop out. Because most PD patients are elderly or middle-aged, the number of peripheral nerve motor units is declared after they are 60 years old. Physiological aging of the nervous system in PD patients can affect a person's motor functions and intelligence. The aging of the movement-related cerebral cortex, subcortical structures, cerebellum, neurotransmitters, peripheral motor units, and muscles leads to poor hand-eye coordination, increased reaction times, and uncoordinated actions.

Another symptom of PD patients is slowness of movement. The initial manifestation is slowness in daily activities and movements and a prolonged reaction time. It causes slowness in subtle exercises (e.g., buttoning, using tableware, and tying laces). Slowness of movement may appear when standing up, turning over, turning, walking, and writing; walking may be clumsy, and writing may be irregular and becomes smaller when there is more to write.

In this experiment, hand-eye coordination in the experimental group tended to improve, but there were no statistically significant differences. After ten weeks of Health Qigong exercise, right- and left-side hand-eye coordination improved. The reason for the lack of statistical significance may be because the intervention time was too short. Hand-eye coordination tests the brain's ability to control the body and is an expression of neurotransmitter levels. Muscle exercise results can be seen within a short time period, but an improvement in neural functions requires more time. As can be seen from the data after 10 weeks of Health Qigong exercise, hand-eye coordination improved. A longer intervention period may significantly affect the results, because a longer time is required for neurological exercises and to repair muscles. The current results are related to the short intervention time and insignificant improvement.

4.3. TUG Test. Gait disorders are a typical symptom of PD. Patients generally lean forward and flex their elbows, knee joints, and lumbar spine. They walk slowly with small strides, and the walking pace is gradually reduced when the stride is increased during the walking process. An abnormal gait seriously affects the daily life of patients, so it is crucial to assess and correct a patient's gait. The TUG test has been widely used by clinicians to evaluate patients with movement disorders and elderly people's balance and mobility. Research studies have shown good reliability and validity to the TUG test in evaluating movement abilities and balance. As a quick and convenient measuring method, the TUG test is an effective method to quantitatively evaluate the functional ability of walking and has been widely applied to evaluate the balance disorders of patients. This provided the theoretical basis for the present study to use the TUG test to evaluate a patient's movement and balance ability after the Health Qigong intervention. Because the TUG test is simple and easy to conduct, it can easily be used in routine clinical examinations.

In this experiment, TUG test times decreased significantly after the 10-week Health Qigong exercise intervention. Health Qigong exercise thus significantly decreased the TUG testing time of PD patients. Furthermore, Health Qigong exercise can improve gait, stride length, and leg movement abilities. Health Qigong is a traditional Chinese exercise that forms a part of traditional Chinese culture. One of the most popular phrases used by the Chinese is, "Be earnest and down-to-earth." Another health-related slang expression is, "Legs become old before people do"; this means that the first part of aging is in the lower limbs. Hence, Chinese people place an emphasis on the ability of the lower limbs. With aging and increasing occurrences of walking disorders, people naturally feel afraid to fall. For this reason they cannot go out and exercise. At the same time, people reduce communications and diminish contact with the outside world. This causes a vicious circle in which people age more rapidly. Health Qigong exercise can improve the functional movements ability of PD patients and reduce their risk of falls, which is particularly crucial for elderly people.

In most Health Qigong exercise, the leg movements can be seen as closed-chain exercise. Closed-chain exercise is used for maintaining and fixing a correct exercise. It improves the recognition ability of an organism and uses a reference to control movement sustainability. It is superior to chain sports training in correcting underpowered walking in PD patients. Close-chain exercise can also be used to correct missing foot heels and knee extensions. In Health Qigong exercise, when centripetal motion is characterized at the ankle, the strategies of the ankle are used to maintain the center of gravity. An effective response strategy depends on knee, hip, and trunk stability. Ankle response strategies are used to control small, slow swinging motions. The exciting sequence of muscles is from far to near. Ankle response strategies are used to maintain and restore balance in the ankle. When foot support surfaces are narrow and relatively soft, skeletal response strategies become the dominant balancing policy. The exciting sequence of muscles is from near to far. The "beginning of Heaven's creation," bird flying, and other actions use this method to regulate balance. In addition, the actions of Health Qigong exercise such as making a fist, watching angrily, and saving the breath can strengthen core muscles to control closed-chain exercise, increase joint stress, and improve input to the trunk and lower-limb joint proprioception. All of this enhances the movement performance of patients in completing the TUG test.

4.4. One-Legged Blind Balance Test. Balance as a basic indicator has always been an essential aspect of physical testing, because the one-legged blind balance test is simple to operate, has a low coefficient of difficulty, is sensitive to age, and is suitable for large-scale test groups. It has been used as a balance assessment method since the last century. This method reflects the ability to balance by measuring the time taken to maintain the body's center of gravity on a single support surface when there are no visual references and relies solely on sensory organs such as the vestibular system and the coordination of muscles.

Research has shown that the aptitude of elderly people to fall is related to a deterioration of the equilibrium function, which can be delayed by physical exercise. Sports suitable for elderly people are mainly soft and slow exercises. Health Qigong, namely, Dao Yin Yang Sheng Gong in the traditional Chinese regimen, is easy to learn and can produce prominent effects. Stressing the integration of the mind, air, and body, Health Qigong is soft and slow with smooth, moderate, calm, and steady motions. When performing Health Qigong, you flex and extend, promote and demote, open and close your limbs and torso, adjust your breathing to your movements, and try to remain balanced when constantly shifting the center of gravity. As a result, the tendons and vessels throughout the body are stretched and pulled, and the main and collateral channels are dredged. Therefore, Health Qigong is an ideal sport for elderly people to improve their balance.

Health Qigong requires that practitioners maintain the gravity of the body, distinguish the true from the false, and move softly and slowly. It relies on the lumbar spinal axis to move limbs up and down, successively acting throughout each motion. Health Qigong requires no intermittent stops during the change of true or fictional actions and the transformation of gestures. It looks like flying clouds, running water, and the silkworm spinning in harmony. Senior citizens, when practicing Health Qigong, should focus more on movement accuracy in body position, arms angle, and direction and whole body coordination.

With this style, practitioners can develop the strength of the lower body muscle, stretch the thenar muscle and ligament, and improve their balance ability. Health Qigong requires symmetrical movement on the left and right sides, to stimulate the left and right brain for improved control and coordination. It is conducive to enhancing the sensitivity of the Parkinson's sense of identity awareness and the integrated processing ability of the nerve system. This is why Health Qigong exercise can have a positive influence on balance functions in patients with PD.

Health Qigong should be adjusted to the needs of each Parkinson's patient, which means that the exercise load, difficulty of movements, movement time, and frequency must be customized step by step. At the same time, Health Qigong is specially fitted with the movement of Parkinson's patients in terms of difficulty and security. It should be popularized among PD patients to increase their strength and coordination and to maintain and promote their balance ability.

In the training process of Health Qigong exercise, the body's center of gravity is constantly moving and changing directions with the upper limb movements. This effective antigravity dynamic can improve the control ability of the body to focus on the supporting surface and improve postural stability. An anticipated decrease in postural control occurs in PD patients; sometimes it may even be lost. When learning, experience and sensory input are received and muscles of the trunk and lower limbs are activated, generating expectations of stable control. The bridge reticulospinal tract in the pathway and the corticospinal reticulospinal tract are activated. First is to complete postural control and then improve postural control disorders such as propulsion. Anatomical and pathological studies of PD patients show that the disease is primarily caused by a reducing synthesis of dopamine and role of acetylcholine exciting enhancement and then there are paralysis tremors. The reduction in dopamine and the globus pallidus actively destroy the network of the central nervous system, affecting exercise cooperative movements, muscle tension, and stiffness. It is shown in agonist and antagonist muscle coordination disorder which is a major problem in starting movements, increased tremors, and muscle tension. Participating in the integration of postural control information, the basal ganglia have a close relationship with the cerebellum. They affect the automatic postural reflex, include the strategies of the hip, ankle, and stepping reflexes, and control postural control in a smooth and coordinated motion. When the basal ganglia are damaged or functional communication is disturbed, rigidity, bradykinesia, akinesia, and static or intentional tremors occur.

In this experiment, the left balance ability of the experimental group improved in comparison to the right; it first increased before returning to a downward trend, but with an overall rise. This shows that after 10 weeks of Health Qigong exercise, the ability of balance in PD patients increased, but it was not significant. This may be related to the short intervention time of only 10 weeks. The testing environment also affected the test results; for example, in the one-legged blind balance test, surrounding words and actions will directly affect balance control, so control is crucial.

5. Conclusion

Areas of Improvement. After the 10 weeks of Health Qigong exercise, the experiment compared muscle hardness on the left and right sides of the round pronator muscle, hand-eye coordination on the left and right sides, stability on the left and right sides, TUG test results on the left and right sides, and the time of one-legged blind balance test on the left and right sides. It was found that Health Qigong exercise could significantly improve PD patients' muscle hardness, functional walking capacity, hand-eye coordination, stability, and balance. However, there were no significant differences in stability. That means Health Qigong exercises can improve body functions in PD patients with early or middle stages of PD. Researchers believe 10 weeks is too short of a time period. If patients continue the exercise program for a longer time, the effects on PD will be more significant.

Effectiveness of Qigong on PD Patients. Qigong is a natural way to keep fit, drawing on the classical philosophy of the Yin-Yang theory and basic theories of traditional Chinese medicine regarding channels and collaterals, guidance, and breathing; the movements are perfect for patients with PD because they are simple, easy to learn, and strengthening and of low cost. Health Qigong can be promoted as a part of exercise rehabilitation therapy for PD that can reduce medical costs. It is significant to carry on their traditional Chinese mind and body exercise as a treatment for many chronic diseases. From a general survey of the experimental process, the success of the experiment is evident not only from the test data, but also from the positive feedback of the participants.

Specially Designed Health Qigong Program Is Feasible and Suitable for PD. The ten Health Qigong movements targeted at Parkinson's symptoms and movement patterns were selelcted and compiled as the 10-movement Health Qigong Program. The 10-movement HQ program matches the characteristics of PD condition based on the nature of these movements. The 10 movements' program was examined and evaluated by the distinguished Health Qigong experts, who analyzed the feasibility and potential effectiveness of the 10 movements in relieving the symptoms of PD, and was confirmed by the five experts as a suitable exercise program for PD patients. The results of this study have supported the effectiveness of this Health Qigong program and its feasibility as well.

Implications for Further Study. Many elderlies related epidemic diseases are rapidly spreading, involving a wider field and increasingly younger ages. Traditional Chinese health movements, including guided operations, Health Qigong exercise, and Tai Chi, have a long historical background with rich cultural connotations. They further have the features of being simple, easy to learn, easy to practice, secure, and obviously effective and of low cost. These features should allow for increasing numbers of people to understand, learn, and participate in their practice. Illnesses are eased while reducing the rate of sickness. Currently, the reasons people do not practice traditional Chinese movements such as Health Qigong are because it proposes high request on the professor who needs expertise and practice experience; otherwise the effect will be reduced. Although this experiment has been completed, the Health Qigong used as a treatment for PD patients is just starting. We committed to improving, mitigating, and treating Parkinson's syndrome, and we continue to strive to study traditional Chinese principles and effects, to further explore the treatment of PD, and to explore solutions of relieving its symptoms.

The Limitations of the Study. The experiment environment was not well controlled because of the hospital location, and there is not a separated room for the experiment, and the participants' attention and their performance might be influenced, especially the movements that need concentration. The electronic instruments sometimes went wrong and increased the testing time, which might influence participants' patience. Although we have three Qigong specialists to be responsible for the quality control (two will be the instructors and one will be supervisor during practice), more supervisors might be needed to correct participants' movement to make sure their postures are correct. The large-scale experiment with more PD patients, more scientific instruments, and better practice environment is recommended in the future.

Competing Interests

The authors declare that they have no competing interests.

References

[1] W. S. Weintraub, J. A. Spertus, P. Kolm et al., "Effect of PCI on quality of life in patients with stable coronary disease," *The New England Journal of Medicine*, vol. 359, no. 7, pp. 677–687, 2008.

[2] M. E. McNeely, R. P. Duncan, and G. M. Earhart, "Medication improves balance and complex gait performance in Parkinson disease," *Gait and Posture*, vol. 36, no. 1, pp. 144–148, 2012.

[3] N. T. Filippin, P. H. Lobo da Costa, and R. Mattioli, "Effects of treadmill-walking training with additional body load on quality of life in subjects with Parkinson's disease," *Revista Brasileira de Fisioterapia*, vol. 14, no. 4, pp. 344–350, 2010.

[4] G. M. Earhart and A. J. Williams, "Treadmill training for individuals with Parkinson disease," *Physical Therapy*, vol. 92, no. 7, pp. 893–897, 2012.

[5] P. Borrione, E. Tranchita, P. Sansone, and A. Parisi, "Effects of physical Activity in Parkinson's disease: a new tool for rehabilitation," *World Journal of Methodology*, vol. 4, no. 3, pp. 133–143, 2014.

[6] J. F. Liu, "Movement therapy improves Parkinson's disease dyskinesia effectiveness analysis," *Chinese Journal of Trauma and Disability Medicine*, vol. 11, pp. 317–318, 2013.

[7] V. A. Goodwin, S. H. Richards, R. S. Taylor, A. H. Taylor, and J. L. Campbell, "The effectiveness of exercise interventions for people with Parkinson's disease: a systematic review and meta-analysis," *Movement Disorders*, vol. 23, no. 5, pp. 631–640, 2008.

[8] B. H. Wood, J. A. Bilclough, A. Bowron, and R. W. Walker, "Incidence and prediction of falls in Parkinson's disease: a prospective multidisciplinary study," *Journal of Neurology Neurosurgery and Psychiatry*, vol. 72, no. 6, pp. 721–725, 2002.

[9] T. A. Boonstra, H. Van Der Kooij, M. Munneke, and B. R. Bloem, "Gait disorders and balance disturbances in Parkinson's disease: clinical update and pathophysiology," *Current Opinion in Neurology*, vol. 21, no. 4, pp. 461–471, 2008.

[10] C. W. Olanow and W. C. Koller, "An algorithm (decision tree) for the management of Parkinson's disease: treatment guidelines," *Neurology*, vol. 50, no. 3, supplement 3, pp. S1–57, 1998.

[11] A. D. Speelman, J. T. Groothuis, M. Van Nimwegen et al., "Cardiovascular responses during a submaximal exercise test in patients with Parkinson's disease," *Journal of Parkinson's Disease*, vol. 2, no. 3, pp. 241–247, 2012.

[12] M. Schenkman, T. M. Cutson, M. Kuchibhatla et al., "Exercise to improve spinal flexibility and function for people with Parkinson's disease: a randomized, controlled trial," *Journal of the American Geriatrics Society*, vol. 46, no. 10, pp. 1207–1216, 1998.

[13] S. Hunot and E. C. Hirsch, "Neuroinflammatory processes in Parkinson's disease," *Annals of Neurology*, vol. 53, supplement 3, pp. S49–S60, 2003.

[14] L. E. Dibble, T. F. Hale, R. L. Marcus, J. Droge, J. P. Gerber, and P. C. LaStayo, "High-intensity resistance training amplifies muscle hypertrophy and functional gains in persons with parkinson's disease," *Movement Disorders*, vol. 21, no. 9, pp. 1444–1452, 2006.

[15] J. M. Hausdorff, J. Lowenthal, T. Herman, L. Gruendlinger, C. Peretz, and N. Giladi, "Rhythmic auditory stimulation modulates gait variability in Parkinson's disease," *European Journal of Neuroscience*, vol. 26, no. 8, pp. 2369–2375, 2007.

[16] A. Nieuwboer, G. Kwakkel, L. Rochester et al., "Cueing training in the home improves gait-related mobility in Parkinson's disease: the RESCUE trial," *Journal of Neurology, Neurosurgery and Psychiatry*, vol. 78, no. 2, pp. 134–140, 2007.

[17] F. Rodrigues de Paula, L. F. Teixeira-Salmela, C. D. Coelho de Morais Faria, P. Rocha de Brito, and F. Cardoso, "Impact of an exercise program on physical, emotional, and social aspects of quality of life of individuals with Parkinson's disease," *Movement Disorders*, vol. 21, no. 8, pp. 1073–1077, 2006.

[18] S. Muhlack, J. Welnic, D. Woitalla, and T. Müller, "Exercise improves efficacy of levodopa in patients with Parkinson's disease," *Movement Disorders*, vol. 22, no. 3, pp. 427–430, 2007.

[19] R. M. Camicioli, J. R. Korzan, S. L. Foster et al., "Posterior cingulate metabolic changes occur in Parkinson's disease patients without dementia," *Neuroscience Letters*, vol. 354, no. 3, pp. 177–180, 2004.

[20] K. Pothakos, M. J. Kurz, and Y.-S. Lau, "Restorative effect of endurance exercise on behavioral deficits in the chronic mouse model of Parkinson's disease with severe neurodegeneration," *BMC Neuroscience*, vol. 10, article 6, 2009.

[21] O. Oguh, A. Eisenstein, M. Kwasny, and T. Simuni, "Back to the basics: regular exercise matters in Parkinson's disease: results from the National Parkinson Foundation QII Registry study," *Parkinsonism & Related Disorders*, vol. 20, no. 11, pp. 1221–1225, 2014.

[22] L. T. B. Gobbi, M. D. T. Oliveira-Ferreira, M. J. D. Caetano et al., "Exercise programs improve mobility and balance in people with Parkinson's disease," *Parkinsonism & Related Disorders*, vol. 15, no. 3, pp. S49–S52, 2009.

[23] L. M. Inkster, J. J. Eng, D. L. MacIntyre, and A. Jon Stoessl, "Leg muscle strength is reduced in Parkinson's disease and relates to the ability to rise from a chair," *Movement Disorders*, vol. 18, no. 2, pp. 157–162, 2003.

[24] M. Nallegowda, U. Singh, G. Handa et al., "Role of sensory input and muscle strength in maintenance of balance, gait, and posture in Parkinson's disease: a pilot study," *American Journal of Physical Medicine and Rehabilitation*, vol. 83, no. 12, pp. 898–908, 2004.

[25] M. Y. C. Pang and M. K. Y. Mak, "Muscle strength is significantly associated with hip bone mineral density in women with Parkinson's disease: A Cross-Sectional Study," *Journal of Rehabilitation Medicine*, vol. 41, no. 4, pp. 223–230, 2009.

[26] L. O. Lima, A. Scianni, and F. Rodrigues-de-Paula, "Progressive resistance exercise improves strength and physical performance in people with mild to moderate Parkinson's disease: a systematic review," *Journal of Physiotherapy*, vol. 59, no. 1, pp. 7–13, 2013.

[27] M. J. Hove, K. Suzuki, H. Uchitomi, S. Orimo, and Y. Miyake, "Interactive rhythmic auditory stimulation reinstates natural 1/f timing in gait of parkinson's patients," *PLoS ONE*, vol. 7, no. 3, Article ID e32600, 2012.

[28] C. Lan, S. Y. Chen, and J. S. Lai, "The exercise intensity of Tai Chi Chuan," *Medicine and Sport Science*, vol. 52, pp. 12–19, 2008.

[29] C. Aurora, P. Jacquelyn, B. Katelyn, and N. Rhonda, "The effects of Tai Chi on physical functioning in older adults with Parkinson's disease," *Herapeutic Recreation Journal*, vol. 4, no. 91, pp. 80–83, 2015.

[30] X. M. Zhang and H. B. Chen, "The effects of Tai Chi for Parkinson's disease rehabilitation," *Spring Breeze*, vol. 10, article 27, 2014.

[31] C.-W. Wang, S.-M. Ng, R. T. H. Ho, E. T. C. Ziea, V. C. W. Wong, and C. L. W. Chan, "The effect of qigong exercise on immunity and infections: a systematic review of controlled trials," *The American Journal of Chinese Medicine*, vol. 40, no. 6, pp. 1143–1156, 2012.

[32] H. W. H. Tsang, L. Cheung, and D. C. C. Lak, "Qigong as a psychosocial intervention for depressed elderly with chronic physical illnesses," *International Journal of Geriatric Psychiatry*, vol. 17, no. 12, pp. 1146–1154, 2002.

[33] M. E. Morris, "Locomotor training in people with Parkinson disease," *Physical Therapy*, vol. 86, no. 10, pp. 1426–1435, 2006.

[34] X. Liu, Y. D. Miller, N. W. Burton, and W. J. Brown, "A preliminary study of the effects of Tai Chi and Qigong medical exercise on indicators of metabolic syndrome, glycaemic control, health-related quality of life, and psychological health in adults with elevated blood glucose," *British Journal of Sports Medicine*, vol. 44, no. 10, pp. 704–709, 2008.

[35] C. Wang, J. P. Collet, and J. Lau, "The effect of Tai Chi on health outcomes in patients with chronic conditions: a systematic review," *Archives of Internal Medicine*, vol. 164, no. 5, pp. 493–501, 2004.

[36] P. Jin, "Efficacy of Tai Chi, brisk walking, meditation, and reading in reducing mental and emotional stress," *Journal of Psychosomatic Research*, vol. 36, no. 4, pp. 361–370, 1992.

