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REVIEW

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The Western and Chinese exercise training for blood pressure reduction among hypertensive patients: An overview of systematic reviews

Kelvin Tsoi BSc, PhD[1,2] | Amy Lam RPh, MPhil[3] | Joshua Tran MD[3] | Ziyu Hao MD[1] | Karen Yiu MSc[2] | Yook-Chin Chia MBBS, FRCP[4,5] | Yuda Turana MD, PhD[6] | Saulat Siddique MBBS, MRCP (UK), FRCP (Lon)[7] | Yuqing Zhang MD[8] | Hao-Min Cheng MD, PhD[9,10,11,12] | Ji-Guang Wang MD, PhD[13] | Kazuomi Kario MD, PhD[14] | on behalf of the HOPE Asia Network

[1]The Jockey Club School of Public Health and Primary Care, Faculty of Medicine, The Chinese University of Hong Kong, Hong Kong, Hong Kong

[2]Stanley Ho Big Data Decision Analytics Research Centre, The Chinese University of Hong Kong, Hong Kong, Hong Kong

[3]Department of Medicine and Therapeutics, Faculty of Medicine, The Chinese University of Hong Kong, Hong Kong, Hong Kong

[4]Department of Medical Sciences, School of Medical and Life Sciences, Sunway University, Bandar Sunway, Malaysia

[5]Department of Primary Care Medicine, Faculty of Medicine, University of Malaya, Kuala Lumpur, Malaysia

[6]Department of Neurology, School of Medicine and Health Sciences, Atma Jaya Catholic University of Indonesia, Jakarta, Indonesia

[7]Punjab Medical Center, Lahore, Pakistan

[8]Divisions of Hypertension and Heart Failure, Fu Wai Hospital, Chinese Academy of Medical Sciences and Peking Union Medical College, Beijing, China

[9]Center for Evidence-based Medicine, Taipei Veterans General Hospital, Taipei, Taiwan

[10]Ph.D. Program of Interdisciplinary Medicine (PIM), National Yang Ming Chiao Tung University College of Medicine, Taipei, Taiwan

[11]Institute of Public Health, National Yang Ming Chiao Tung University College of Medicine, Taipei, Taiwan

[12]Institute of Health and Welfare Policy, National Yang Ming Chiao Tung University College of Medicine, Taipei, Taiwan

[13]Department of Cardiovascular Medicine, the Shanghai Institute of Hypertension, Shanghai Key Laboratory of Hypertension, State Key Laboratory of Medical Genomics, National Research Centre for Translational Medicine, Ruijin Hospital, Shanghai Jiaotong University School of Medicine, Shanghai, China

[14]Division of Cardiovascular Medicine, Department of Medicine, Jichi Medical University School of Medicine, Tochigi, Japan

Correspondence
Kelvin Tsoi, JC School of Public Health and Primary Care, The Chinese University of Hong Kong, Hong Kong, Hong Kong.
Email: kelvintsoi@cuhk.edu.hk

Abstract

Hypertension remains the world's leading cause of premature death. Interventions such as exercise, diet modification, and pharmacological therapy remain the mainstay of hypertension treatment. Numerous systematic reviews and meta-analyses demonstrated the effectiveness of western exercises, such as aerobic exercise and resistance exercise, in reducing blood pressure in hypertensive patients. There is recently emerging evidence of blood pressure reduction with Chinese exercises, such as Tai Chi, Baduanjin, and Qigong. The current overview of systematic reviews aims to evaluate

Kelvin Tsoi and Amy Lam made an equal contribution to this study.

the quality and descriptively summarize the evidence for the effectiveness of western and Chinese exercises for hypertension management. Thirty-nine systematic reviews were included in this overview, with 15 of those being on Chinese exercise. Evidence suggests that exercise training, regardless of Western or Chinese exercise, generally reduced both systolic and diastolic blood pressure. High-intensity intermittent training did not further reduce blood pressure when compared to moderate-intensity continuous training. Conflicting results on the effectiveness of blood pressure reduction when comparing Chinese and Western exercise training were observed. This suggests the comparable effectiveness of Chinese exercise training, in particularly Tai Chi, to general or aerobic exercise training in terms of blood pressure reduction. The Chinese exercise modality and intensity may be more suitable for the middle-aged and elderly population.

KEYWORDS
Antihypertensive Therapy, Exercise/Hypertension, Lifestyle Modification/Hypertension, Non-Pharmacological Therapy, Western and Chinese exercise

1 | INTRODUCTION

Hypertension and pre-hypertension remain the world's leading causes of premature death, accounting for 8.5 million deaths annually.[1,2] Hypertension is shown to be an important risk factor for various cardiovascular diseases, chronic kidney disease, and end-stage renal disease, contributing to a large portion of annual deaths.[3,4] The global prevalence of hypertension remained stable in 2019 compared to 1990 with 32% of women and 34% of men being affected by hypertension, along with an undiagnosed rate of 40%–50%.[5] However, the prevalence disparity between countries is increasing, disproportionately affecting low- and middle-income countries in multiple metrics including risk factors, awareness, treatment, and control.[6,7] The disparity is compounded by differences in social determinants of health that affect risk factors for hypertension such as unhealthy diet, alcohol consumption, and lack of physical activity.[7,8] With large annual economic losses due to cardiovascular diseases, low- and middle-income countries need cost-effective hypertension treatment tools.[9,10] Globally, the prevalence of hypertension also comes at a cost. The direct costs of treating hypertension and its consequences account for 10% of the total health expenditure, while also affecting the productivity and quality of life of hypertensive patients.[11,12]

There is a continual need to improve treatment options for hypertension consequent to the high costs of treatment and associated losses as well as the growing disparity in hypertension prevalence across countries. Hypertension treatment comprises pharmacological treatment and lifestyle modifications, with patient education influencing these treatments.[13,14] Within lifestyle modifications, exercise training has shown strong evidence in managing hypertension as a sole intervention or as a combined intervention.[15,16] Exercise training has become part of clinicians' prescription and may even be the first-line treatment for some hypertensive patients.[17,18