Hindawi Publishing Corporation
Evidence-Based Complementary and Alternative Medicine
Volume 2016, Article ID 6016532, 10 pages
http://dx.doi.org/10.1155/2016/6016532

Review Article

The Effects of Yoga on Pain, Mobility, and Quality of Life in Patients with Knee Osteoarthritis: A Systematic Review

Laidi Kan,[1,2] Jiaqi Zhang,[3] Yonghong Yang,[1,2,4] and Pu Wang[1,2,4]

[1] *Rehabilitation Medicine Center, West China Hospital of Sichuan University, Chengdu, China*
[2] *West China School of Medicine, Sichuan University, Chengdu, China*
[3] *Department of Surgery, Faculty of Medicine, The Chinese University of Hong Kong, Shatin, Hong Kong*
[4] *Key Laboratory of Rehabilitation Medicine in Sichuan, Chengdu, China*

Correspondence should be addressed to Pu Wang; wangpu0816@qq.com

Received 4 June 2016; Revised 24 August 2016; Accepted 28 August 2016

Academic Editor: Yi Yang

Objective. To systematically assess the effects of yoga on pain, mobility, and quality of life in patients with knee osteoarthritis. *Methods.* Pubmed, Medline, EMBASE, the Cochrane Central Register of Controlled Trials, Physiotherapy Evidence Database (PEDro), and other sources were searched systematically in this study. Two reviewers identified eligible studies and extracted data independently. Downs and Black's Quality Index were used to evaluate the methodological quality of the included studies. *Results.* A total of 9 articles (6 studies) involving 372 patients with knee osteoarthritis met the inclusion criteria. The most common yoga protocol is 40~90 minutes/session, lasting for at least 8 weeks. The effect of yoga on pain relief and function improvement could be seen after two-week intervention. *Conclusion.* This systematic review showed that yoga might have positive effects in relieving pain and mobility on patients with KOA, but the effects on quality of life (QOL) are unclear. Besides, more outcome measure related to mental health of yoga effects on people with KOA should be conducted.

1. Introduction

Knee osteoarthritis (KOA) is a degenerative knee disease associated with pain, swelling, stiffness, limited ambulation, and declined balance function [1]. It has been believed that chondrocytes undergo premature aging, which called "stress-induced senescent state" that is the reason for cartilage degeneration [2]. The inflammatory processes, the reduction of lubricin levels, and also the impairments of the synovial fluid lubricating ability, which are closely related to the development of osteoarthritis have also been believed [3]. It is a wear-and-tear arthritis result from the repetitive stress injuries of the joint and sometimes physical damage can make things worse [1, 4]; however, according to the Osteoarthritis Research International (OARSI) guidelines for the nonsurgical management of KOA, exercise was recommended to improve the function and activities participation of people with KOA [5]. The mechanism behind this phenomena may be that physical activity can limit the ameliorating cartilage degeneration by contributing more lubricin expression and decrease the deleterious effects of chondrocyte senescence [6]. In this condition, choosing an appropriate exercise modality is one of the biggest challenges on the field of rehabilitation.

The primary component of exercise training focuses on improving muscles strength; however the balance deficits and stress management are often overlooked [7], which are also other two important factors that affect the mobility of KOA patients. Yoga, as an interesting exercise modality, not only has been proved to have positive effects on physical building [8] but also could give the practitioner a union over their mind, body, and spirit [9, 10], which means yoga may have effects on mental health. The benefits of yoga have been explored in different population [11], including stroke, chronic obstructive pulmonary disease (COPD), and heart disease [8, 12, 13], which prove that yoga may have effect on mood, balance, exercise capacity, and lung function. Besides, yoga has also been used to relieve pain in those with rheumatoid arthritis and chronic low back pain [14, 15]. Some studies have explored the effects of yoga in people with KOA, but no systematic review has stressed that. We conducted this systematic review intentioned to summarize the available evidences on the effect of yoga on people with KOA.

2. Methods

2.1. Database Sources and Search Strategy. Relevant articles were identified using the following databases: Medline (1966 to Jul 2015; via Ovid), EMBASE (1980 to Jul 2015; via Ovid), the Cochrane Central Register of Controlled Trials (CENTRAL) (The Cochrane Library, Issue 7 of 12 Jul 2015), Pubmed (1966 to Jul 2015), and Physiotherapy Evidence Database (PEDro) (1929 to Jul 2015; via website). Key words included osteoarthritis, knee, yoga, randomized controlled trial, trial, pain, mobility, balance, symptoms, and quality of life. The last search was conducted on December 6, 2015.

2.2. Selection Criteria. Articles were considered included when they met the following criteria: (1) studies were published in English; (2) the patients had clear diagnostic criteria of KOA; (3) the intervention type of experimental group is yoga. Articles were excluded if they were (1) patients diagnosed with secondary KOA; (2) animal studies; (3) published as conference processing.

2.3. Data Extraction and Quality Assessment. The following pieces of information were extracted from each article: the demographic characteristic of patients, type of study, description of both experimental and control interventions, duration of trial period, and outcome measure. Two authors independently extracted the date and disagreement was resolved by discussion with the third author.

The methodological quality was assessed using the Downs and Black's Quality Index which has well-established validity for both randomized and nonrandomized studies [25]. The Downs and Black's Quality Index has five subscales: (1) clear description of some characteristic; (2) external validity; (3) internal validity; (4) selection bias; and (5) power, which consists of 27 items. The item in power scored 0 to 5 and one item in description scored 0 to 2, and the other items scored 0 or 1; the total score was 32 points. A score of 23 or higher indicates good-quality article with low risk of bias, a score between 22 and 13 indicates medium-quality article with moderate risk of bias, and a score of 12 or lower represents a poor-quality article with high risk of bias. Two reviewers independently assess the quality of article and the disagreements were resolved by the discussion.

3. Results

3.1. Study Selection. We obtained 71 articles initially, of which 13 articles were excluded for duplication and 47 records were excluded after reading the title and abstracts. After in-depth screening of the remaining 11 articles, two studies were eliminated owing to unpublished conference reports [26, 27]. Finally, 9 articles (6 studies) were selected in this review (Figure 1). Six articles (three RCTs) [16–19, 22, 23], one quasi-RCT [24], and two single group pre-post studies [20, 21] were included.

3.2. Participants. The characteristics of 9 (6 studies) articles are given in Table 1. In all studies, 372 subjects were involved; the number of participants in intervention and control group ranged from 11 to 125. The duration of KOA ware required at least 6 months in three studies [19, 23, 24]; only one study had clear description about the duration of KOA [16]. Although the KOA duration of subjects in other two studies has no clear description, they showed consequence in certain symptoms, for example, pain [21, 22]. The mean age of subjects varied from 51 to 71 years. The subjects gender of four studies was all females [19–21, 24]; in one study, the number of males was about half of the females [16], and in other studies the number of males was almost equal to that of females [23].

3.3. Quality Assessment. The consequence of quality assessment about the 9 articles (6 studies) is present in Table 2. In view of their score, one of them is considered as good-quality trials (Downs and Black's Quality Index of 23 or higher) [19], seven of them are medium-quality articles (Downs and Black's Quality Index between 22 and 13) [16–18, 20–22, 24], and one trial was poor-quality article (Downs and Black's Quality Index of 12 or lower) [23].

3.4. Intervention Characteristics. Among included studies, three of them had control group which does conventional exercise during the experimental time [16, 19, 24], but the control group does yoga exercise similar to yoga group after 8 weeks in one study [19]. In another study, both groups were treated with EMG biofeedback, knee muscle strengthening exercises, and Transcutaneous Electrical Nerve Stimulation (TENS), and the yoga group received additionally Iyengar yoga [23]. Two other studies did not have control group [20, 21].

The yoga group received yoga exercise for 8 weeks in three studies [20, 23, 24]. The experiment time is 20 weeks in one study, but the comparison between two groups just took 8 weeks [19]. 12-week yoga exercise was applied in other two studies [16, 21]. Almost every study had 3-4 sessions per week with each session varying from 60 to 90 minutes. The type of yoga practice in three studies all consisted of *asana* (movement), *pranayama* (breathing), and *meditation* (relaxation) [16, 19, 24], and the type of yoga practiced in other two studies just had *asana* (movement) [20, 23]; the last study did not mention the yoga type but described the subjects posture when doing yoga exercise [21].

4. Outcomes

4.1. Pain. Two outcome measurements were used to test the pain change in five studies [19–21, 23, 24].

4.1.1. Western Ontario and McMaster Universities OA Index Scale (LK Scale 3.1) (WOMAC). Two studies used WOMAC

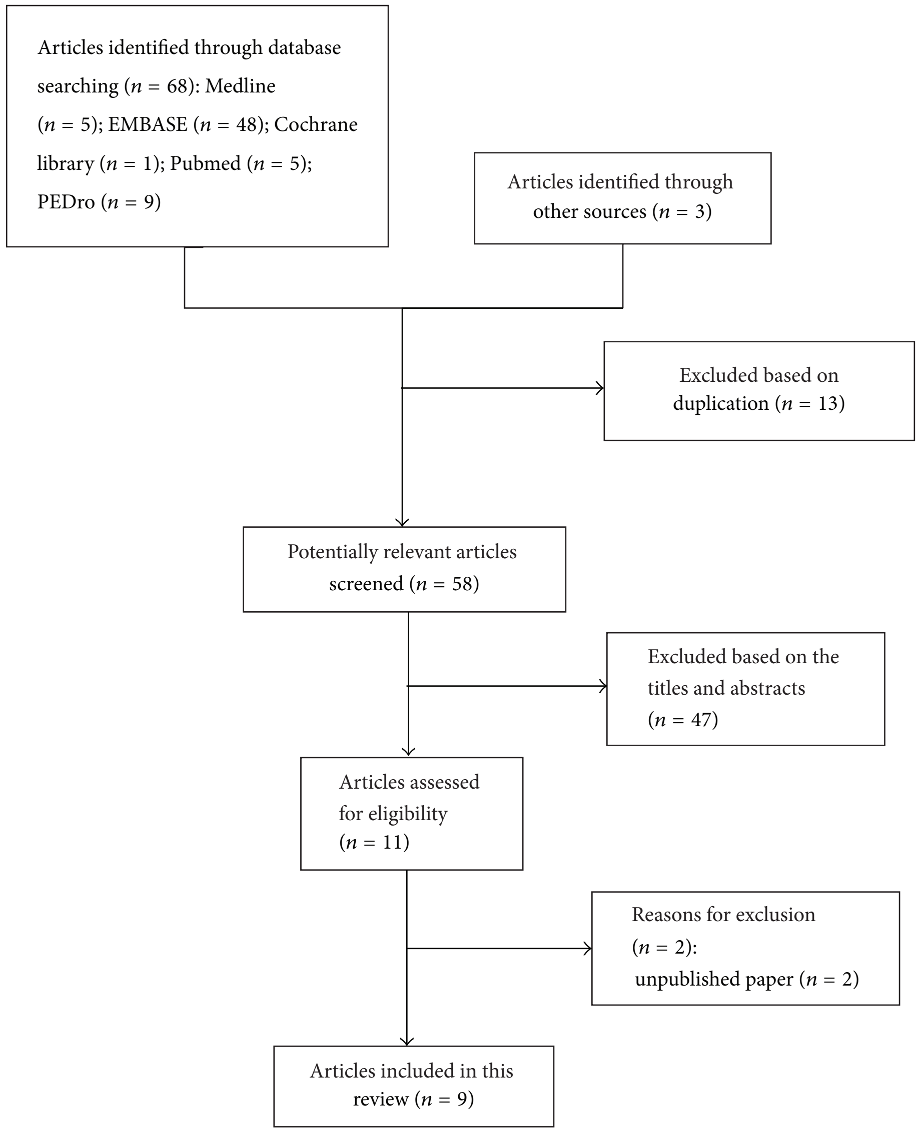


Figure 1: Search strategy and flow chart for this review.

as an outcome measure to assess the effects of yoga exercise on pain relief for people with KOA [19, 20]. In Kolasinski et al., the pre- and postintervention scores had significantly improved in pain after 8 weeks of yoga exercise. In Cheung et al. [19], the between-group differences at 8 weeks were significant for pain. There was significant difference in pain in both 4 to 8 weeks' yoga group and 4 to 20 weeks' yoga group [19].

4.1.2. Visual Analog Scale (VAS). Four studies used VAS assessed pain in people with KOA [16, 21, 23, 24]. In Ebnezar et al. [16], there was a significant difference in pain both within ($p < 0.001$) and between groups ($p < 0.001$) after the 3-month yoga intervention combined with physiotherapy with higher effect size in the yoga group than in the control group (therapeutic exercise with physiotherapy). In Nambi and Shah, yoga group showed a more reduced VAS (56.83%) than control group (38.15%) after 8 weeks of intervention. And the pre- and postintervention ratings of VAS score showed a statistically significant reduction of pain intensity in yoga group compared with control group ($p < 0.05$) [23]. In Brenneman et al. [21], the pre- and postintervention scores had a significant improvement in pain after 12 weeks of yoga-based exercise, and in Ghasemi et al. [24] no significant differences were detected in pain between the 8-week yoga group and the control group (home-based activities); however, the pre-post scores showed a significant difference in the yoga group but not in the control group.

4.2. Mobility. Three studies assessed mobility in many ways [16, 20]. In Ebnezar et al. [16], there was a significant difference in walking time within ($p < 0.001$) and between

Table 1: Characteristics of included studies in this review.

(a)

Study	Study design	Number of Participants	Analyzed number of participants	Duration of KOA (yrs)	Age of the participants (mean ± SD)	Gender (F/M)
Ebnezar et al., 2012 [16]	RCT	Y/C = 125/125	Y/C = 118/117	<1 yr/1-2 yrs/>2 yrs = 121/79/50	Y/C = 59.56 ± 9.54/59.42 ± 10.66	174/76
Ebnezar et al., 2012 [17]	RCT	Y/C = 125/125	Y/C = 118/117	<1 yr/1-2 yrs/>2 yrs = 121/79/50	Y/C = 59.56 ± 8.18/59.42 ± 10.66	174/76
Ebnezar and Yogitha, 2012 [18]	RCT	Y/C = 125/125	Y/C = 118/117	Unclear	Y/C = 59.6 ± 8.2/59.4 ± 10.7	Unclear
Cheung et al., 2014 [19]	RCT	Y/C = 18/18	Y/C = 18/18	At least 6 months	Y/C = 71.9 ± 2.7/71.9 ± 3.1	All females
Kolasinski et al., 2005 [20]	Single group pre-post study	Y = 11	Y = 7	At least 6 months	Y = 58.6 ± 8.6	All females
Brenneman et al., 2015 [21]	Single group pre-post study	Y = 45	Y = 39	Unclear	Y = 60.3 ± 6.5	All females
Ebnezar et al., 2012 [22]	RCT	Y/C = 125/125	Y/C = 118/117	<1 yr/1-2 yrs/>2 yrs = 121/79/50	Y/C = 59.6 ± 8.2/59.4 ± 10.7	174/76
Nambi and Shah, 2013 [23]	RCT	Y/C = 15/15	Y/C = 15/15	At least 6 months	Y/C = 52 ± 5/54 ± 4	13/17
Ghasemi et al., 2013 [24]	Quasi-RCT	Y/C = 15/15	Y/C = 11/14	Unclear	Y/C = 51 ± 8.9/53.11 ± 10.9	All females

(b)

Study	Comparison Intervention	Intervention of control group	Intervention of yoga group	Yoga therapy practice	Main outcomes	Time point
Ebnezar et al., 2012 [16]	Yoga + PT versus PT	PT (20 minutes/day/2 weeks) Practices (40 minutes/day) Home practice (12 weeks) Compliance (once/3 days) Weekly review (once/week/12 weeks)	PT (20 minutes/day/2 weeks) Integrated yoga therapy (40 minutes/day/2 weeks) Integrated yoga therapy (40 minutes/day/10 weeks)	Yogic sukshma vyayamas Relaxation techniques Asanas (physical postures) Pranayama Meditation Lectures and counseling	Walking pain Walking time (50 m) WOMAC Sign: active range of movements Sign: tenderness Sign: swelling Sign: crepitus	14 weeks
Ebnezar et al., 2012 [17]	Yoga + PT versus PT	PT (20 minutes/day/2 weeks) Practices (40 minutes/day; 6 days/week) Home practice (12 weeks) Compliance (once/3 days) Weekly review (once/week/12 weeks)	PT (20 minutes/day/2 weeks) Integrated yoga therapy (40 minutes/day/2 weeks) Integrated yoga therapy (40 minutes/day/10 weeks)	Yogic sukshma vyayamas Relaxation techniques Asanas (physical postures) Pranayama Meditation Lectures and counseling	QOL (SF-36)	14 weeks

(b) Continued.

Study	Comparison Intervention	Intervention of control group	Intervention of yoga group	Yoga therapy practice	Main outcomes	Time point
Ebnezar and Yogitha, 2012 [18]	Yoga + PT versus PT	PT (20 minutes/day/2 weeks) Practices (40 minutes/day) Home practice (12 weeks) Compliance (once/3 days) Weekly review (once/week/12 weeks)	PT (20 minutes/day/2 weeks) Integrated yoga therapy (40 minutes/day/2 weeks) Integrated yoga therapy (40 minutes/day/10 weeks)	Yogic sukshma vyayamas Relaxation techniques Asanas (physical postures) Pranayama Meditation Lectures and counseling	Walking pain WOMAC Sign: tenderness Sign: early morning stiffness	14 weeks
Cheung et al., 2014 [19]	Yoga versus Usual care (8 weeks) Preyoga intervention versus postyoga intervention (8 weeks–20 weeks)	Another program (8 weeks) Hatha yoga intervention (8–20 weeks)	Hatha yoga (60 minutes/week/8 weeks) Home practice yoga (30 minutes/time; 4 times/week)	Asanas Pranas Meditation	WOMAC SPPB PSQI QOL (SF-12 & Cantril Self-Anchoring Ladder)	20 weeks
Kolasinski et al., 2005 [20]	Yoga versus control (no specific exercise)		Modified Iyengar yoga (90-minute classes/week/8 weeks)	Asanas	WOMAC AIMS2 GA Psychological subsets Physician Global Assessment 50-foot walk time	8 weeks
Brenneman et al., 2015 [21]	Yoga versus control (no specific exercise)		Yoga (60 minutes/sessions/3 sessions/week/12 weeks)	Unclear	VAS KOOS Fitness and peak KAM Strength Mobility performance	12 weeks
Ebnezar et al., 2012 [22]	Yoga + PT versus PT	PT (20 minutes/day/2 weeks) Practices (40 minutes/day) Home practice (12 weeks) Compliance (once/3 days) Weekly review (once/week/12 weeks)	PT (20 minutes/day/2 weeks) Integrated yoga therapy (40 minutes/day/2 weeks) Integrated yoga therapy (40 minutes/day/10 weeks)	Yogic sukshma vyayamas Relaxation techniques Asanas (physical postures) Pranayama Meditation Lectures and Counseling	Anxiety scores Resting pain Sign: early morning stiffness	14 weeks
Nambi and Shah, 2013 [23]	Yoga + EMG biofeedback + Knee strengthening exercise + TENS versus EMG biofeedback + Knee strengthening exercise + TENS	EMG biofeedback (3 times/week/8 weeks) Knee strengthening exercise (3 times/week/8 weeks) TENS (20 minutes/time/3 times/week)	Iyengar yoga (90 minutes/session, 3 times/week/8 weeks) EMG biofeedback (3 times/week/8 weeks) Knee strengthening exercise (3 times/week/8 weeks) TENS (20 minutes/time/3 times/week)	Asanas	VAS WOMAC	8 weeks

(b) Continued.

Study	Comparison Intervention	Intervention of control group	Intervention of yoga group	Yoga therapy practice	Main outcomes	Time point
Ghasemi et al., 2013 [24]	Yoga versus ordinary daily activities	Ordinary daily activities	Hatha yoga (60 minutes/session, 3 times/week/8 weeks)	*Asana* (movement) *Pranayama* (breathing) Meditation (relaxation)	VAS KOOS	8 weeks

WOMAC: Western Ontario and McMaster Universities Osteoarthritis Index (lower scores = better state); SPPB: Short Physical Performance Battery (higher scores = better state); QOS: quality of sleep; QOL: quality of life; PSQI: Pittsburgh Sleep Quality Index (lower scores = better state); SF-12: Health Related Short Form 12 (higher scores = better state); PCS: physical component summary; MCS: mental component summary; Cantril current and 5 years (higher scores = better state); AIMS2: Arthritis Impact Measurement Scale 2; GA: Global Assessment; ADL: Activities of Daily Life; VAS: Visual Analog Scale; KOOS: Knee Injury and Osteoarthritis Outcome Scale; KAM: knee adduction moment; PT: physiotherapy; EMG: electromyography.

the groups ($p < 0.001$) after 12 weeks of intervention with higher effect size in the yoga than in the control group. But in Kolasinski et al. [20], the 50-foot walk time was unchanged after 8 weeks of yoga exercise. In Brenneman et al. [21], a Six-Minute Walk Test (6MWT), a 30-second chair stand test (30 s CST), and a stair-climbing protocol were used to assesse mobility; the pre- and postintervention scores had a significant improvement when measured with 6MWT ($p < 0.001$) and 30 s CST ($p = 0.006$) after 12 weeks of yoga intervention, but no significant change could be detected in stair-climbing protocol.

4.3. Quality of Life. Four studies assessed the quality of life (QOL) as an outcome [17, 19, 21, 24]. Two of them applied Knee Injury and Osteoarthritis Outcome Scale (KOOS) [21, 24]; in Brenneman et al. [21], the pre- and postintervention scores had a significant improvement in QOL after 12 weeks of yoga exercise ($p < 0.001$), and in Ghasemi et al. [24] the pre- and postintervention scores had a significant difference in QOL in the yoga group ($p < 0.05$), but there was no significant difference between the control group and yoga group. In Ebnezar et al., Short Form 36 (SF-36) was used to assess QOL [17]; between and within group differences were highly significant on all domains of the SF-36 ($p < 0.001$) with better improvement in the yoga group than the control group on 15th day and 90th day. And in Cheung et al. they used Short Form Health Survey (SF-12) and Cantril Self-Anchoring Ladder to assess QOL; the Cantril Self-Anchoring Ladder could assess QOL both in "current" times and "in 5 years" times [19]; there was no significant difference between yoga and control group in QOL after 8 weeks of intervention in view of this two assessment scales. During intervention in yoga group, the Cantril Self-Anchoring Ladder "QOL current" scores significantly improved between 4 and 8 weeks ($p = 0.045$), but for "QOL in 5 years" the changes were not significant. No significant improvement was noted in SF-12 over time.

5. Discussion

The purpose of this review is to evaluate the effect of yoga on pain, mobility, and QOL in people with KOA. Although majority of these studies seem to exhibit a favorable effect after yoga intervention, there are still some inconsistent findings in this review.

5.1. Pain. Pain is a major symptom for osteoarthritis [1]. The cushioning between joints-cartilage wears away and muscle weakness is considered the major cause of pain and disability. Yoga have been proved to be a positive effect in pain relief in all included studies, which provide some evidence to support the application of yoga as an alternative therapeutic modality in pain management of patients with KOA. Some studies demonstrated that people will achieve better muscle strength and stamina as well as steadiness and flexibility after yoga exercise [28, 29], and, in our included studies, some benefits related to physical functions, like range of motion, and arthritis symptom can be found after yoga intervention, which partly explain the effect on pain relief. The experience of pain is also a psychological phenomenon which has several additional central processes including affective, behavioral, and cognitive factors [30]. However, outcome related to psychological issue is hard to discuss in our included articles. Yoga is considered to be an aerobic exercise combined with breathing training and relaxation therapy and it may have positive effects on pain relief in a comprehensive way, not just in physical but also psychological aspects, so a broaden assessment system for yoga is needed to be established in future studies.

5.2. Mobility. The symptoms of KOA, like pain and stiffness, can cause a series of consequences, such as limited ambulation, and worsen quality of life [1]. Yoga exercise had been proved to relieve pain and strengthen muscle strength where both support the fact that yoga may have positive effect on mobility.

Our review show that yoga has positive effect on mobility in two studies [16, 21], but not in Kolasinski et al. [20]. One possible explanation is that the duration of yoga intervention in Kolasinski et al. [20] is not long enough (8 weeks). Also a possible situation is that Kolasinski et al. relatively have larger bias for small sample size (only seven analyzed case). From available evidence [16, 21], 12 weeks of yoga in combination with physical therapy may help improve the short-distance mobility.

Subjects in Kolasinski et al. reported that they had heightened awareness of how they were positioning their bodies

Table 2: Quality of article included in this review using Downs and Black scale.

Measures	Ebnezar et al., 2012 [16]	Ebnezar et al., 2012 [17]	Ebnezar and Yogitha, 2012 [18]	Cheung et al., 2014 [19]	Kolasinski et al., 2005 [20]	Brenneman et al., 2015 [21]	Ebnezar et al., 2012 [22]	Nambi and Shah, 2013 [23]	Ghasemi et al., 2013 [24]
Clear description of the following?									
(1) Hypothesis/aim/objective	1	1	1	1	1	1	1	1	1
(2) Main outcome	1	1	1	1	1	1	1	1	1
(3) Characteristics of participants	1	1	1	1	1	1	1	1	1
(4) Intervention of interest	1	1	1	1	1	1	1	1	1
(5) Distribution of principal confounders in each group	0	0	0	0	0	0	0	0	2
(6) Main findings	1	1	1	1	1	1	1	1	1
(7) Estimates of random variability for main outcomes	1	1	1	1	1	1	1	1	1
(8) All important adverse events that may be a consequence of intervention	0	0	0	1	1	0	0	1	0
(9) Characteristics of patients lost to follow-up	1	1	1	1	1	1	1	0	0
(10) Actual probability values for main outcomes	1	1	1	1	1	1	1	1	1
External validity									
(11) Were invitees representative of the population from which they were recruited?	0	0	0	1	0	0	0	0	0
(12) Were subjects who were prepared to participate representative of the population from which recruited?	0	0	0	1	0	1	0	0	0
(13) Were the staff, places, and facilities representative of the treatment that the majority of subjects received?	0	0	0	1	1	1	0	0	0
Internal validity									
(14) Was an attempt made to blind subjects to the intervention they received?	0	0	0	0	0	0	0	0	0
(15) Was an attempt made to blind those measuring main outcomes of the intervention?	0	0	0	1	0	0	0	0	0
(16) If any results were based on "data dredging," was this made clear?	0	0	0	1	1	1	0	1	1
(17) In trials and cohort studies, did analyses adjust for length of follow-up? Or, in case-control studies, was the period between intervention and outcome the same for cases and controls?	1	1	1	1	1	1	1	1	0

TABLE 2: Continued.

Measures	Ebnezar et al., 2012 [16]	Ebnezar et al., 2012 [17]	Ebnezar and Yogitha, 2012 [18]	Cheung et al., 2014 [19]	Kolasinski et al., 2005 [20]	Brenneman et al., 2015 [21]	Ebnezar et al., 2012 [22]	Nambi and Shah, 2013 [23]	Ghasemi et al., 2013 [24]
(18) Were appropriate statistical tests used to assess the main outcomes?	1	1	1	1	1	1	1	0	1
(19) Was compliance with the intervention reliable?	1	1	1	1	1	1	1	1	1
(20) Were main outcome measures reliable and valid?	1	1	1	1	1	1	1	0	1
Internal validity-confounding (selection bias)									
(21) For trials and cohort studies, were patients in different intervention groups? For case-control studies, were cases and controls recruited from the same population?	1	1	1	1	1	1	1	0	0
(22) For trials and cohort studies, were subjects in different intervention groups? For case-control studies, were cases and controls recruited over same period of time?	1	1	1	1	1	0	1	0	0
(23) Were subjects randomized to intervention groups?	1	1	1	1	0	0	1	0	0
(24) Was the randomized intervention assignment concealed from both patients and staff until recruitment was complete? Was it irrevocable?	1	1	1	1	0	0	1	0	0
(25) Was there adequate adjustment for confounding in analyses from which main findings were drawn?	0	0	0	0	0	0	0	0	0
(26) Were losses of subjects to follow-up taken into account?	1	1	1	1	1	0	1	0	0
Power									
(27) Was there sufficient power to detect a clinically important effect when $p < 0.05$?	0	0	0	0	0	0	0	0	0
Total score (maximum 32)	17	17	17	23	18	16	17	11	13

A score of 23 or higher indicates good-quality article with low risk of bias.
A score between 22 and 13 indicates medium-quality article with moderate risk of bias.
A score of 12 or lower represents a poor-quality article with high risk of bias [25].

in space after yoga intervention [20]. And it seems to improve balance ability to some degree, similar to previous article which reported that yoga had positive effect on balance in people with stroke [8]. But only one study in this review had assessed the balance [19], in which balance ability did not have significant improvement after yoga intervention, but it had a positive effect on repeated chair stands, which means yoga may have positive effects on balance in people with KOA; the most common yoga protocol is 40–90 minutes/session, lasting for at least 8 weeks. But more studies are needed to prove that.

5.3. Quality of Life. In addition to a lot of disturbing symptoms that KOA have, the most important thing is that it greatly affects the quality of life of patients with KOA [1]. Quality of life (QOL) is getting more attention to social life [31] and yoga has been proved to have positive effect on Health Related Quality of Life (HRQOL) [7].

The present systematic review showed that yoga intervention has positive effect on QOL based on three studies [17, 21, 24], but Cheung et al. [19] reported an inconsistent result in QOL. However, we think the outcome measure about QOL may have more accurate results if it narrows to HRQOL, which has more reliability in ending change about patients. It seems that yoga have short-term effect on QOL of KOA patients, but more and high quality studies are needed in terms of long-term effects.

In addition to the physical health we discussed above, we believe that the mental health also have a great impact on QOL. Previous studies showed that yoga has positive effect on depression, anxiety, and stress reducing [32, 33]. In our included articles, only Kolasinski and colleagues had description on mental health. It had been assessed using Arthritis Impact Measurement Scale 2 (AIMS 2). Only the AIMS2 Affect Component showed a statistically significant improvement which means yoga may have positive effects on mental health in people with KOA, but more studies and concern are needed for the outcomes of yoga for KOA in mental health.

Yoga may be a safe and tolerable exercise for patients with KOA since no studies reported adverse event both during and after yoga intervention.

6. Limitations

Three limitations could be found in this systematic review. First, we would not conduct quantitative research by performing a meta-analysis because of the heterogeneity of the studies and missing data of some important outcomes. Second, excluded non-English language studies and unpublished articles and conference processing may result in bias. Thirdly, just small amount of RCTs were focused on this area and were included in this review; the lower quality of the studies will limit the power of drawing any conclusion.

7. Conclusion

This systematic review showed that yoga has positive effect on pain relief on people with KOA with good evidence. A relative long period (12 weeks) of yoga intervention may help to improve the short-distance mobility in patients with KOA. More RCTs with high quality and larger sample size are needed. Further work will be needed to address the mechanisms of yoga effect on KOA people and more specific outcomes are needed to concern psychological issues.

Competing Interests

The authors declare that they have no competing interests.

References

[1] D. Zelman, "Osteoarthritis of the knee (Degenerative arthritis of the knee)," WebMD, 2014, http://www.webmd.com/osteoarthritis/guide/ostearthritis-of-the-knee-degenerative-arthritis-of-the-knee?page=2.

[2] G. Musumeci, A. Mobasheri, and M. A. Szychlinska, "Age-related degeneration of articular cartilage in the pathogenesis of osteoarthritis: molecular markers of senescent chondrocytes," *Histology and Histopathology*, vol. 30, no. 1, pp. 1–12, 2015.

[3] M. Szychlinska, R. Leonardi, M. Al-Qahtani, A. Mobasheri, and G. Musumeci, "Altered joint tribology in osteoarthritis: reduced lubricin synthesis due to the inflammatory process. New horizons for therapeutic approaches," *Annals of Physical and Rehabilitation Medicine*, vol. 59, no. 3, pp. 149–156, 2016.

[4] M. Fransen, S. McConnell, A. R. Harmer, M. Van der Esch, M. Simic, and K. L. Bennell, "Exercise for osteoarthritis of the knee," *Cochrane Database of Systematic Reviews*, no. 1, Article ID CD004376, 2015.

[5] T. E. McAlindon, R. R. Bannuru, M. C. Sullivan et al., "OARSI guidelines for the non-surgical management of knee osteoarthritis," *Osteoarthritis and Cartilage*, vol. 22, no. 3, pp. 363–388, 2014.

[6] G. Musumeci, P. Castrogiovanni, F. M. Trovato et al., "Physical activity ameliorates cartilage degeneration in a rat model of aging: a study on lubricin expression," *Scandinavian Journal of Medicine and Science in Sports*, vol. 25, no. 2, pp. e222–e230, 2015.

[7] L. Desveaux, A. Lee, R. Goldstein, and D. Brooks, "Yoga in the management of chronic disease," *Medical Care*, vol. 53, no. 7, pp. 653–661, 2015.

[8] A. Lazaridou, P. Philbrook, and A. A. Tzika, "Yoga and mindfulness as therapeutic interventions for stroke rehabilitation: a systematic review," *Evidence-Based Complementary and Alternative Medicine*, vol. 2013, Article ID 357108, 9 pages, 2013.

[9] E. Ernst, M. H. Pittler, B. Wider et al., *Oxford Handbook of Complementary Medicine*, Oxford University Press, Oxford, UK, 2008.

[10] K. L. Kappmeier and D. M. Ambrosini, *Instructing Hatha Yoga*, Human Kinetics, Champaign, Ill, USA, 2006.

[11] R. B. Saper, D. M. Eisenberg, R. B. Davis, L. Culpepper, and R. S. Phillips, "Prevalence and patterns of adult yoga use in the United States: results of a national survey," *Alternative Therapies in Health and Medicine*, vol. 10, no. 2, pp. 44–49, 2004.

[12] X.-C. Liu, L. Pan, Q. Hu, W.-P. Dong, J.-H. Yan, and L. Dong, "Effects of yoga training in patients with chronic obstructive pulmonary disease: a systematic review and meta-analysis," *Journal of Thoracic Disease*, vol. 6, no. 6, pp. 795–802, 2014.

[13] H. Cramer, R. Lauche, H. Haller, G. Dobos, and A. Michalsen, "A systematic review of yoga for heart disease," *European Journal of Preventive Cardiology*, vol. 22, no. 3, pp. 284–295, 2015.

[14] P. R. Bosch, T. Traustadóttir, P. Howard, and K. S. Matt, "Functional and physiological effects of yoga in women with rheumatoid arthritis: a pilot study," *Alternative Therapies in Health and Medicine*, vol. 15, no. 4, pp. 24–31, 2009.

[15] E. J. Groessl, K. R. Weingart, K. Aschbacher, L. Pada, and S. Baxi, "Yoga for veterans with chronic low-back pain," *Journal of Alternative and Complementary Medicine*, vol. 14, no. 9, pp. 1123–1129, 2008.

[16] J. Ebnezar, R. Nagarathna, B. Yogitha, and H. R. Nagendra, "Effects of an integrated approach of hatha yoga therapy on functional disability, pain, and flexibility in osteoarthritis of the knee joint: a randomized controlled study," *Journal of Alternative and Complementary Medicine*, vol. 18, no. 5, pp. 463–472, 2012.

[17] J. Ebnezar, R. Nagarathna, B. B. Yogitha et al., "Effects of an integrated approach of hatha yoga therapy on quality of life in osteoarthritis of the knee joint: a randomized control study," *International Journal of Yoga*, vol. 4, pp. 55–63, 2012.

[18] J. Ebnezar and B. Yogitha, "Effectiveness of yoga therapy with the therapeutic exercises on walking pain, tenderness, early morning stiffness and disability in osteoarthritis of the knee joint—a comparative study," *Journal of Yoga & Physical Therapy*, vol. 2, no. 3, article 114, 2012.

[19] C. Cheung, J. F. Wyman, B. Resnick, and K. Savik, "Yoga for managing knee osteoarthritis in older women: a pilot randomized controlled trial," *BMC Complementary and Alternative Medicine*, vol. 14, article 160, 2014.

[20] S. L. Kolasinski, M. Garfinkel, A. G. Tsai, W. Matz, A. Van Dyke, and H. R. Schumacher Jr., "Iyengar yoga for treating symptoms of osteoarthritis of the knees: A Pilot Study," *Journal of Alternative and Complementary Medicine*, vol. 11, no. 4, pp. 689–693, 2005.

[21] E. C. Brenneman, A. B. Kuntz, E. G. Wiebenga, and M. R. Maly, "A yoga strengthening program designed to minimize the knee adduction moment for women with knee osteoarthritis: a proof-of-principle cohort study," *PLoS ONE*, vol. 10, no. 9, Article ID e0136854, 2015.

[22] J. Ebnezar, R. Nagarathna, B. Yogitha, and H. R. Nagendra, "Effect of integrated yoga therapy on pain, morning stiffness and anxiety in osteoarthritis of the knee joint: a randomized control study," *International Journal of Yoga*, vol. 5, no. 1, pp. 28–36, 2012.

[23] G. S. Nambi and A. K. Shah, "Additional effect of iyengar yoga and EMG biofeedback on pain and functional disability in chronic unilateral knee osteoarthritis," *International Journal of Yoga*, vol. 6, no. 2, pp. 123–127, 2013.

[24] G. A. Ghasemi, A. Golkar, and S. M. Marandi, "Effects of *Hata* yoga on knee osteoarthritis," *International Journal of Preventive Medicine*, vol. 4, supplement 1, pp. S133–S138, 2013.

[25] S. H. Downs and N. Black, "The feasibility of creating a checklist for the assessment of the methodological quality both of randomised and non-randomised studies of health care interventions," *Journal of Epidemiology and Community Health*, vol. 52, no. 6, pp. 377–384, 1998.

[26] R. N. Srivastava, V. Avasthi, S. R. Srivastava, and S. Raj, "Does yoga improve pain, stiffness and physical disability in knee osteoarthritis?—a randomize controlled clinical trial," *Osteoarthritis and Cartilage*, vol. 23, supplement 2, article A167, 2015.

[27] C. Cheung, J. Wyman, and B. Resnick, "Is yoga effective for knee osteoarthritis in older women?" *Osteoarthritis Cartilage*, vol. 20, p. S280, 2012.

[28] M. Dash and S. Telles, "Improvement in hand grip strength in normal volunteers and rheumatoid arthritis patients following yoga training," *Indian Journal of Physiology and Pharmacology*, vol. 45, no. 3, pp. 355–360, 2001.

[29] P. Raghuraj and S. Telles, "Muscle power, dexterity skill and visual perception in community home girls trained in yoga or sports and in regular school girls," *Indian Journal of Physiology and Pharmacology*, vol. 41, no. 4, pp. 409–415, 1997.

[30] D. G. A. Burton, M. C. Allen, J. L. E. Bird, and R. G. A. Faragher, "Bridging the gap: ageing, pharmacokinetics and pharmacodynamics," *The Journal of Pharmacy and Pharmacology*, vol. 57, no. 6, pp. 671–679, 2005.

[31] M. Nussbaum and A. Sen, *The Quality of Life*, Clarendon Press, Oxford, UK, 1993.

[32] P. Cabral, H. B. Meyer, and D. Ames, "Effectiveness of yoga therapy as a complementary treatment for major psychiatric disorders: a meta-analysis," *The Primary Care Companion for CNS Disorders*, vol. 13, no. 4, 2011.

[33] A. Ross and S. Thomas, "The health benefits of yoga and exercise: a review of comparison studies," *Journal of Alternative and Complementary Medicine*, vol. 16, no. 1, pp. 3–12, 2010.

Hindawi Publishing Corporation
Evidence-Based Complementary and Alternative Medicine
Volume 2016, Article ID 2156969, 6 pages
http://dx.doi.org/10.1155/2016/2156969

Review Article

Self-Administered Mind-Body Practices for Reducing Health Disparities: An Interprofessional Opinion and Call to Action

Patricia A. Kinser,[1] Jo Lynne W. Robins,[1] and Saba W. Masho[2]

[1] *Virginia Commonwealth University School of Nursing, Richmond, VA, USA*
[2] *Department of Family Medicine and Population Health, Division of Epidemiology, Virginia Commonwealth School of Medicine, Richmond, VA, USA*

Correspondence should be addressed to Patricia A. Kinser; kinserpa@vcu.edu

Received 23 March 2016; Accepted 22 August 2016

Academic Editor: Florian Pfab

Health disparities (HD) continue to persist in the United States which underscores the importance of using low-cost, accessible, evidence-based strategies that can improve health outcomes, especially for chronic conditions that are prevalent among underserved minority populations. Complementary/integrative health modalities, particularly self-administered mind-body practices (MBP), can be extremely useful in reducing HD because they are intrinsically patient-centered and they empower patients to actively engage in self-care of health and self-management of symptoms. Interprofessional healthcare providers and patients can engage in powerful partnerships that encompass self-administered MBP to improve health. This is a call to action for interprofessional researchers to engage in high-quality research regarding efficacy and cost-effectiveness of self-administered MBP, for practitioners to engage patients in self-administered MBP for health promotion, disease prevention, and symptom management, and for healthcare institutions to integrate self-administered MBP into conventional health practices to reduce HD in their communities.

1. Introduction

Racial/ethnic health disparities (HD) or inequalities in access to healthcare and in quality of healthcare are well documented across a range of health conditions, services, and settings in the United States [1]. Despite widespread awareness and recommendations regarding the importance of increasing access and culturally appropriate health delivery systems, HD continue to persist. Health disparities are defined by the Institute of Medicine (IOM) as differences in the quality of healthcare due to racial or ethnic differences, typically due to discrimination at the patient-provider level or at the level of health systems [2]. Although HD also can be defined more broadly as being due to disadvantages which occur beyond racial/ethnic status such as socioeconomic status, gender, age, disability, environment, and geographic location [3], this paper is focused in scope on addressing racial/ethnic minority-based HD. Immediate, creative, accessible, cost-effective solutions that are interprofessional in nature and that complement other on-going efforts are greatly needed for addressing HD.

The use of complementary/integrative health practices may provide a creative, accessible, cost-effective solution to complement other on-going efforts for addressing HD. As a subcategory of complementary/integrative health approaches, self-administered mind-body practices (MBP) typically involve an initial education or training session by a clinician or trainer after which patients continue using them on their own as needed or on a regular schedule. For example, a patient is taught a simple breathing technique to enhance relaxation when feeling anxious and the patient then practices the technique on his/her own as needed. Self-administered MBP include a variety of practices such as yoga, tai chi, qi gong, meditation/mindfulness, progressive relaxation, guided imagery, and sensory-therapies (e.g., art, music, play, aroma, and similar therapies) [4, 5]. MBP have been shown to enhance resilience to stress, improve symptom management, and maintain health in various populations

[4]. When MBP are self-administered and do not require regular treatment from or payment to a clinician/specialist, these practices may provide a cost-effective method for empowering patients to promote and maintain health and/or self-manage disease symptoms [6, 7]. Self-administered MBP may be relevant for decreasing the incidence and sequelae of disparity-related biopsychosocial stress in underserved minority populations who have limited resources yet high levels of stress vulnerability and related morbidity and mortality.

The sources of disparities in the healthcare system are typically attributed to multilevel factors (e.g., those which occur at the patient level, the provider level, and the care-system level) and the use of multilevel strategies is recommended in order to address HD and improve health outcomes [2]. As such, we propose an interprofessional multilevel solution based on the integration of complementary health practices into conventional health settings, particularly the teaching and recommending of self-administered MBP by healthcare providers to patients with the goal of enhancing stress resilience and improving health. The goal of this paper is to describe the current use of complementary/integrative approaches in the United States, to discuss how MBP can be based upon patient-centered interprofessional collaboration, and to propose that self-administered MBP may be powerful tool for addressing provider level factors (e.g., enhancing patient-provider partnerships) and system-level factors (e.g., addressing limitations in healthcare access) to ultimately reduce HD in racial/ethnic minority populations [2].

2. Use of Complementary/Integrative Approaches

The popularity of complementary/integrative health approaches, such as MBP, by consumers has grown substantially over the last decade. Approximately 34–36% of the US population has used at least one complementary approach in the prior two years [8–10], with the most common therapies including natural products, relaxation and breathing exercises, meditation, yoga, and massage. Data from the 2012 National Health Information Survey (NHIS) suggests that approximately 33.2% of the population in the United States uses some form of complementary health approach and the most commonly stated reasons for use of these approaches are for pain management and stress relief [9]. Approximately 9.5% of the US population uses a mind-body complementary health approach, such as yoga, chiropractic manipulation, meditation, and massage therapy [9]. Hispanics and non-Hispanic Blacks constitute 41.3% of all complementary health practice users (22% by Hispanics; 19.3% by non-Hispanic Blacks) [9]. Of particular interest for HD researchers, NHIS data suggests that 5.4% of the US population or 12.3 million use complementary approaches as alternative therapies to conventional medications in order to save money [11]. The people who do so are more likely to be Hispanic (6.9%), be uninsured (11.9%), and have an income below the federal poverty line (7.6%) [11]. Further, a substantial percentage of the population (47.6%) does not inform their healthcare providers about use of these approaches [12].

Many factors likely influence the use of complementary/integrative approach by minority populations which face HD. First, individuals may have past experiences in which conventional medical care did not meet specific needs, was inaccessible, or was cost-prohibitive; thus the individuals turn to complementary approaches for symptom management or health maintenance [10, 13, 14]. Second, there may be a community-wide historic inherent distrust of conventional healthcare providers or institutions (e.g., Tuskegee Syphilis Study) or a history of overt negative experiences with conventional healthcare. For example, data from the National Survey of Midlife Development in the United States of Black adults suggest that a history of racial discrimination, even in nonmedical contexts, is associated with a higher likelihood of using complementary approaches as a means of healthcare [15]. A third motivation for turning to complementary approaches includes the desire to embrace practices which avoid conventional treatment-related side effects [16]. Fourth and finally, many racial and ethnic groups have long used complementary/integrative health approaches as part of their holistic culturally based understanding of health [16]. Of importance, NHIS data suggest that non-Hispanic White adults are more likely to choose complementary approaches which are provider-based, such as chiropractic manipulation, massage, and acupuncture, whereas non-White adults are more likely to choose self-administered therapies, such as relaxation practices, yoga, meditation, and tai chi [10].

3. Interprofessional Approach

An interprofessional approach to healthcare delivery has received attention as a means to improve patient-centered care. An interprofessional approach entails the collaboration of professionals from different disciplines, working and communicating with each other, providing knowledge and skills, to augment and support the contributions of others and optimize patient care [17]. The IOM report, *The Future of Nursing: Leading Change, Advancing Health*, strategically called for and initiated a movement towards transforming the healthcare system to integrate interprofessional collaboration and coordination as the standard of care [18].

MBP lends itself for an interprofessional collaboration and can be integrated into any system of care. Healthcare professionals including physicians, nurses, psychologists, social workers, and other therapists can work together to teach or recommend self-administered MBP as needed. In fact, nurses, nurse practitioners, and therapists are strategically positioned to coordinate or educate patients on self-administered MBP. Interprofessional teams are positioned to connect a multitude of providers and promote a collaborative practice that hinges on each profession recognizing and utilizing each other's expertise to provide an effective patient-centered care.

4. Self-Administered MBP: Patient and Provider Level

Given that ethnic and racial minority populations tend to choose self-administered therapies, it is relevant to explore how these MBP may enhance health. Self-administered MBP are focused on the integration of the mind-body to affect physical and mental functioning, enhance stress resilience, and promote overall health [4]. There are a wide variety of self-administered MBP, yet most of them share basic, easily accessible processes for achieving relaxation, enhanced attention, and mindful awareness. In self-administered MBP, breathing and gentle physical movement are paired with focused attention and mindfulness (or present moment awareness) [19]. Clinical trials evaluating various forms of self-administered MBP, including relaxation practices, yoga, tai chi, and meditation, have been shown to help various populations maintain health through self-regulation and stress resilience [20–22]. Further, self-administered MBP may help participants manage acute or chronic conditions. In particular, trials of yoga, tai chi, and mindfulness meditation have been shown to decrease physical and psychological symptoms associated with the following conditions: depression [23–25], hypertension [26], cardiometabolic conditions [27], chronic inflammatory conditions [28, 29], PTSD [30], menopause [31], chronic pain [32–35], and substance abuse [36], among others.

The process of self-administration of a MBP allows patients to self-manage an illness or maintain health. Self-management of health or illness is based upon the patient's active participation in healthy self-care activities [37]. This act of self-administration and self-management can be an incredibly empowering experience for the patient, particularly when the efforts are supported by their healthcare providers [38, 39]. Self-management approaches have successfully helped patient address many chronic diseases [37, 38, 40, 41]. We contend that self-administration of a MBP might be a key component of health or illness self-management.

Healthcare providers may incorporate information about self-administered MBP into clinical practice in multiple ways. First, providers may wish to refer patients to community resources, web-based resources, or printed literature about MBP. Second, providers who are personally familiar with MBP and are comfortable with the content may provide informal teaching and education during patient interactions. Third, providers may offer more formalized sessions or workshops during which patients may learn about self-administered MBP; this may require formal institutional support of MBP, addressed in the next section.

With basic training, healthcare providers can be in an excellent position to educate on and encourage the use of basic self-administered MBP for enhancing stress resilience and health. Unfortunately, many healthcare providers have not received formal training about complementary/integrative health practices during their educational experiences; however many are seeking out resources for their own self-care or to enhance their patient care [22, 42]. Increasingly, nursing and medical schools are incorporating information about complementary/integrative approaches into curricula [43, 44] and continuing education programs opportunities are available for practicing clinicians. However, educational opportunities for healthcare providers about self-administered MBP should become more available because, given simple tools, healthcare providers may quickly and easily teach or refer MBP to patients who would benefit from enhanced self-care and improvements in physical and mental health [45]. Providers may find that partnering with patients in this way could create powerful health promoting patient-provider relationships as well as help alleviate issues of alienation and mistrust in racially and ethnically diverse underserved populations, potentially leading to greater engagement in self-management of health and illness in these populations.

5. Self-Administered MBP: Health System and Policy Levels

At the health system level, limitations on access to care, including limited availability of facilities or services in certain areas and limited time available for patients to see healthcare providers, are important contributors to HD. These circumstances present an important opportunity for engaging underserved populations in self-care. Healthcare providers and healthcare systems may consider the low cost of brief education sessions and encouragement regarding self-administered MBP to enhance the health of populations in need, particularly when other resources are limited. In order to do so, policies that support and encourage the use of MBP are required. Financial incentives should be available to reduce barriers to therapies which may be beneficial to patients and to enhance the time available for patient-provider communication about these therapies [2]. In those conditions for which evidence is building that MBP can improve health outcomes, discussed above, payment policies should be developed to support provider facilitation for MBP among patient populations.

Another systems-level strategy for encouraging the use of MBP is to encourage its use and target providers in facilities where underserved minority patients are likely to seek care. For example, community-based health centers might introduce key concepts of MBP in structured classes and provide resources for individuals to self-administer the MBP in the future. It has been reported that as many as two-thirds of community health centers are already actively using complementary/integrative approaches [46] and numerous academic medical centers have incorporated integrative health into healthcare and educational programs [45, 47]. Therefore, models exist and should be replicated by interprofessional groups interested in incorporating self-administered MBP therapies into community health centers and academic medical centers.

Certainly, large-scale research studies are required to analyze implementation costs into health systems and to evaluate cost versus benefits for various therapies. However, numerous high-quality studies report that complementary/integrative health therapies may be cost-effective and even provide cost-savings to institutions [6, 48]. For example, the systematic review of economic evaluations by Herman and colleagues (2012) suggests that, in high-quality studies which compared a complementary therapy with usual care, approximately 30% of cost-effectiveness comparisons showed cost-savings, as opposed to only 9% of economic comparisons across allopathic therapies [6]. At a research and policy level, innovative research questions and designs that foster a better understanding of the impact of historical and sociopolitical contributors on psychosocial risk factors, health disparities, and health outcomes are needed. Priority should be given to high-quality research on complementary/integrative health therapies that have some demonstrated intervention efficacy with high potential benefits and that focus on highly prevalent conditions that cause great burdens of suffering [45].

6. Summary

We propose that self-administered MBP therapies can be useful in reducing HD and call interprofessional providers and researchers to engage in this important area of research and practice. Continued HD in the United States underscore the significance of encouraging the use of simple, low-cost, highly accessible, evidence-based strategies that can improve health outcomes, particularly for health promotion and prevention of chronic conditions that are prevalent among underserved minority populations. While the focus of this paper has been on HD in racial and ethnic minorities, we recognize that HD exist in any group that experiences greater morbidity and mortality as a result of disadvantage or discrimination and believe research is warranted regarding how MBP may provide opportunities to decrease HD along multiple other dimensions, such as income, education, gender, disability, and insurance status [49]. Although research is required to more fully evaluate efficacy, efficiency, and cost-savings of using complementary/integrative health therapies, the preliminary evidence suggests that the use of self-administered MBP in underserved populations is highly relevant.

The integration of MBP into daily life and care practices may require a shift in perspective for healthcare providers and patients. However, the goal of reducing and ultimately eliminating HD requires that healthcare providers, patients, and policy-makers creatively work together on health promotion, disease prevention, and symptom management. Discussions of the potential benefits and basic techniques of MBP along with the provision of conventional healthcare are well within the scope of practice for interprofessional healthcare providers. Given the right tools, patients can engage in powerful partnerships with their care providers and healthcare systems that encompass self-care practices to improve quality of life and health.

Competing Interests

The authors declare that they have no competing interests.

Acknowledgments

This work was partially supported by 5P60MD002256 (PI: Strauss) NIMHD VCU Comprehensive Center of Excellence on Minority Health and Health Disparities, Clinical Faculty Scholar Program (PK). The authors would like to thank Lindsay Sabik for her assistance with the development of this manuscript.

References

[1] Agency for Healthcare Research and Quality, "2014 National healthcare quality and disparities report," Tech. Rep. 15-0007, Agency for Healthcare Research and Quality, Rockville, Md, USA, 2015.

[2] Committee on Understanding and Eliminating Racial and Ethnic Disparities in Health Care and Institute of Medicine (IOM), *Unequal Treatment: Confronting Racial and Ethnic Disparities in Healthcare*, National Academies Press, Washington, DC, USA, 2003.

[3] Department of Health and Human Services, Office of Disease Prevention and Health Promotion, Disparities, 2014, https://www.healthypeople.gov/2020/about/foundation-health-measures/Disparities.

[4] National Center for Complementary and Integrative Health (NCCIH), "Complementary, alternative, or integrative health: what's in a name?" 2014, https://nccih.nih.gov/health/whatiscam.

[5] R. Delgado, A. York, C. Lee et al., "Assessing the quality, efficacy, and effectiveness of the current evidence base of active self-care complementary and integrative medicine therapies for the management of chronic pain: a rapid evidence assessment of the literature," *Pain Medicine*, vol. 15, supplement 1, pp. S9–S20, 2014.

[6] P. M. Herman, B. L. Poindexter, C. M. Witt, and D. M. Eisenberg, "Are complementary therapies and integrative care cost-effective? A systematic review of economic evaluations," *BMJ Open*, vol. 2, no. 5, Article ID e001046, 2012.

[7] P. M. Herman, B. M. Craig, and O. Caspi, "Is complementary and alternative medicine (CAM) cost-effective? A systematic review," *BMC Complementary and Alternative Medicine*, vol. 5, article 11, 2005.

[8] P. M. Barnes, B. Bloom, and R. L. Nahin, "Complementary and alternative medicine use among adults and children: United States, 2007," *National Health Statistics Reports*, no. 12, pp. 1–23, 2009.

[9] T. C. Clarke, L. I. Black, B. J. Stussman, P. M. Barnes, and R. L. Nahin, "Trends in the use of complementary health approaches among adults: United States, 2002–2012," *National Health Statistics Reports*, vol. 79, pp. 1–16, 2015.

[10] D. Su and L. Li, "Trends in the use of complementary and alternative medicine in the United States: 2002–2007," *Journal of Health Care for the Poor and Underserved*, vol. 22, no. 1, pp. 296–310, 2011.

[11] C.-C. Wang, J. Kennedy, and C.-H. Wu, "Alternative therapies as a substitute for costly prescription medications: results from the 2011 National Health Interview Survey," *Clinical Therapeutics*, vol. 37, no. 5, pp. 1022–1030, 2015.

[12] M. A. Laiyemo, G. Nunlee-Bland, F. A. Lombardo, R. G. Adams, and A. O. Laiyemo, "Characteristics and health perceptions of complementary and alternative medicine users in the United States," *American Journal of the Medical Sciences*, vol. 349, no. 2, pp. 140–144, 2015.

[13] S.-I. Wu, P. Chou, M.-L. Chen, J. H. Chen, M.-L. Yeh, and K.-C. Lin, "Multiple interacting factors corresponding to repetitive

use of complementary and alternative medicine," *Complementary Therapies in Medicine*, vol. 20, no. 4, pp. 190–198, 2012.

[14] J. G. Grzywacz, W. Lang, C. Suerken, S. A. Quandt, R. A. Bell, and T. A. Arcury, "Age, race, and ethnicity in the use of complementary and alternative medicine for health self-management: evidence from the 2002 National Health Interview Survey," *Journal of Aging and Health*, vol. 17, no. 5, pp. 547–572, 2005.

[15] T. P. Shippee, M. H. Schafer, and K. F. Ferraro, "Beyond the barriers: racial discrimination and use of complementary and alternative medicine among Black Americans," *Social Science and Medicine*, vol. 74, no. 8, pp. 1155–1162, 2012.

[16] R. Struthers and L. A. Nichols, "Utilization of complementary and alternative medicine among racial and ethnic minority populations: implications for reducing health disparities," *Annual Review of Nursing Research*, vol. 22, pp. 285–313, 2004.

[17] P. Hall and L. Weaver, "Interdisciplinary education and teamwork: a long and winding road," *Medical Education*, vol. 35, no. 9, pp. 867–875, 2001.

[18] Institute of Medicine (US) Committee on the Robert Wood Johnson Foundation Initiative on the Future of Nursing, at the Institute of Medicine, 2011.

[19] J. L. W. Robins, L. Kiken, M. Holt, and N. L. Mccain, "Mindfulness: an effective coaching tool for improving physical and mental health," *Journal of the American Association of Nurse Practitioners*, vol. 26, no. 9, pp. 511–518, 2014.

[20] T. Gard, J. J. Noggle, C. L. Park, D. R. Vago, and A. Wilson, "Potential self-regulatory mechanisms of yoga for psychological health," *Frontiers in Human Neuroscience*, vol. 8, article 770, pp. 1–20, 2014.

[21] G.-Y. Yang, L.-Q. Wang, J. Ren et al., "Evidence base of clinical studies on Tai Chi: a bibliometric analysis," *PLoS ONE*, vol. 10, no. 3, Article ID e0120655, 2015.

[22] H. Williams, L. A. Simmons, and P. Tanabe, "Mindfulness-based stress reduction in advanced nursing practice: a non-pharmacologic approach to health promotion, chronic disease management, and symptom control," *Journal of Holistic Nursing*, vol. 33, no. 3, pp. 247–259, 2015.

[23] P. A. Kinser, R. K. Elswick, and S. Kornstein, "Potential long-term effects of a mind-body intervention for women with major depressive disorder: sustained mental health improvements with a pilot yoga intervention," *Archives of Psychiatric Nursing*, vol. 28, no. 6, pp. 377–383, 2014.

[24] H. Cramer, R. Lauche, J. Langhorst, and G. Dobos, "Yoga for depression: a systematic review and meta-analysis," *Depression and Anxiety*, vol. 30, no. 11, pp. 1068–1083, 2013.

[25] W. R. Marchand, "Mindfulness meditation practices as adjunctive treatments for psychiatric disorders," *Psychiatric Clinics of North America*, vol. 36, no. 1, pp. 141–152, 2013.

[26] R. D. Brook, L. J. Appel, M. Rubenfire et al., "Beyond medications and diet: alternative approaches to lowering blood pressure: a scientific statement from the american heart association," *Hypertension*, vol. 61, no. 6, pp. 1360–1383, 2013.

[27] J. L. W. Robins, R. K. Elswick, and N. L. McCain, "The story of the evolution of a unique tai chi form: origins, philosophy, and research," *Journal of Holistic Nursing*, vol. 30, no. 3, pp. 134–146, 2012.

[28] M. A. Rosenkranz, R. J. Davidson, D. G. MacCoon, J. F. Sheridan, N. H. Kalin, and A. Lutz, "A comparison of mindfulness-based stress reduction and an active control in modulation of neurogenic inflammation," *Brain, Behavior, and Immunity*, vol. 27, no. 1, pp. 174–184, 2013.

[29] N. Morgan, M. R. Irwin, M. Chung, and C. Wang, "The effects of mind-body therapies on the immune system: meta-analysis," *PLoS ONE*, vol. 9, no. 7, Article ID e100903, 2014.

[30] B. A. Van Der Kolk, L. Stone, J. West et al., "Yoga as an adjunctive treatment for posttraumatic stress disorder: a randomized controlled trial," *Journal of Clinical Psychiatry*, vol. 75, no. 6, pp. e559–e565, 2014.

[31] H. Cramer, R. Lauche, J. Langhorst, and G. Dobos, "Effectiveness of yoga for menopausal symptoms: a systematic review and meta-analysis of randomized controlled trials," *Evidence-Based Complementary and Alternative Medicine*, vol. 2012, Article ID 863905, 11 pages, 2012.

[32] M. C. Davis, A. J. Zautra, L. D. Wolf, H. Tennen, and E. W. Yeung, "Mindfulness and cognitive-behavioral interventions for chronic pain: differential effects on daily pain reactivity and stress reactivity," *Journal of Consulting and Clinical Psychology*, vol. 83, no. 1, pp. 24–35, 2015.

[33] H. Cramer, H. Haller, R. Lauche, and G. Dobos, "Mindfulness-based stress reduction for low back pain. A systematic review," *BMC Complementary and Alternative Medicine*, vol. 12, article 162, 2012.

[34] H. Cramer, R. Lauche, C. Hohmann, J. Langhorst, and G. Dobos, "Yoga for chronic neck pain: a 12-month follow-up," *Pain Medicine*, vol. 14, no. 4, pp. 541–548, 2013.

[35] R. Lauche, H. Cramer, G. Dobos, J. Langhorst, and S. Schmidt, "A systematic review and meta-analysis of mindfulness-based stress reduction for the fibromyalgia syndrome," *Journal of Psychosomatic Research*, vol. 75, no. 6, pp. 500–510, 2013.

[36] H. Amaro, S. Spear, Z. Vallejo, K. Conron, and D. S. Black, "Feasibility, acceptability, and preliminary outcomes of a mindfulness-based relapse prevention intervention for culturally-diverse, low-income women in substance use disorder treatment," *Substance Use and Misuse*, vol. 49, no. 5, pp. 547–559, 2014.

[37] K. R. Lorig and H. R. Holman, "Self-management education: history, definition, outcomes, and mechanisms," *Annals of Behavioral Medicine*, vol. 26, no. 1, pp. 1–7, 2003.

[38] K. Lorig, "Self-management education: more than a nice extra," *Medical Care*, vol. 41, no. 6, pp. 699–701, 2003.

[39] R. McCorkle, E. Ercolano, M. Lazenby et al., "Self-management: enabling and empowering patients living with cancer as a chronic illness," *CA: Cancer Journal for Clinicians*, vol. 61, no. 1, pp. 50–62, 2011.

[40] T. Zimmermann, E. Puschmann, M. Ebersbach, A. Daubmann, S. Steinmann, and M. Scherer, "Effectiveness of a primary care based complex intervention to promote self-management in patients presenting psychiatric symptoms: study protocol of a cluster-randomized controlled trial," *BMC Psychiatry*, vol. 14, no. 1, article 2, 2014.

[41] K. Kroenke, M. Bair, T. Damush et al., "Stepped Care for Affective Disorders and Musculoskeletal Pain (SCAMP) study: design and practical implications of an intervention for comorbid pain and depression," *General Hospital Psychiatry*, vol. 29, no. 6, pp. 506–517, 2007.

[42] M. J. Sirgy and P. A. Jackson, "How to enhance the well-being of healthcare service providers and their patients? A mindfulness proposal," *Frontiers in Psychology*, vol. 6, article 276, 2015.

[43] V. S. Cowen and V. Cyr, "Complementary and alternative medicine in US medical schools," *Advances in Medical Education and Practice*, vol. 2015, no. 6, pp. 113–117, 2015.

[44] K. Moore, "Rationale for complementary and alternative medicine in nursing school curriculum," *Journal of Alternative and Complementary Medicine*, vol. 16, no. 6, pp. 611–612, 2010.

[45] Committee on the Use of Complementary and Alternative Medicine by the American Public and Board on Health Promotion and Disease Prevention and Institute of Medicine, *Complementary and Alternative Medicine in the United States*, National Academies Press, Washington, DC, USA, 2005.

[46] M. Fritts, A. Calvo, W. Jonas, and C. Bezold, "Integrative medicine and health disparities: a scoping meeting," *Explore*, vol. 5, no. 4, pp. 228–241, 2009.

[47] S. Vohra, K. Feldman, B. Johnston, K. Waters, and H. Boon, "Integrating complementary and alternative medicine into academic medical centers: experience and perceptions of nine leading centers in North America," *BMC Health Services Research*, vol. 5, article 78, 2005.

[48] B. K. Lind, W. E. Lafferty, P. T. Tyree, and P. K. Diehr, "Comparison of health care expenditures among insured users and nonusers of complementary and alternative medicine in Washington state: a cost minimization analysis," *Journal of Alternative and Complementary Medicine*, vol. 16, no. 4, pp. 411–417, 2010.

[49] P. Braveman, "Social conditions, health equity, and human rights," *Health and Human Rights*, vol. 12, no. 2, pp. 31–48, 2010.

Hindawi Publishing Corporation
Evidence-Based Complementary and Alternative Medicine
Volume 2016, Article ID 1813979, 10 pages
http://dx.doi.org/10.1155/2016/1813979

Review Article

The Effects of Tai Chi Chuan on Improving Mind-Body Health for Knee Osteoarthritis Patients: A Systematic Review and Meta-Analysis

Wen-Dien Chang,[1] Shuya Chen,[2] Chia-Lun Lee,[3] Hung-Yu Lin,[4] and Ping-Tung Lai[5]

[1]*Department of Sports Medicine, China Medical University, No. 91, Hsueh-Shih Road, Taichung 404402, Taiwan*
[2]*Department of Physical Therapy, China Medical University, No. 91, Hsueh-Shih Road, Taichung 404402, Taiwan*
[3]*Division of Physical and Health Education, Center for General Education, National Sun Yat-sen University, No. 70 Lienhai Road, Kaohsiung 80424, Taiwan*
[4]*Department of Occupational Therapy, Asia University, No. 500, Lioufeng Road, Wufeng District, Taichung 41354, Taiwan*
[5]*Department of Physical Therapy and Rehabilitation, Rehabilitation Assistive Device Center, Da-Chien General Hospital, No. 6, Shin Guang Street, Miaoli 36049, Taiwan*

Correspondence should be addressed to Ping-Tung Lai; drlaipt@gmail.com

Received 2 March 2016; Revised 27 May 2016; Accepted 19 July 2016

Academic Editor: Yongtai Wang

Purpose. To conduct a meta-analysis and systematic review examining whether Tai Chi Chuan could have mental and physical benefits for patients with knee osteoarthritis. *Methods*. MEDLINE, PUBMED, EMBASE, and CINAHL databases were searched for relevant studies. Data of the studies were collected, and outcomes were classified using the International Classification of Functioning, Disability, and Health model. Effect sizes of the mental and physical components were determined, along with the recommendation grades of Philadelphia Panel Classification System for Tai Chi Chuan on knee osteoarthritis. *Results*. Eleven studies were selected and retrieved from the databases. The results of meta-analysis revealed that the effects of Tai Chi Chuan were observed for physical components in the body functions and structures domain. The effects favoring Tai Chi Chuan were observed in the physical component in the activities and participation domain. Insufficient data was included in the meta-analysis of the mental component. *Conclusions*. The review revealed that Tai Chi Chuan had beneficial outcomes for patients with knee osteoarthritis. The evidence-based results represented that it had small-to-moderate effects on body functions and structures, activities, and participation of physical component. However, there was insufficient evidence to support that Tai Chi Chuan had beneficial mental effect.

1. Introduction

The worldwide elderly population was increasing considerably while the prevalence of knee osteoarthritis is increasing among the older adults [1]. Knee osteoarthritis symptoms include joint pain, inflammation, and swelling [2]. Joint discomfort can impede the ability of the older adults to engage in daily and functional activities [1]. Conservative treatments for knee osteoarthritis often involve physical therapy, weight control, and therapeutic exercise [2]. Therapeutic exercise, a widely accepted treatment approach, increases the muscle strength of the thighs, thereby enhancing joint stability and reducing cartilage loss in the knee [3]. Selecting an appropriate form of therapeutic exercise is vital for treating and preventing knee osteoarthritis because high-impact or heavy-load exercises may exacerbate knee osteoarthritis.

Approximately 18% and 27% of male and female older adults suffered from knee osteoarthritis, respectively [4]. Previous study demonstrated that depression had positive correlation with the physical impairment and disability, and the patients with knee osteoarthritis were inclined to feel depressed compared to healthy people [5]. They had high depressed mood and anxiety, because of worrying over worse physical functions and discomfortable symptoms of knee osteoarthritis. The older adults worried at these symptoms and searched for more complementary therapies. Tai Chi Chuan, which is a traditional Chinese martial art, is a common type of palliative low-impact and aerobic exercise [6]. Because it emphasizes body relaxation, rhythmic breathing, and slow motion, Tai Chi Chuan can be appropriate for the older adults intending to perform therapeutic exercise [7]. The results of previous studies had shown that Tai Chi Chuan could improve the balance ability, muscle strength, and cardiopulmonary function for osteoarthritis patients [7, 8] and relieve psychological problems such as depression, anxiety, and tension [9]. Thus, selecting therapeutic exercise appropriate for treating knee osteoarthritis is of interest to the older adults.

Being a palliative therapeutic exercise technique, Tai Chi Chuan includes mind-body exercises and is considered appropriate for older adults [6]. To the best of our knowledge, previous studies of systematic review focused on the evidence to support the effects of Tai Chi Chuan on pain relief and physical function improvement in the patients with knee osteoarthritis [10, 11]. However, empirical medical evidence supporting the efficacy of Tai Chi Chuan in treating knee osteoarthritis was scant, and its mental and physical effects have not been confirmed. In the present study, a systematic review was conducted using a comprehensive meta-analysis for exploring the mental and physical effects of Tai Chi Chuan when managing knee osteoarthritis.

2. Methods

2.1. Search Strategy. Published articles were searched and related to Tai Chi Chuan and osteoarthritis in the MEDLINE, PUBMED, EMBASE, and CINAHL databases by using "Tai Chi," "Tai Chi Chuan," "Tai Ji," "knee osteoarthritis," and "osteoarthritis" as the keywords. Inclusion criteria were that the experimental design was a randomized control trial; the experimental and control groups comprised people practicing and not practicing Tai Chi Chuan, respectively; the participants were clinically diagnosed with knee osteoarthritis (i.e., clinical and radiographic evidence of osteoarthritis); and the articles were published in international journals. Two investigators, each with more than 10 years of professional experience in sports medicine, screened and identified the articles which satisfied the criteria. The Jadad Quality Score was used to assess the quality of the articles. The scale comprised five items: whether the experiment was randomized, whether the randomization method was appropriate, whether the participants received blind tests, whether the evaluators conducted blind tests, and whether participant dropouts were recorded [12]. The highest score was 5, indicating the highest quality study. The recruited articles were recorded by the published year, first authors, participant number, movement type, duration and frequency of Tai Chi Chuan practice, and the assessments and outcomes after the intervention. By referring to the International Classification of Functioning, Disability, and Health (ICF), which developed by the World Health Organization in 2001, the assessments for the outcomes of Tai Chi Chuan in treating knee osteoarthritis were classified into two domains: body functions and structures as well as activities and participation [13]. Mental and physical components of the assessments were also categorized, respectively [13].

2.2. Data Collection and Meta-Analysis. Meta-analysis was conducted to evaluate the effects of Tai Chi Chuan. Various effects of Tai Chi Chuan were assessed to determine the outcomes. The extracted data were outcomes in terms of means and standard deviations in the experimental and control groups, which were then used to estimate the standardized mean differences (SMDs) and 95% confidence intervals (CIs) to determine the effect size of Tai Chi Chuan. A subgroup analysis for the individual effect size of the outcome variables was performed on the extracted data by using the MedCalc software (MedCalc, Mariakerke, Belgium). Publication bias was determined using Rosenthal's file drawer method, and the fail-safe number was observed to be higher than the tolerance level. *Q* statistic test was used to analyze homogeneity or heterogeneity of the extracted data. The effects of various assessment outcomes were categorized into subgroups by using ICF. The effect sizes were characterized using the method developed by Cohen, and values of 0.2–0.5, 0.5–0.8, and >0.8 were considered small, moderate, and large effect sizes, respectively. Finally, the Philadelphia Panel Classification System was used to analyze the recommendation grades of the evaluated efficacies [14].

3. Results

3.1. Quantity and Quality of the Articles. After searching the databases, 68 articles were collected; however, 28 review, 2 cross-sectional study, and 1 study protocol articles were excluded (Figure 1). After excluding 20 articles not related to Tai Chi Chuan and osteoarthritis, 17 experimental articles regarding the effects of Tai Chi Chuan on knee osteoarthritis were retrieved. Among these, 6 articles were excluded because participants had osteoarthritis of the hip or other joints, a control group was not included, and outcome data was not reported. Finally, 11 articles were analyzed [15–25]. The recruited articles were published from 2003 to 2015 year, and had high quality scores of 3–5 (Table 1).

3.2. Intervention Programs. In the experimental groups, 12–31 movements of Sun-style form and 10–24 movements of Yang-style form were adopted; however, Lee et al. [18] used an unnamed 18-movement form of Tai Chi Chuan (Table 1). Furthermore, 40–65-min training sessions of Tai Chi Chuan class were conducted over 1–4 times each week for 6–24 weeks in all experimental groups. The control groups did not have Tai Chi Chuan programs but received education classes or telephone interviews for the same duration along with the experimental groups. The contents of the education classes and telephone interviews were related to healthy diets, exercise benefits, and the managements of knee osteoarthritis. By contrast, in 2 studies conducted by Song et al. [15] and Lee et al. [18], the control group did not receive any form of intervention.

Table 1: Summary of intervention programs in the included articles.

Author (year)	n	Age	Experimental groups	Tai Chi sessions	Control groups	Sessions	Jadad
Song et al. (2003) [15]	43	63.65	12 movements of Sun-style form ($n = 22$)	60 min class program, 3 times each week for 12 weeks	No intervention ($n = 21$)	No session	3
Brismée et al. (2007) [16]	41	69.80	24 movements of Yang-style form ($n = 22$)	40 min class program, 3 times each week for 6 weeks 40 min home-based program, 3 times each week for 6 weeks	Education class ($n = 19$)	40 min class program, 3 times each week for 6 weeks	5
Song et al. (2007) [17]	43	63.65	12 movements of Sun-style form ($n = 22$)	60 min class program, 3-4 times each week for 12 weeks	Interview ($n = 21$)	15–20 min, 2 times	4
Lee et al. (2009) [18]	44	68.55	18 movements ($n = 29$)	60 min class program, 2 times each week for 8 weeks	No intervention ($n = 15$)	No session	4
Song et al. (2009) [19]	69	61.15	31 movements of Sun-style form ($n = 30$)	60 min class program, 2 times each week for the first 3 weeks and 1 time each week for the next 6 months	Education class ($n = 39$)	120 min class program, 1 time each month for 6 months	3
Wang et al. (2009) [20]	40	65.50	10 movements of Yang-style form ($n = 20$)	60 min class program, 2 times each week for 12 weeks	Education class ($n = 20$)	60 min class program, 2 times each week for 12 weeks	4
Ni et al. (2010) [21]	35	63.18	24 movements of Yang-style form ($n = 18$)	45 min class program, gradually increased from 2 to 4 times each week for 24 weeks	Education class ($n = 17$)	45 min class program, 1 time each week for 24 weeks	5
Song et al. (2010) [22]	65	62.11	31 movements of Sun-style form ($n = 30$)	55–65 min class program, 1 time each week for 6 months 20 min home-based program, every day for 6 months	Education class ($n = 35$)	120 min class program, 1 time each month for 6 months	3
Tsai et al. (2013) [23]	55	78.91	12 movements of Sun-style form ($n = 28$)	40 min class program, 3 times each week for 20 weeks	Education class ($n = 27$)	40 min class program, 3 times each week for 20 weeks	4
Wortley et al. (2013) [24]	18	69.30	12 movements of Yang-style form ($n = 12$)	60 min class program, 2 times each week for 10 weeks	Telephone interview ($n = 6$)	1 time	3
Tsai et al. (2015) [25]	55	79.01	12 movements of Sun-style form ($n = 28$)	20–40 min class program, 3 times each week for 20 weeks	Education class ($n = 27$)	20–40 min class program, 3 times each week for 20 weeks	5

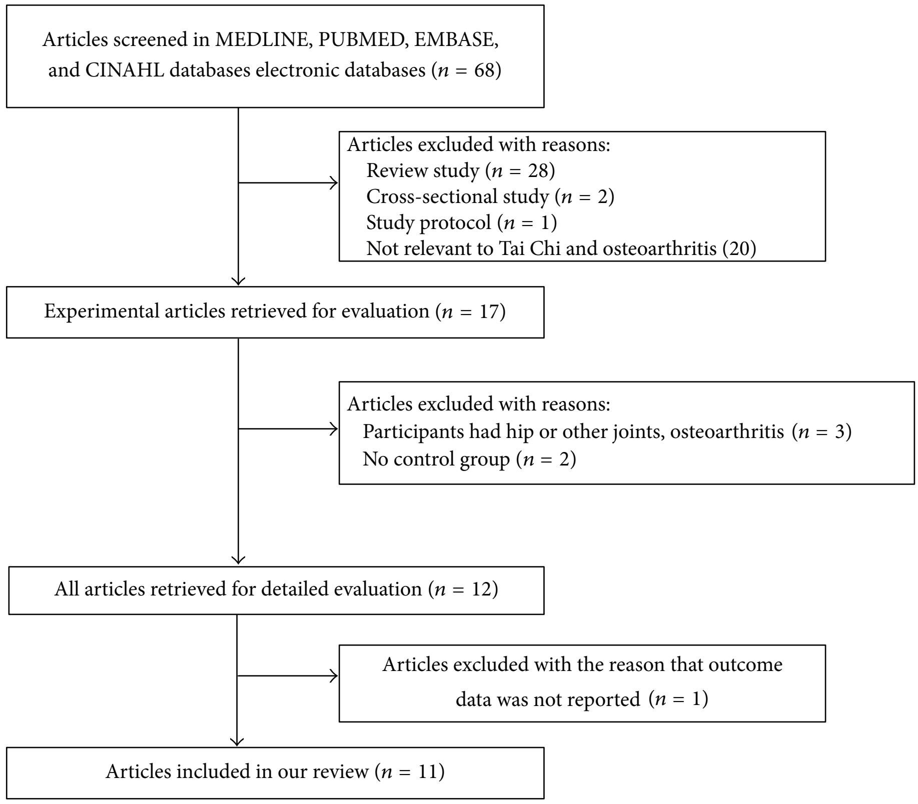


Figure 1: Flow diagram of article search.

3.3. Effects on Mental and Physical Components. According to the ICF model [13], the assessment methods of the selected articles were classified into the following four categories.

3.3.1. Mental Component in the Body Functions and Structures Domain. A 28-item motivation scale for health behaviors was used to assess perceived self-efficacy, benefits, barriers, and emotional salience [17]. The 5-point self-efficacy scores were also used for assessments [20]. The 60-point Center for Epidemiologic Studies Depression Index and 30-point mini-mental state examination were used to evaluate cognitive and emotional impairment [20, 23].

3.3.2. Physical Component in the Body Functions and Structures Domain. The 10-point visual analog scale and 35-point knee pain scale of Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) were used to assess the severity of pain during knee movement [15–21, 23, 24]. A verbal descriptive pain scale specific for older adults with cognitive impairment to assess pain-related behaviors during functional activities was also used [25]. The active range of motion for knee movement was assessed through goniometry [16], and the flexibility of the affected knee joint was assessed using the knee stiffness scale of WOMAC [15–21, 24]. An isokinetic dynamometer (Cybex 770, Lumex, USA) was used to measure the knee flexor and extensor strength and endurance at the speeds of 60°/s and 180°/s [15, 22]. Bone mineral density was measured using dual-energy X-ray absorptiometry (GE Lunar PIXImus, Lunar Co., West Indian Federation) [22]. The factors affecting knee joint loading, such as body weight and body mass index (BMI), were also recorded [15, 20, 21, 24].

3.3.3. Mental Component in the Activities and Participation Domain. The 25-item scale for health behaviors comprised the variables of health responsibility, exercise, diet behavior, stress management, and smoking habits [17]. Mental component of the 36-item Short Form Health Survey (SF-36) was used to assess the mental health [18, 20].

3.3.4. Physical Component in the Activities and Participation Domain. Cardiovascular functioning test [15], 6-minute walk test [18, 20, 21, 24], stair climb test [21, 24], sit-to-stand test [20, 23], and timed-up-and-go test [23, 24] were performed to assess physical performance. As the symptoms subsided, the motion frequency and time consumption decreased. The physical function scale of WOMAC [15, 16, 18–21, 23, 24], physical health component of SF-36 [18, 20], and Physical Activity Scale for the Elderly [24] were used to assess physical activity. Furthermore, the Survey of Activities and Fear of Falling in the Elderly was also used to assess the frequency of falling [19, 22].

3.4. Review Results of Studies. Analyses of all the included articles revealed that the WOMAC scale scores significantly decreased after Tai Chi Chuan intervention (Table 2),

TABLE 2: Summary of assessments and outcomes in the included articles.

Author (year)	Assessments	Outcomes	Adverse effects
Song et al. (2003) [15]	WOMAC (pain/stiffness/physical function); knee extensor strength and endurance; flexibility; BMI; cardiovascular functioning test	Knee extensor strength and endurance, flexibility, cardiovascular functioning test were improved* BMI and WOMAC were decreased*	No adverse event
Brismée et al. (2007) [16]	WOMAC (pain/stiffness/physical function); VAS; knee range of motion	WOMAC and VAS were decreased*	No adverse event
Song et al. (2007) [17]	WOMAC (pain/physical function); motivation; health behaviors	Motivation and health behaviors were improved* WOMAC was decreased*	No adverse event
Lee et al. (2009) [18]	WOMAC (pain/stiffness/physical function); SF-36; 6-min walking test	SF-36 and 6-min walking test were improved* WOMAC was decreased	No adverse event
Song et al. (2009) [19]	WOMAC (pain/stiffness/physical function); Survey of Activities and Fear of Falling in the Elderly	WOMAC was decreased Survey of Activities and Fear of Falling in the Elderly was improved*	No adverse event
Wang et al. (2009) [20]	WOMAC (pain/stiffness/physical function); VAS; SF-36; BMI; 6-min walking test; sit-to-stand test; Center for Epidemiology Studies Depression Index; self-efficacy	6-min walking test, sit-to-stand test, SF-36, self-efficacy were improved* WOMAC, VAS, Center for Epidemiology Studies Depression Index were decreased*	One participant reported an increase of knee pain
Ni et al. (2010) [21]	WOMAC (pain/stiffness/physical function); 6-min walking test; stair climb test; body weight	6-min walking test, stair climb test, body weight were improved* WOMAC was decreased*	No adverse event
Song et al. (2010) [22]	Bone mineral density; knee extensor and flexor strength and endurance; Survey of Activities and Fear of Falling in the Elderly	Knee extensor endurance was increased* Bone mineral density and Survey of Activities and Fear of Falling in the Elderly were improved*	No adverse event
Tsai et al. (2013) [23]	WOMAC (pain/stiffness/physical function); timed-up-and-go test; sit-to-stand test; mini-mental state examination	Timed-up-and-go test, sit-to-stand test, mini-mental state examination were improved* WOMAC was decreased*	No adverse event
Wortley et al. (2013) [24]	WOMAC (pain/stiffness/physical function); BMI; 6-min walking test; timed-up-and-go test; stair climb test; Physical Activity Scale for the Elderly	Physical Activity Scale for the Elderly, 6-min walking test, stair climb test, timed-up-and-go test* were improved WOMAC was decreased	No adverse event
Tsai et al. (2015) [25]	Verbal descriptive scale; pain behavior	Verbal descriptive scale and pain behavior were decreased*	No adverse event

$^{*}P < 0.05$, significant differences between before and after Tai Chi Chuan. WOMAC, Western Ontario and McMaster Universities Osteoarthritis Index; BMI, body mass index; VAS, Visual Analog Scale; and SF-36, 36-item Short Form Health Survey.

Authors (years)	Subgroups	n	SMD	95% CI
	WOMAC pain			
Brismée et al. (2007) [16]		41	0.06	−0.57–0.69
Song et al. (2007) [17]		43	−1.32	−2.00–−0.63
Lee et al. (2009) [18]		44	−0.32	−0.97–0.31
Song et al. (2009) [19]		69	0.13	−0.35–0.61
Ni et al. (2010) [21]		35	−1.72	−2.54–−0.90
Wortley et al. (2013) [24]		18	−0.14	−1.20–0.91
Total		250	−0.41	−0.67–−0.14
Test of homogeneity: $Q = 25.45$, df = 5, $P_{\text{heterogeneity}} = 0.0001$, $I^2 = 80\%$				
	WOMAC stiffness			
Brismée et al. (2007) [16]		41	0.47	−0.16–1.12
Song et al. (2007) [17]		43	−0.89	−1.54–−0.24
Lee et al. (2009) [18]		44	−0.17	−0.81–0.47
Song et al. (2009) [19]		69	−0.14	−0.63–0.34
Ni et al. (2010) [21]		35	−0.63	−1.34–0.07
Wortley et al. (2013) [24]		18	0.43	−0.64–1.50
Total		250	−0.20	−0.45–0.05
Test of homogeneity: $Q = 12.39$, df = 5, $P_{\text{heterogeneity}} = 0.02$, $I^2 = 59\%$				

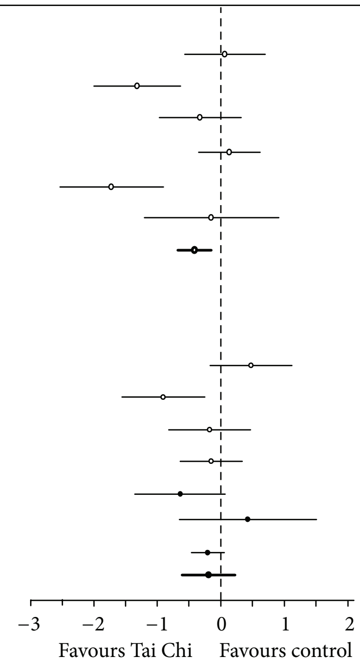


Figure 2: Effect of Tai Chi Chuan on physical component in body functions and structures domain.

suggesting that the symptoms and physical function of knee osteoarthritis were improved. Wang et al. [20] and Brismée et al. [16] reported that Tai Chi Chuan intervention significantly improved pain assessment results of the experimental group compared with those of the control group. Regarding functional activities and participation, stair climb test [21, 24], timed-up-and-go test [23, 24], and sit-to-stand test [20, 23] scores improved significantly after Tai Chi Chuan intervention in the experimental group compared with those in the control group. Song et al. [19, 22] also reported that the scores of the Survey of Activities and Fear of Falling in the Elderly improved significantly after Tai Chi Chuan intervention. Some studies showed that BMI and body weight decreased significantly in the experimental group [15, 20, 24]. In addition, Wang et al. [20] and Lee et al. [18] revealed that Tai Chi Chuan yielded significant improvements in the physical and mental health components of the SF-36 in the experimental group compared with that in the control group.

3.5. Results of Meta-Analysis. In the meta-analysis, the publication bias did not influence the outcomes of data analysis (fail-safe number = 189; tolerance level = 65). Insufficient data was included in the meta-analysis of the mental component in the body functions and structures as well as activities and participation domains. The results of meta-analyses revealed that the effects of Tai Chi Chuan were observed for physical components in the body functions and structures domain: WOMAC pain (total SMD = −0.41; 95% CI = −0.67 to −0.74; and $P_{\text{heterogeneity}} < 0.05$) and stiffness (total SMD = −0.20; 95% CI = −0.45 to −0.05; and $P_{\text{heterogeneity}} < 0.05$, Figure 2). Small effects were observed in the WOMAC pain and stiffness scale scores among patients with knee osteoarthritis practicing Tai Chi Chuan. The effects favouring Tai Chi Chuan were observed in the physical component in the activities and participation domain: WOMAC physical function (total SMD = −0.16; 95% CI = −0.44 to −0.11; and $P_{\text{heterogeneity}} = 0.14$), 6-min walking test (total SMD = −0.16; 95% CI = −1.23 to 0.90; and $P_{\text{heterogeneity}} < 0.05$), stair climb test (total SMD = −0.76; 95% CI = −1.34 to 0.15; and $P_{\text{heterogeneity}} < 0.05$), and the Survey of Activities and Fear of Falling in the Elderly (total SMD = −0.63; 95% CI = −0.98 to −0.27; and $P_{\text{heterogeneity}} = 0.78$, Figure 3); in other words, the meta-analysis results indicated that, after the intervention of Tai Chi Chuan, the patients with knee osteoarthritis showed small-to-moderate effects in WOMAC physical function, 6-min walking test, stair climb test, and Survey of Activities and Fear of Falling in the Elderly. Weak evidence result indicated the effects of Tai Chi Chuan for treating knee osteoarthritis on the change in the mental component, because there was insufficient data to perform a meta-analysis.

4. Discussion

4.1. Summary of Review Results. The current study revealed that after 8-week to 6-month class training sessions of Tai Chi Chuan, the patients with knee osteoarthritis exhibited improvements in their physiological and psychological states in 11 articles. Fransen et al. [26] indicated that short duration (i.e., <10 weeks) class training of Tai Chi Chuan alleviates knee osteoarthritis pain. By using 8-week class training of Tai Chi Chuan, Lee et al. [18] demonstrated a nonsignificant improvement in the WOMAC scores. Nevertheless, after the

Authors (years)	Subgroups	n	SMD	95% CI
	WOMAC physical function			
Brismée et al. (2007) [16]		41	0.06	−0.56–0.70
Lee et al. (2009) [18]		44	−0.42	−1.07–0.22
Song et al. (2009) [19]		69	0.08	−0.39–0.57
Ni et al. (2010) [21]		35	−0.88	−1.60–−0.15
Wortley et al. (2013) [24]		18	0.20	−0.86–1.26
Total		207	−0.16	−0.44–0.11
Test of homogeneity: $Q = 6.83$, df = 4, $P_{\text{heterogeneity}} = 0.14$, $I^2 = 41\%$				
	6-min walking test			
Lee et al. (2009) [18]		44	−0.59	−1.25–0.06
Ni et al. (2010) [21]		35	0.84	0.11–1.56
Wortley et al. (2013) [24]		18	−0.83	−1.94–0.28
Total		97	−0.16	−1.23–0.90
Test of homogeneity: $Q = 11.29$, df = 2, $P_{\text{heterogeneity}} = 0.003$, $I^2 = 82\%$				
	SAFE			
Song et al. (2009) [19]		69	−0.68	−1.17–−0.18
Song et al. (2010) [22]		65	−0.58	−1.08–−0.07
Total		134	−0.63	−0.98–−0.27
Test of homogeneity: $Q = 0.07$, df = 1, $P_{\text{heterogeneity}} = 0.78$, $I^2 = 99\%$				
	Stair climb test			
Ni et al. (2010) [21]		35	−1.18	−1.93–−0.43
Wortley et al. (2013) [24]		18	0.04	−1.01–1.10
Total		53	−0.74	−1.34–−0.15
Test of homogeneity: $Q = 3.88$, df = 1, $P_{\text{heterogeneity}} = 0.04$, $I^2 = 74\%$				

SMD, 95% CI

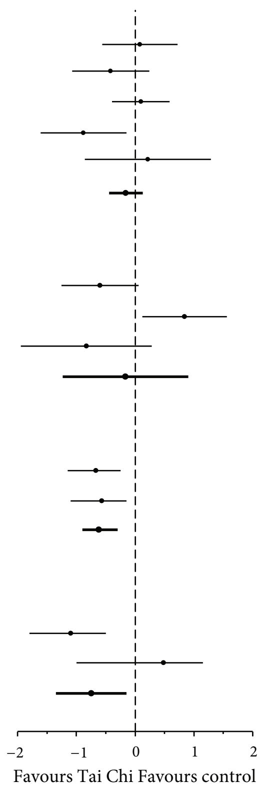


Figure 3: Effect of Tai Chi Chuan on physical component in the activities and participation domain.

class training, significant improvements were observed on the SF-36 and 6-min walking test scores, indicating that Tai Chi Chuan caused potential improvements in muscle endurance. Similar to endurance and aerobic exercises, Tai Chi Chuan comprised rhythmic movements and emphasis on body balance and coordination [19]. Tai Chi Chuan movements involve several postures, such as slight knee bending, arms below the shoulder level, forward or backward strides, and turning around while shifting the center of gravity [17]. Tai Chi Chuan was divided into at least five styles of Tai Chi Chuan, which were Chen-style, Wu-style, W'u-style, Sun-style, and Yang-style forms, according to Chinese martial art styles. Considering the geography and physical conditions of elderly participants, scholars had designed Tai Chi Chuan sets comprising 10–31 movements, the basic components of which resemble moves used in the original styles. The motivation and health behaviors of the elderly can improve by practicing Tai Chi Chuan styles comprising numerous movements [17]. In addition, the muscle strength of lower extremity as well as balance and coordination abilities of patients with knee osteoarthritis could be improved, and the mental capacity of the older adults can be enhanced [18, 20]. By contrast, Tai Chi Chuan set comprising relatively few movements are easy for the elderly to learn, thereby reducing their frustration of failure in learning. The study results of Brismée et al. [16] also indicated that elderly participants practicing 10 movements of Tai Chi Chuan exhibited a high level of acceptance and their dropout rates were low. In addition, Tai Chi Chuan was set as a few movement patterns, which consumed relatively less time during each cycle of the training, specifically for older adults [16]. Therefore, the number of cycles and duration of Tai Chi Chuan must be increased to achieve the positive effects, which is similar to effects of endurance and aerobic exercises. The effect of this factor should be considered when using Tai Chi Chuan as a therapeutic exercise.

Tai Chi Chuan could improve the physical functions of patients with osteoarthritis in terms of performance in the 6-minute walking test, stair climb test, and balance test [18, 20, 21]. Wortley et al. [24] revealed that Tai Chi Chuan effectively improves aerobic capacity, based on 11% and 12% increases in the stair climb test and timed-up-and-go test, respectively. The results indicated that Tai Chi Chuan can enhance the lower extremity muscle strength and cardiopulmonary function. Ni et al. [21] indicated that Tai Chi Chuan can increase the quadriceps muscle strength of the patients with osteoarthritis; thus alleviating quadriceps weakness was the main factor causing knee osteoarthritis. Wang et al. [20] and Lee et al. [18] also reported that Tai Chi Chuan was a low-intensity and low-impact exercise and could improve the motor functions of patients with osteoarthritis. Song et al. [15, 22] investigated the effects of Tai Chi Chuan on the strength and endurance of knee extensor and flexor muscles. They reported that Tai Chi Chuan enhanced the knee extensor endurance of patients with knee osteoarthritis; however, the difference in the strength of the knee extensor and flexor muscles between the experimental and control groups was nonsignificant. Tai Chi Chuan involved full-weight-bearing movement, in which an individual applies loading and uploading patterns in various directions [22]. In addition, while maintaining core stability, shifting the center of gravity requires the use of knee extensor endurance for maintaining postural balance [20, 23]. Therefore, Tai Chi Chuan could improve knee extensor endurance to manage knee osteoarthritis.

Obesity could increase the severity of knee osteoarthritis, and Tai Chi Chuan was beneficial for reducing the body weight of patients with knee osteoarthritis. Ni et al. [21] indicated that Tai Chi Chuan training produces effects similar to those of aerobic sports. This is specifically because the patients practicing Tai Chi Chuan engage in a wide range of motions which involve large muscle groups, along with calorie consumption as the metabolic rates of the body are increased, thereby resulting in weight loss. These factors were vital for relieving osteoarthritis-induced pain. Nevertheless, Wang et al. [20] reported that no weight loss was observed after patients with knee osteoarthritis practiced Tai Chi Chuan. Nevertheless, the osteoarthritis-induced knee pain was relieved. It indicated that weight loss was not the mechanism through which Tai Chi Chuan training reduces pain. A comparison revealed that the research design of Wang et al. [20] comprised a 12-week, 10-movement Tai Chi Chuan training, whereas that of Ni et al. [21] consisted of a 24-week, 24-movement training of Tai Chi Chuan. The difference in training intensity and duration may have contributed to the difference in the observed results and ultimately different conclusions. Among the 11 studies examined, only Song et al. [22] investigated the effects of Tai Chi Chuan training on bone density. Tai Chi Chuan practice for 6–12 months could slow bone density loss [27, 28]. By contrast, Song et al. [22] observed that Tai Chi Chuan training lasting only 6 months also had similar effects on slowing bone density loss. Tai Chi Chuan could reduce bone density loss because it involves weight-bearing movement [29]. According to Wolf's law, Tai Chi Chuan involved changes in postures resulting in forces similar to the foot-floor impact force generated while walking [30]. When bones are subjected to pressure, bone cell proliferation occurs, thereby reducing bone loss. Because Tai Chi Chuan can improve the metabolism, patients must continue Tai Chi Chuan for a longer duration. Specifically, patients with knee osteoarthritis must practice Tai Chi Chuan for at least 6 months to achieve considerable reduction in bone loss.

4.2. Evidence on Physical and Mental Component Effects of Tai Chi Chuan. The most crucial benefit of Tai Chi Chuan training was the increase in quadriceps muscle strength, and enhanced lower extremity strength can aid in preventing or reducing daily function loss and deterioration in the elderly [24]. Song et al. [22] also indicated that Tai Chi Chuan can effectively decrease fear of falling during daily functional activities of patients with knee osteoarthritis and that the positive effects of Tai Chi Chuan were attributed to increases in the muscle strength and endurance of the lower extremity. Improved daily life functions enable the elderly to readily interact with society, thereby enhancing self-efficacy and social function [17, 20]. This indicated a high efficacy of Tai Chi Chuan training in alleviating the psychological symptoms and depression resulting from knee osteoarthritis. Furthermore, patients with knee osteoarthritis were prone to a high risk of falling because of knee deformation and insufficient lower extremity muscle strength [19, 22]. By enhancing the endurance of the quadriceps, Tai Chi Chuan training could improve the posture control ability in the older adults, thereby reducing the risk of falling [22]. Numerous studies had confirmed that engaging in endurance sports can reduce the risks of falling in the older adults, increase self-care abilities, decrease mental illnesses, and increase social interaction frequency. Tai Chi Chuan training had similar effects to mind-body exercises [17, 20, 24, 25]. Furthermore, Tai Chi Chuan is also a low-impact endurance exercise and thus is appropriate for patients with knee osteoarthritis. The results of meta-analyses revealed that Tai Chi Chuan had small effect on the body functions and structures and small-to-moderate effects on the activities and participation domain of the physical component. Hence, on the basis of the improvements in the physical component of patients with knee osteoarthritis, a Philadelphia Panel Classification System level B was assigned to Tai Chi Chuan because of the significant improvements, with clinical significance, observed after the intervention.

Knee osteoarthritis was an inflammation resulting from knee degeneration, and knee cartilage damage may result in knee inflammation and pain [31]. The results of our meta-analysis indicated that Tai Chi Chuan could alleviate osteoarthritis-induced pain. However, the mechanism of the analgesic effectiveness of Tai Chi Chuan training remained unknown. On the basis of their evidence-based results, Bennell and Hinman [32] attributed the analgesic effectiveness to Tai Chi Chuan being a low-impact exercise, which increased lower extremity muscle strength. Tai Chi Chuan training could improve cardiopulmonary capacity, balance ability, and functional performances through increased muscle strength of lower extremity [15, 18, 20, 21, 24]. A significant correlation had been reported between weak lower extremity muscle strength and the pain experienced by patients with knee osteoarthritis [33]. Various subsequent assessments for evaluating the mental effects of Tai Chi Chuan had shown beneficial outcomes. Due to the lack of consistent assessments and result data for meta-analysis, insufficient evidence indicated that Tai Chi Chuan had mental component effects on improvements in body functions and structures or activities and participation domains for knee osteoarthritis.

Tai Chi Chuan was considered a form of mind and body component that enables people to maintain the mind and body balance [17, 20]. Subsequently, the functions of the immune and autonomic nervous systems can be improved and regulated, thereby achieving pain relief effects. Wang et al. [20] reported that Tai Chi Chuan is a form of rhythmic exercise, in which people achieve enhanced self-efficacy by regulating breathing and sustaining mind and body balance.

These findings can aid in disrupting the "pain cycle" experienced by patients with knee osteoarthritis. Currently, the mechanism underlying the effects of Tai Chi Chuan training on knee osteoarthritis had not been identified. However, reduced pain enables patients to continue exercising, thereby increasing muscle strength of lower extremity and improving abilities of balance and coordination and functions of daily life. At the psychological level, reduced pain was beneficial for achieving emotional stability and a balanced mood [25]. Hence, although the exact mechanism underlying its knee osteoarthritis pain reduction remains unknown, Tai Chi Chuan had significant positive effects for alleviating knee osteoarthritis symptoms. But there was insufficient data performing a meta-analysis to support the mental effects. On the basis of the mental component of participants with knee osteoarthritis, Tai Chi Chuan was assigned a Philadelphia Panel Classification System level C+ because of the significant improvements, without clinical significance, observed after the intervention.

4.3. Limitations and Suggestions for Future Research. This study had some limitations in our review. In the subgroup analysis, insufficient assessment items could be classified, and, hence, the meta-analysis could be performed using only a few studies. Although the various outcomes were presented and analyzed in the subgroup, the effects may be influenced by the data of few articles. Furthermore, a main limitation of the subgroup analysis based on ICF model was that effects on mental and components were not analyzed for lack of data in the recruited articles. There are also several suggestions for further investigations. First, the study results demonstrated that Tai Chi Chuan training has significant physiological and psychological effects on patients with knee osteoarthritis because Tai Chi Chuan could reduce osteoarthritis-induced pain and increase the quadriceps endurance. However, the interaction of biomechanical mechanism of Tai Chi Chuan and psychological outcomes of patients with knee osteoarthritis has not been identified. Second, no studies have explored exercise intensity, duration, and frequency appropriate for patients with knee osteoarthritis. Because of the long duration and complex movements involved in Tai Chi Chuan, participant dropouts are common; therefore, further studies on the need for exercise among older adults are necessary. Finally, several of the 11 analyzed studies included small sample sizes and limited long term follow-up outcomes. Most studies are concerned with assessments of Tai Chi Chuan in the physical component, but very few are concerned with the assessments of the mental component.

5. Conclusions

In summary, Tai Chi Chuan had beneficial outcomes for patients with knee osteoarthritis, that is, improving knee extensor endurance, aerobic capacity, and body balance and coordination and reducing the body weight and bone density loss. Positive effects can be observed in the physical component in body functions and structures as well as activities and participation domains. There was insufficient evidence to support that Tai Chi Chuan had beneficial mental effect on patients with knee osteoarthritis, because of insufficient data in the recruited articles. Consequently, future studies could emphasize mental effects of Tai Chi in patients with knee osteoarthritis. More studies with large samples and a long term follow-up were also suggested to be conducted.

Competing Interests

There are no competing interests.

Acknowledgments

The authors are grateful for financial support from China Medical University under Contracts nos. CMU104-S-35 and CMU105-SR-103.

References

[1] A. J. Metcalfe, M. L. Andersson, R. Goodfellow, and C. A. Thorstensson, "Is knee osteoarthritis a symmetrical disease? Analysis of a 12 year prospective cohort study," *BMC Musculoskeletal Disorders*, vol. 13, no. 1, article 153, 2012.

[2] T. Adams, D. Band-Entrup, S. Kuhn et al., "Physical therapy management of knee osteoarthritis in the middle-aged athlete," *Sports Medicine and Arthroscopy Review*, vol. 21, no. 1, pp. 2–10, 2013.

[3] H. Chen and K. Onishi, "Effect of home exercise program performance in patients with osteoarthritis of the knee or the spine on the visual analog scale after discharge from physical therapy," *International Journal of Rehabilitation Research*, vol. 35, no. 3, pp. 275–277, 2012.

[4] I. Krauss, G. Mueller, G. Haupt et al., "Effectiveness and efficiency of an 11-week exercise intervention for patients with hip or knee osteoarthritis: a protocol for a controlled study in the context of health services research," *BMC Public Health*, vol. 16, no. 1, article 367, 2016.

[5] W. Tuszyńska-Bogucka, T. Saran, B. Jurkowska, and W. Dziaduch, "Psychosocial generalised resistance resources and clinical indicators of patients suffering from osteoarthritis at the institute of rural health in Lublin, Poland," *Annals of Agricultural and Environmental Medicine*, vol. 22, no. 2, pp. 380–384, 2015.

[6] R. Shengelia, S. J. Parker, M. Ballin, T. George, and M. C. Reid, "Complementary therapies for osteoarthritis: are they effective?" *Pain Management Nursing*, vol. 14, no. 4, pp. e274–e288, 2013.

[7] S. Vallabhajosula, B. L. Roberts, and C. J. Hass, "Tai Chi intervention improves dynamic postural control during gait initiation in older adults: a pilot study," *Journal of Applied Biomechanics*, vol. 30, no. 6, pp. 697–706, 2014.

[8] M. S. Lee, M. H. Pittler, and E. Ernst, "Tai chi for osteoarthritis: a systematic review," *Clinical Rheumatology*, vol. 27, no. 2, pp. 211–218, 2008.

[9] L. Zhang, C. Layne, T. Lowder, and J. Liu, "A review focused on the psychological effectiveness of Tai Chi on different populations," *Evidence-Based Complementary and Alternative Medicine*, vol. 2012, Article ID 678107, 9 pages, 2012.

[10] R. Lauche, J. Langhorst, G. Dobos, and H. Cramer, "A systematic review and meta-analysis of Tai Chi for osteoarthritis of the

knee," *Complementary Therapies in Medicine*, vol. 21, no. 4, pp. 396–406, 2013.

[11] J. Ye, S. Cai, W. Zhong, S. Cai, and Q. Zheng, "Effects of Tai Chi for patients with knee osteoarthritis: a systematic review," *Journal of Physical Therapy Science*, vol. 26, no. 7, pp. 1133–1137, 2014.

[12] H. D. Clark, G. A. Wells, C. Huët et al., "Assessing the quality of randomized trials: reliability of the Jadad scale," *Controlled Clinical Trials*, vol. 20, no. 5, pp. 448–452, 1999.

[13] Y. Kurtaiş, D. Öztuna, A. A. Küçükdeveci, Ş. Kutlay, M. Hafiz, and A. Tennant, "Reliability, construct validity and measurement potential of the ICF comprehensive core set for osteoarthritis," *BMC Musculoskeletal Disorders*, vol. 12, article 255, 2011.

[14] G. R. Harris and J. L. Susman, "Managing musculoskeletal complaints with rehabilitation therapy: summary of the Philadelphia Panel evidence-based clinical practice guidelines on musculoskeletal rehabilitation interventions," *The Journal of Family Practice*, vol. 51, no. 2, pp. 1042–1046, 2002.

[15] R. Song, E.-O. Lee, P. Lam, and S.-C. Bae, "Effects of tai chi exercise on pain, balance, muscle strength, and perceived difficulties in physical functioning in older women with osteoarthritis: a randomized clinical trial," *The Journal of Rheumatology*, vol. 30, no. 9, pp. 2039–2044, 2003.

[16] J.-M. Brismée, R. L. Paige, M.-C. Chyu et al., "Group and home-based tai chi in elderly subjects with knee osteoarthritis: a randomized controlled trial," *Clinical Rehabilitation*, vol. 21, no. 2, pp. 99–111, 2007.

[17] R. Song, E. O. Lee, P. Lam, and S. C. Bae, "Effects of a Sun-style Tai Chi exercise on arthritic symptoms, motivation and the performance of health behaviors in women with osteoarthritis," *Journal of Korean Academy of Nursing*, vol. 37, no. 2, pp. 249–256, 2007.

[18] H.-J. Lee, H.-J. Park, Y. Chae et al., "Tai Chi Qigong for the quality of life of patients with knee osteoarthritis: a pilot, randomized, waiting list controlled trial," *Clinical Rehabilitation*, vol. 23, no. 6, pp. 504–511, 2009.

[19] R. Y. Song, A. Y. Eam, E. O. Lee, P. Lam, and S. C. Bae, "Effects of Tai Chi combined with self-help program on arthritic symptoms and fear of falling in women with osteoarthritis," *Journal of Muscle and Joint Health*, vol. 16, no. 1, pp. 46–54, 2009.

[20] C. Wang, C. H. Schmid, P. L. Hibberd et al., "Tai Chi is effective in treating knee osteoarthritis: a randomized controlled trial," *Arthritis Care and Research*, vol. 61, no. 11, pp. 1545–1553, 2009.

[21] G.-X. Ni, L. Song, B. Yu, C.-H. Huang, and J.-H. Lin, "Tai chi improves physical function in older Chinese women with knee osteoarthritis," *Journal of Clinical Rheumatology*, vol. 16, no. 2, pp. 64–67, 2010.

[22] R. Song, B. L. Roberts, E.-O. Lee, P. Lam, and S.-C. Bae, "A randomized study of the effects of *T'ai Chi* on muscle strength, bone mineral density, and fear of falling in women with osteoarthritis," *The Journal of Alternative and Complementary Medicine*, vol. 16, no. 3, pp. 227–233, 2010.

[23] P.-F. Tsai, J. Y. Chang, C. Beck, Y.-F. Kuo, and F. J. Keefe, "A pilot cluster-randomized trial of a 20-week tai chi program in elders with cognitive impairment and osteoarthritic knee: effects on pain and other health outcomes," *Journal of Pain and Symptom Management*, vol. 45, no. 4, pp. 660–669, 2013.

[24] M. Wortley, S. Zhang, M. Paquette et al., "Effects of resistance and Tai Ji training on mobility and symptoms in knee osteoarthritis patients," *Journal of Sport and Health Science*, vol. 2, no. 4, pp. 209–214, 2013.

[25] P.-F. Tsai, J. Y. Chang, C. Beck, Y.-F. Kuo, F. J. Keefe, and K. Rosengren, "A supplemental report to a randomized cluster trial of a 20-week Sun-style Tai Chi for osteoarthritic knee pain in elders with cognitive impairment," *Complementary Therapies in Medicine*, vol. 23, no. 4, pp. 570–576, 2015.

[26] M. Fransen, L. Nairn, J. Winstanley, P. Lam, and J. Edmonds, "Physical activity for osteoarthritis management: a randomized controlled clinical trial evaluating hydrotherapy or Tai Chi classes," *Arthritis Care & Research*, vol. 57, no. 3, pp. 407–414, 2007.

[27] K. Chan, L. Qin, M. Lau et al., "A randomized, prospective study of the effects of Tai Chi Chun exercise on bone mineral density in postmenopausal women," *Archives of Physical Medicine and Rehabilitation*, vol. 85, no. 5, pp. 717–722, 2004.

[28] J. Woo, A. Hong, E. Lau, and H. Lynn, "A randomised controlled trial of Tai Chi and resistance exercise on bone health, muscle strength and balance in community-living elderly people," *Age and Ageing*, vol. 36, no. 3, pp. 262–268, 2007.

[29] S. S.-C. Hui, Y. J. Xie, J. Woo, and T. C.-Y. Kwok, "Effects of Tai Chi and walking exercises on weight loss, metabolic syndrome parameters, and bone mineral density: a cluster randomized controlled trial," *Evidence-Based Complementary and Alternative Medicine*, vol. 2015, Article ID 976123, 10 pages, 2015.

[30] H. Wang, B. Yu, W. Chen, Y. Lu, and D. Yu, "Simplified Tai Chi resistance training versus traditional Tai Chi in slowing bone loss in postmenopausal women," *Evidence-Based Complementary and Alternative Medicine*, vol. 2015, Article ID 379451, 6 pages, 2015.

[31] C. Wang, M. D. Iversen, T. McAlindon et al., "Assessing the comparative effectiveness of Tai Chi versus physical therapy for knee osteoarthritis: design and rationale for a randomized trial," *BMC Complementary and Alternative Medicine*, vol. 14, article 333, 2014.

[32] K. L. Bennell and R. S. Hinman, "A review of the clinical evidence for exercise in osteoarthritis of the hip and knee," *Journal of Science and Medicine in Sport*, vol. 14, no. 1, pp. 4–9, 2011.

[33] S. C. O'Reilly, A. Jones, K. R. Muir, and M. Doherty, "Quadriceps weakness in knee osteoarthritis: the effect on pain and disability," *Annals of the Rheumatic Diseases*, vol. 57, no. 10, pp. 588–594, 1998.

Hindawi Publishing Corporation
Evidence-Based Complementary and Alternative Medicine
Volume 2016, Article ID 5672580, 7 pages
http://dx.doi.org/10.1155/2016/5672580

Research Article

Evaluation of Exercise Tolerance in Dialysis Patients Performing Tai Chi Training: Preliminary Study

Wioletta Dziubek,[1] Katarzyna Bulińska,[1] Mariusz Kusztal,[2] Joanna Kowalska,[1] Łukasz Rogowski,[3] Agnieszka Zembroń-Łacny,[4] Tomasz Gołębiowski,[2] Bartosz Ochmann,[5] Weronika Pawlaczyk,[1] Marian Klinger,[2] and Marek Woźniewski[1]

[1]*Department of Physiotherapy, University of Physical Education, Paderewskiego 35 Street, 51-612 Wroclaw, Poland*
[2]*Department and Clinic of Nephrology and Transplantation Medicine, Wroclaw Medical University, Borowska 213 Street, 50-556 Wroclaw, Poland*
[3]*Non-Public Medical College of Wroclaw, Nowowiejska 69 Street, 50-340 Wroclaw, Poland*
[4]*Faculty of Medicine and Health Sciences, University of Zielona Gora, Licealna 9 Street, 65-417 Zielona Gora, Poland*
[5]*Department of Physical Education, University of Physical Education, Paderewskiego 35 Street, 51-612 Wroclaw, Poland*

Correspondence should be addressed to Wioletta Dziubek; wioletta.dziubek@awf.wroc.pl

Received 31 March 2016; Accepted 19 June 2016

Academic Editor: Gloria Duke

Introduction. Patients with end-stage renal disease (ESRD) have poor physical performance and exercise capacity due to frequent dialysis treatments. Tai Chi exercises can be very useful in the area of rehabilitation of people with ESRD. Objectives. The aim of the study was to assess exercise capacity in ESRD patients participating in 6-month Tai Chi training. *Patients and Methods*. Twenty dialysis patients from Wroclaw took part in the training; at the end of the project, 14 patients remained (age 69.2 ± 8.6 years). A 6-minute walk test (6MWT) and spiroergometry were performed at the beginning and after 6 months of training. Results. After 6 months of Tai Chi, significant improvements were recorded in mean distance in the 6MWT (387.89 versus 436.36 m), rate of perceived exertion (7.4 versus 4.7), and spiroergometry (8.71 versus 10.08 min). *Conclusions*. In the ESRD patients taking part in Tai Chi training, a definite improvement in exercise tolerance was recorded after the 6-month training. Tai Chi exercises conducted on days without dialysis can be an effective and interesting form of rehabilitation for patients, offering them a chance for a better quality of life and fewer falls and hospitalisations that are the result of it.

1. Introduction

Chronic kidney disease (CKD) is a common illness that affects approximately 150 million people worldwide each year. Furthermore, the number of patients with end-stage CKD, when it becomes necessary to start dialysis, is quickly growing. Currently, more than half of the patients included in the dialysis programmes in Europe are people over the age of 65. The largest increase among all patients who qualified for dialysis has been recorded in the 70+ age group. For example, in 2012 in Poland, 64% of all qualified subjects were over the age of 65.

An increase in morbidity is associated with the phenomenon of prolonging average life expectancy and the escalation of lifestyle diseases. Patients with CKD are burdened with a number of comorbidities, such as diabetes and cardiovascular diseases, which are often the cause of kidney failure and, at the same time (cardiovascular events), are responsible for their death. Poor physical performance predicts the high risk of mortality and cardiovascular events in patients with CKD.

Progressive renal failure is often accompanied by an unhealthy lifestyle, including a lack of regular physical activity. This contributes to a deterioration of functioning in everyday life. The culmination of poor functioning in end-stage renal failure occurs when a patient requires renal replacement therapy. It is estimated that, after each month of dialysis, the level of physical activity of people with end-stage renal disease (ESRD) decreases by 3.4% [1]. Compared to healthy subjects and patients with a milder form of the disease, the level of exercise tolerance, exercise capacity, strength, and endurance of those on dialysis are significantly reduced [2, 3]. It is estimated that the ability for physical exertion in patients with ESRD is 60–65% compared to healthy individuals with sedentary lifestyles [4, 5].

The introduction of physical training to a therapeutic process of people with CKD is recommended regardless of the severity of the disease. Recommendations of the Kidney Disease: Improving Global Outcomes (KDIGO) indicate a need to introduce rehabilitation programmes based on the principles of cardiac training due to the high risk of cardiovascular events [6]. Patients with ESRD are offered two possibilities of supervised physical training: during dialysis treatments (the first two hours or up until ultrafiltration at 2.5 l of fluids) and on days without dialysis.

There is a lot of scientific evidence confirming the effectiveness of regular physical exercise during and between dialysis treatments [7–11]. Physical training performed at least twice a week for 45–60 minutes on average has an effect, i.a., on improved aerobic capacity, reduced tissue insulin resistance, and blood pressure, thereby modifying cardiovascular risk factors [12]. Regular physical exercise also causes hypertrophy of skeletal muscles (an increase of surface area of type I and types IIa and IIx fibres in a cross section) [13], improving muscle strength and power, lowering fatigability, and causing an overall increase in physical functioning in patients with ESRD [11, 14]. An improvement in physical fitness significantly improves quality of life and daily functioning [15].

Physical exercises performed on days without dialysis offer more health benefits compared to training undertaken during dialysis treatments [16]. On such days, patients generally feel better; they can perform free-range movements at all levels and train in a standing position. An additional benefit of these types of activities is their group character, which improves social contact and motivation to exercise and maintains regularity. However, it requires constant supervision by a qualified physiotherapist and doctor during each training unit. Because of the burden of coexisting comorbidities, there are programmes introduced with low (30–49% of HR_{max}; 25–44% VO_{2max}) to moderate (50–69% HR_{max}; 45–59% VO_{2max}) intensity, which is gradually increased as patients adapt to the exercise [17].

Tai Chi exercises have been very useful in the area of rehabilitation of people with ESRD. Because of their low intensity, fluidity of movement, mindfulness, and diversity of forms, they are considered safe and have many benefits in terms of psychophysical aspects. The unquestionable advantage of Chinese gymnastics is its relaxing nature, together with breathing, overcoming the resistance of one's own body, carefully shifting the center of gravity, and normalising muscle tone, which are of great importance to people with ESRD due to myopathy, renal osteodystrophy, and concomitant cardiovascular disorders [18]. The low intensity of Tai Chi exercises is recommended for those leading a sedentary lifestyle, people who are frail, and the elderly [19].

In the literature, there is little scientific information about the effects of Tai Chi exercises on patients undergoing dialysis [20–23], including only two investigations concerning Tai Chi exercises on days without dialysis [21, 22]. Therefore, the aim of the study was to assess the exercise capacity of patients with end-stage renal failure participating in a six-month Tai Chi training conducted on days without dialysis.

2. Methods

Studies were performed in the Laboratory of Functional Studies at the Department of Physiotherapy of the University of Physical Education in Wroclaw. Tai Chi training was undertaken by twenty dialysis patients of the Clinic of Nephrology and Transplantation Medicine at the Wroclaw Medical University. All were residents of the city who met the following inclusion criteria: end-stage renal failure, hemodialysis therapy for at least six months prior to the commencement of research, attending practitioner's consent to participate in training, and adequate dialysis therapy (dialysis adequacy ratio $Kt/V > 1.2$: protein catabolic rate 0.8–1.4 g protein/kg of body weight/day). The final analysis excluded patients who died during the study, received a kidney transplant, did not want to complete the questionnaire again, or attended fewer than 36 training sessions (<75% of the training cycle). Lack of cooperation (especially due to dementia) and absence of written informed consent were other reasons for exclusion from the study.

To participate in the study, patients were qualified by a nephrologist and a cardiologist (see study flow chart, Figure 1). The nephrologist's permission to participate in the study was based on the patient's recent health status and biochemistry results. Each patient was informed of the voluntary nature of the study and of the option to withdraw from the exercise training. To carry out the study, approval from the Bioethics Committee of the University of Physical Education in Wroclaw was obtained. All patients gave their informed written consent to participate in the study. During the study project, one patient died of pneumonia (high CRP, WBC) and the death was not associated with participation in Tai Chi training.

2.1. Outcome Measures. A personal questionnaire, six-minute walk test (6MWT), and spiroergometry on a K4b2 by COSMED (Italy) ergospirometer were used in the study. Each patient filled out a personal questionnaire once, before the training. At the beginning (t_1) and after six months of Tai Chi exercise training (t_2), a 6MWT and spiroergometry were performed.

2.2. A Personal Questionnaire. The questionnaire consisted of two parts and included both sociodemographic data (age, gender, marital status, education, and number of years on dialysis) and clinical data related to the disease (date of diagnosis, date of commencement of dialysis, cause of renal failure, and number of comorbidities). The first part was to be filled by the patient and the other part by the staff based on the medical history report.

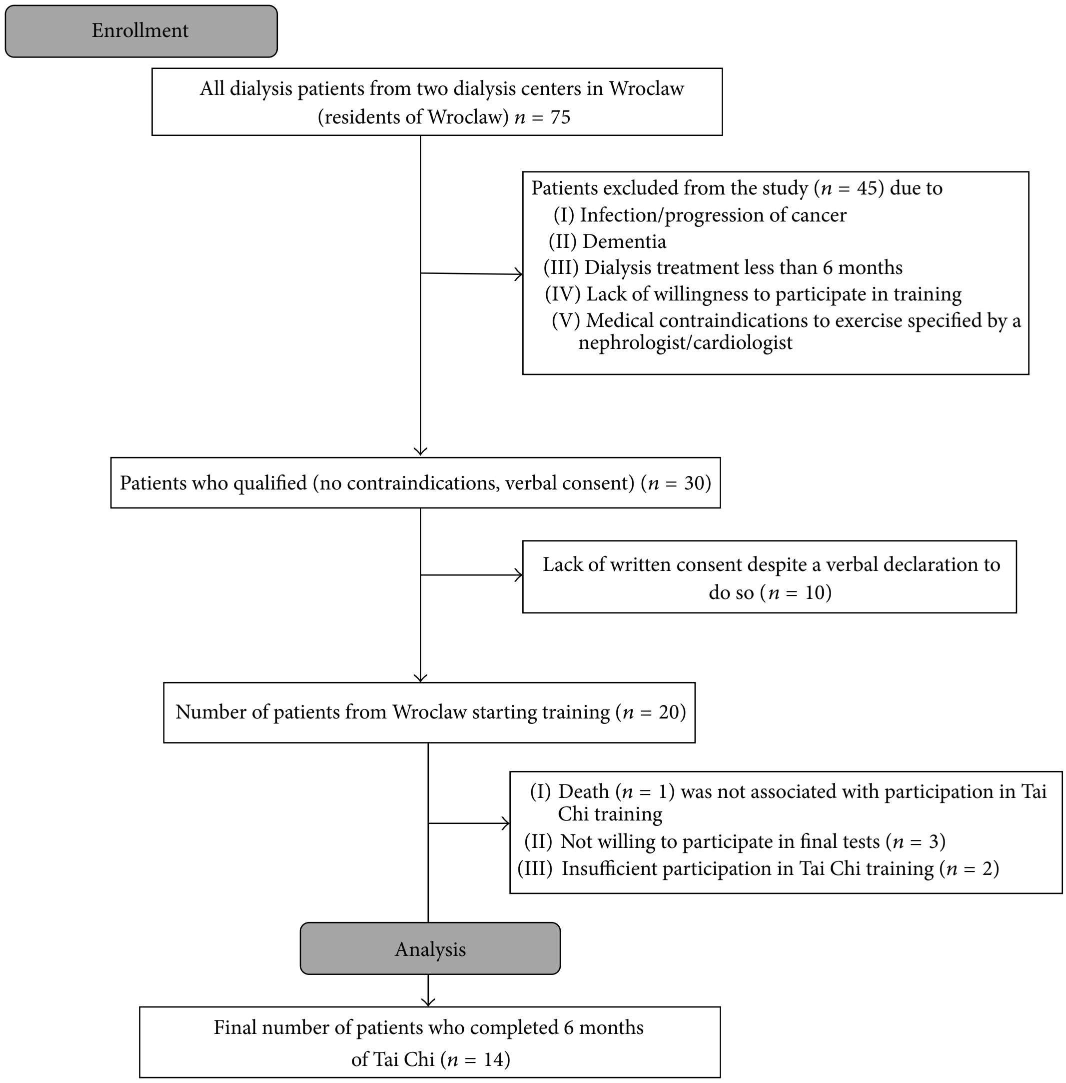


Figure 1: The recruitment process towards the study group.

2.3. 6MWT. A 6MWT was performed in accordance with the guidelines of the American Thoracic Society, that is, along a 30 m corridor under medical supervision [24]. The respondent was asked to walk for six minutes at a pace that they used daily. The study measured the distance covered during the entire test. This test allowed for the assessment of the levels of exercise tolerance and exercise capacity. Covering a distance of 600–700 m was considered satisfactory, while a distance of fewer than 300 m indicated a poor prognosis [24]. Before the test, the respondents were informed of the possibility of resting during the test in a standing or sitting position (on chairs located along the corridor) when symptoms of exercise intolerance (dyspnoea, shortness of breath, maximum pain of the lower extremities, general fatigue, etc.) intensified.

In the case of severe symptoms of exercise intolerance (dyspnoea, shortness of breath, dizziness, blurred vision, sudden sweating, cyanosis, general weakness, and fatigue) that did not subside despite a temporary rest in a sitting or standing position, the test was discontinued immediately.

The test results consisted of a distance, measured in m (with accuracy of 1 m), and a level of subjective fatigue according to the 10-point Borg scale (where 0 is no fatigue/dyspnoea and 10 is extreme fatigue/shortness of breath). Before beginning the test, immediately after it, and in the fifth minute of restitution, as well as at a time when the respondent was resting as a result of intensifying symptoms of exercise intolerance, pulse rate measurements were taken at the radial artery of the upper extremity without a fistula. In addition, blood pressure readings were taken in a sitting position [24].

2.4. Spiroergometry. The test was performed using a k4b2 cardiopulmonary ergospirometer by COSMED (Italy), in line with the protocol developed at Bartnet-Lab using the cycle-ergometer by Kettler. The measurement of gas exchange during the exercise test (spiroergometry) is a sophisticated measurement for assessing exercise capacity.

The exercise test was conducted in the form of a progressive test. During the first minute of the test, resting parameters were recorded. The initial power load for both women and men was 25 W. Patients pedalled on the ergometer with a frequency of revolutions of 60–90 rpm. In each subsequent minute, the load was increased by 5 W for women and 10 W for men. The test lasted until the patients refused to continue or until the pedalling frequency dropped below 59 rpm.

After the completion of the test, for another three minutes, the ergospirometer registered the restitution parameters. The following parameters were analysed: minute ventilation VE (L/min), oxygen uptake VO_2 (mL/min), and oxygen uptake per kg of body weight VO_2/kg (mL/min/kg). These were maximal values obtained in the progressive maximal test (largest values, averaged over 15-second intervals).

2.5. Tai Chi Training. The Tai Chi training was held twice a week for 60 minutes for a period of six months (48 training sessions). Training sessions took place at a gymnasium in the Department of Physiotherapy of the University of Physical Education in Wroclaw on days without dialysis, under constant supervision of a certified Tai Chi specialist and an attending practitioner. The Tai Chi 24-form Yang (24 forms of Beijing) was used in the training. The form 24 Tai Chi Chuan of the Yang style was the most common form of Tai Chi training, defined as a standardised form from Beijing [25].

The intensity of classes increased gradually. For patients' safety, a team of therapists were monitoring the limits permissible in cardiac rehabilitation concerning heart rate and blood pressure, as defined by international standards [26]. In addition, the basic parameter determining the maximum safe level of physical activity was the heart rate limit (HR_{max}), which was determined individually for each patient during the exercise stress test. An increase in the heart rate of up to 50% of HR_{max} in weeks 1–4, up to 60% of the rate in weeks 4–8, up to 70% in weeks 8–16, and up to 80% in weeks 16–24 was deemed safe. An allowable subjective submaximal fatigue during training, not exceeding 7-8 points on a simplified 10-point Borg scale, was also considered.

2.6. Statistical Analysis. A statistical description of the data included the determination of mean values, standard deviations, and a range of variations, that is, maximum and minimum values in the distribution of a characteristic. The normality of the distribution of analysed characteristics was assessed using the Shapiro-Wilk test. The sexual dimorphism of the age distribution was evaluated using Student's t-test for independent samples. Changes in the distribution of characteristics as a result of the six-month Tai Chi training were examined using Student's t-test for dependent samples. Correlations were evaluated using Pearson's correlation coefficient (r). The critical significance level was set at $\alpha = 0.05$. Statistical analysis was conducted using STATISTICA 10 software package by StatSoft.

Table 1: Baseline characteristics of the patients.

Baseline characteristics	Total patients (%) ($n = 14$)
Age	
Mean (SD)	69.2 (8.6)
Range	55–83
Gender	
Women	7 (50)
Men	7 (50)
Education	
Primary and vocational	2 (14.3)
Secondary	8 (57.14)
Higher	4 (28.57)
Marital status	
Married	7 (50)
Single people (widow(er), unmarried)	7 (50)
Cause of ESRD:	
Nephropathy (diabetic + hypertensive)	6 (42.85)
Glomerulonephritis	5 (35.72)
ADPDK	2 (14.3)
Other	1 (7.14)
Disease duration (years)	
Mean (SD)	11.5 (9.2)
Duration of dialysis (years)	
Mean	7.2 (4.1)
Number of comorbidities	
Mean (SD)	2.85 (2.1)
Comorbidities:	
Hypertension	11
Diabetes	5
Cardiovascular disease (ischemic heart disease, atrial fibrillation, TIA, stroke)	9
Peripheral artery disease	7
Degenerative joint disease	2
Other	6

3. Results

Twenty patients met the study criteria. At the end of the research project, 14 patients remained (Figure 1). Their mean age was 69.2 ± 8.6 years, including seven women and seven men. The characteristics of the study group are shown in Table 1.

The average distance achieved in the 6MWT test was 387.89 m, which improved significantly after six months of Tai Chi training ($P = 0.019$). There was also a decline in subjective fatigue as a result of physical effort, which was assessed using a 10-point Borg scale ($P = 0.002$) (Table 2). Mean values of heart rate frequency and blood pressure did not change significantly (Table 3).

The analysis of changes to the spiroergometric parameters in response to a six-month cycle of Tai Chi showed a statistically significant prolongation of the exercise stress test regarding time using a cycloergometer ($P = 0.013$). The remaining parameters were not statistically significant (Table 4).

Table 2: The changes in result of 6MWT after 6 months of Tai Chi training.

Variable	Measurement	Mean	SD	Mean change	Student's t-test	
					t	P
6MWT [m]	t_1	387.89	139.80	48.5	2.67	0.019[a]
	t_2	436.36	186.49			
Borg scale	t_1	7.4	0.7	2.7	8.80	0.002[a]
	t_2	4.7	0.7			

[a] $P < 0.05$; t_1: before Tai Chi training; t_2: after Tai Chi training.

Table 3: Effects of Tai Chi training on heart rate and blood pressure before and after 6MWT.

Variable	Measurement	Mean		Mean change	Student's t-test	
		Before 6MWT	After 6MWT		t	P
HR, bpm	t_1	79.1	89.3	10.2	0.18	0.857
	t_2	78.7	88.4	9.6		
SBP, mmHg	t_1	125.6	151.0	25.4	1.20	0.253
	t_2	133.4	149.4	15.9		
DBP, mmHg	t_1	74.9	85.5	10.6	1.19	0.257
	t_2	77.9	84.6	6.7		

[a] $P < 0.05$; DBP: diastolic blood pressure; HR: heart rate; SBP: systolic blood pressure; t_1: before Tai Chi training; t_2: after Tai Chi training.

Table 4: Changes of spiroergometry parameters after 6-month Tai Chi training.

Variable	Measurement	Mean	SD	Mean change	Student's t-test	
					t	P
Test time, min	t_1	8.71	2.76	1.37	2.89	0.013[a]
	t_2	10.08	3.72			
MET	t_1	4.34	1.53	0.35	1.72	0.109
	t_2	4.69	1.90			
VE, L/min	t_1	43.00	16.98	0.89	0.55	0.594
	t_2	43.89	18.17			
VO_2, mL/min	t_1	1096.6	502.9	96.00	1.70	0.113
	t_2	1192.6	609.8			
VO_2/kg, mL/min/kg	t_1	15.37	5.55	0.98	1.64	0.125
	t_2	16.36	6.48			

[a] $P < 0.05$; t_1: before Tai Chi exercise training; t_2: after Tai Chi exercise training; VE: minute ventilation; VO_2: oxygen uptake; VO_2/kg: oxygen uptake per kg of body weight.

The analysis of the correlation showed a positive relationship between the distance obtained in the 6MWT and VE, VO_2 mL/min, and VO_2/kg both prior to partaking in Tai Chi exercises (t_1) and after six months of training (t_2) (Table 5). The correlation of respondents' ages with the 6MWT test results and the spiroergometric variables was negative and statistically insignificant.

4. Discussion

Thus far, only a few scientific reports confirmed the beneficial effects of Tai Chi training among patients with ESRD. Positive effects were confirmed in studies on physical fitness, muscular strength, balance and falls, cardiorespiratory parameters, immune system efficacy, quality of sleep, and quality of life [27–32]. However, the subject of Tai Chi training in kidney diseases is still poorly understood.

The results obtained showed that, after six months of Tai Chi training conducted on days without dialysis, the average walking distance was lengthened by 12.5%. The improvement applied to all respondents and was statistically significant, as opposed to studies by Ling et al. [20], who evaluated, among others, walking capacity of ESRD patients using the 6MWT. The improvement recorded over the average walking distance in the 6MWT after three months of training was only 4.1%. The reason could regard the unsupervised nature of the proposed exercises (at home using a video), as well as a shorter, three-month period of training [20].

The subjective feeling of fatigue following exercise was reduced as a result of long-term, systematic Tai Chi training.

Table 5: Pearson's correlation of 6MWT with spiroergometry parameters before and after Tai Chi training.

6MWT	VE, L/min	VO_2, mL/min	VO_2/kg, mL/min/kg
t_1	0.83[a]	0.78[a]	0.77[a]
t_2	0.87[a]	0.78[a]	0.83[a]

[a]Significant Pearson's correlation; r_k (0.05) = 0.53; t_1: before Tai Chi training; t_2: after Tai Chi training; VE: minute ventilation; VO_2: oxygen uptake; VO_2/kg: oxygen uptake per kg of body weight.

Prior to the six-month programme, the physical effort exerted during the test was perceived as very hard; after Tai Chi training, it was perceived as somewhat hard. This additionally showed an increase in exercise tolerance among respondents. This was also confirmed in the correlation analysis, which indicated a significant relationship between distance covered in the 6MWT test and exercise capacity. Therefore, the longer the distance a patient covered, the greater the exercise capacity. This was important for patients with ESRD and it was reflected in the improvement in their quality of life and daily functioning.

The evaluation of exercise capacity by means of spiroergometry showed a significant increase in exercise stress test time (by 1.37 minutes). The respiratory parameters examined did not change significantly. This was probably because Tai Chi training was a low-intensity exercise, which did not significantly increase respiratory rate; thus, it only slightly improved the respiratory component of exercise capacity. Therefore, the main process of the body's physiological adaptation to physical activity must take place in the cardiovascular and muscular system.

Thus far, the effects of Tai Chi training on the level of exercise capacity in dialysis patients were not analysed. However, many studies conducted among people with cardiovascular diseases, which often coexist in patients with ESRD, confirmed the significant impact of long-term (over three months) Tai Chi training on aerobic capacity, especially in patients that had previously functioned at a very low level of physical activity [28, 33].

It was worth noting that, in patients with ESRD, more benefits were obtained when the training was performed on days without dialysis, though it was burdened with a higher percentage of resignation among participants (up to 50%) [20]. Furthermore, Konstantinidou et al. (2002) confirmed a greater effectiveness in improving exercise capacity among people training on days without dialysis compared to training performed during dialysis [16]. Also, in the present study, Tai Chi training conducted on days without dialysis produced measurable benefits. This method of rehabilitation seemed to be more attractive and encouraging compared to training during dialysis, while the group character of the activities additionally motivated people to continue this form of training, thus improving the psychophysical condition of patients.

The obtained results require further research and verification on a larger group of patients with ESRD. A control group should also be introduced, which is a limitation of this study. Nevertheless, even at this stage, it can be said that Tai Chi training for six months significantly improves exercise capacity and walking qualities and can be introduced into the rehabilitation programmes of dialysis patients due to its safe and effective form.

In conclusion, after six months of Tai Chi training, the average 6MWT score and the time on a cycle-ergometer significantly improved, which indicated a definite improvement in exercise tolerance in all respondents. Tai Chi training conducted on days without dialysis was an effective and interesting form of rehabilitation for patients, providing a chance for fewer falls and hospitalisations and a higher quality of life.

Disclosure

The funding agency had no role in the study design; collection, analysis, and interpretation of data; or the decision to submit this original work for publication. The results presented in this paper have not been published previously in whole or part, except in abstract form.

Competing Interests

The authors report no competing interests.

Acknowledgments

The study was supported by a research grant from the National Science Centre in Poland (no. 2011/03/B/NZ7/01764, to Wioletta Dziubek). The authors thank the nursing and medical staff at the Dialysis Center at the University Hospital in Wroclaw for their friendly support.

References

[1] K. L. Johansen, G. A. Kaysen, B. S. Young, A. M. Hung, M. da Silva, and G. M. Chertow, "Longitudinal study of nutritional status, body composition, and physical function in hemodialysis patients," *The American Journal of Clinical Nutrition*, vol. 77, no. 4, pp. 842–846, 2003.

[2] C. W. McIntyre, N. M. Selby, M. Sigrist, L. E. Pearce, T. H. Mercer, and P. F. Naish, "Patients receiving maintenance dialysis have more severe functionally significant skeletal muscle wasting than patients with dialysis-independent chronic kidney disease," *Nephrology Dialysis Transplantation*, vol. 21, no. 8, pp. 2210–2216, 2006.

[3] K. L. Johansen, J. Doyle, G. K. Sakkas, and J. A. Kent-Braun, "Neural and metabolic mechanisms of excessive muscle fatigue in maintenance hemodialysis patients," *American Journal of Physiology—Regulatory Integrative and Comparative Physiology*, vol. 289, no. 3, pp. R805–R813, 2005.

[4] P. Painter, D. Messer-Rehak, P. Hanson, S. W. Zimmerman, and N. R. Glass, "Exercise capacity in hemodialysis, CAPD and renal transplant patients," *Nephron*, vol. 42, no. 1, pp. 47–51, 1985.

[5] K. L. Johansen, G. M. Chertow, A. V. Ng et al., "Physical activity levels in patients on hemodialysis and healthy sedentary controls," *Kidney International*, vol. 57, no. 6, pp. 2564–2570, 2000.

[6] L. A. Inker, B. C. Astor, C. H. Fox et al., "KDOQI US commentary on the 2012 KDIGO clinical practice guideline for the evaluation and management of CKD," *American Journal of Kidney Diseases*, vol. 63, no. 5, pp. 713–735, 2014.

[7] B. S. B. Cheema and M. A. Fiatarone Singh, "Exercise training in patients receiving maintenance hemodialysis: a systematic review of clinical trials," *American Journal of Nephrology*, vol. 25, no. 4, pp. 352–364, 2005.

[8] K. Chojak-Fijałka and O. Smolenski, "Rehabilitacja ruchowa chorych przewlekle hemodializowanych—wyniki badań własnych," *Problemy Lekarskie*, vol. 45, no. 3, pp. 247–256, 2006.

[9] T. Gołębiowski, M. Kusztal, W. Weyde et al., "A program of physical rehabilitation during hemodialysis sessions improves the fitness of dialysis patients," *Kidney and Blood Pressure Research*, vol. 35, no. 4, pp. 290–296, 2012.

[10] K. Girija and R. Radha, "Beneficial effect of physical activity in hemodialysis patients," *Universal Journal of Engineering Science*, vol. 1, no. 2, pp. 40–44, 2013.

[11] W. Dziubek, K. Bulińska, Ł. Rogowski et al., "The effects of aquatic exercises on physical fitness and muscle function in dialysis patients," *BioMed Research International*, vol. 2015, Article ID 912980, 9 pages, 2015.

[12] E. J. Kouidi, "Central and peripheral adaptations to physical training in patients with end-stage renal disease," *Sports Medicine*, vol. 31, no. 9, pp. 651–665, 2001.

[13] E. Kouidi, M. Albani, K. Natsis et al., "The effects of exercise training on muscle atrophy in haemodialysis patients," *Nephrology Dialysis Transplantation*, vol. 13, no. 3, pp. 685–699, 1998.

[14] T. W. Storer, R. Casaburi, S. Sawelson, and J. D. Kopple, "Endurance exercise training during haemodialysis improves strength, power, fatigability and physical performance in maintenance haemodialysis patients," *Nephrology Dialysis Transplantation*, vol. 20, no. 7, pp. 1429–1437, 2005.

[15] P. Painter, L. Carlson, S. Carey, S. M. Paul, and J. Myll, "Physical functioning and health-related quality-of-life changes with exercise training in hemodialysis patients," *American Journal of Kidney Diseases*, vol. 35, no. 3, pp. 482–492, 2000.

[16] E. Konstantinidou, G. Koukouvou, E. Kouidi, A. Deligiannis, and A. Tourkantonis, "Exercise training in patients with end-stage renal disease on hemodialysis: comparison of three rehabilitation programs," *Journal of Rehabilitation Medicine*, vol. 34, no. 1, pp. 40–45, 2002.

[17] S. J. Strath, L. A. Kaminsky, B. E. Ainsworth et al., "Guide to the assessment of physical activity: clinical and research applications: a scientific statement from the American Heart Association," *Circulation*, vol. 128, no. 20, pp. 2259–2279, 2013.

[18] S. A. Jamal, S. L. West, and P. D. Miller, "Fracture risk assessment in patients with chronic kidney disease," *Osteoporosis International*, vol. 23, no. 4, pp. 1191–1198, 2012.

[19] S. P. Bonifonte, *Tai Chi for Seniors*, The Career Press, Franklin Lakes, NJ, USA, 2004.

[20] K.-W. Ling, F. S. Y. Wong, W.-K. Chan et al., "Effect of a home exercise program based on Tai Chi in patients with end-stage renal disease," *Peritoneal Dialysis International*, vol. 23, no. 2, pp. S99–S103, 2003.

[21] N. Shahgholian, A. Eshghinezhad, and M. Mortazavi, "The effect of tai chi exercise on quality of life in hemodialysis patients," *Iranian Journal of Nursing and Midwifery Research*, vol. 19, no. 2, pp. 152–158, 2014.

[22] S. Mustafa, L. Cooper, N. Langrick, N. Simon, S. V. Jassal, and D. G. Oreopoulos, "The effect of a Tai Chi exercise program on quality of life in patients on peritoneal dialysis: a pilot study," *Peritoneal Dialysis International*, vol. 25, no. 3, pp. 291–294, 2005.

[23] S. Phisitkul, M. C. Chyu, Y. Zhang et al., "Intradialytic modified Tai Chi exercise among end-stage renal disease patients undergoing hemodialysis: an exploratory pilot study," *Alternative & Integrative Medicine*, vol. 2, no. 5, pp. 1–7, 2013.

[24] ATS Committee on Proficiency Standards for Clinical Pulmonary Function Laboratories, "ATS statement: guidelines for the six-minute walk test," *American Journal of Respiratory and Critical Care Medicine*, vol. 166, no. 1, pp. 111–117, 2002.

[25] A. Topor, A. Kajfasz, and T. C. Chuan, *The Path of Health, Longevity and Martial Arts. Part I*, Złote Myśli, Gliwice, Poland, 2006.

[26] P. Dylewicz, A. Jegier, R. Piotrowicz et al., "Kompleksowa rehabilitacja kardiologiczna," *Folia Cardiologica*, vol. 11, pp. 1–48, 2004.

[27] C. Wang, J. P. Collet, and J. Lau, "The effect of Tai Chi on health outcomes in patients with chronic conditions: a systematic review," *Archives of Internal Medicine*, vol. 164, no. 5, pp. 493–501, 2004.

[28] A. P. Verhagen, M. Immink, A. van der Meulen, and S. M. A. Bierma-Zeinstra, "The efficacy of Tai Chi Chuan in older adults: a systematic review," *Family Practice*, vol. 21, no. 1, pp. 107–113, 2004.

[29] A. M. Kuramoto, "Therapeutic benefits of Tai Chi exercise: research review," *Wisconsin Medical Journal*, vol. 105, no. 7, pp. 42–46, 2006.

[30] G. Y. Yeh, C. Wang, P. M. Wayne, and R. S. Phillips, "The effect of Tai Chi exercise on blood pressure: a systematic review," *Preventive Cardiology*, vol. 11, no. 2, pp. 82–89, 2008.

[31] R. Jahnke, L. Larkey, C. Rogers, J. Etnier, and 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.

[32] C. Wang, R. Bannuru, J. Ramel, B. Kupelnick, T. Scott, and C. H. Schmid, "Tai Chi on psychological well-being: Systematic review and meta-analysis," *BMC Complementary and Alternative Medicine*, vol. 10, article 23, 2010.

[33] R. E. Taylor-Piliae, "The effectiveness of Tai Chi exercise in improving aerobic capacity: an updated meta-analysis," in *Tai Chi Chuan. State of the Art in International Research*, Y. Hong, Ed., vol. 52 of *Medicine and Sport Science*, pp. 40–53, Karger, Basel, Switzerland, 2008.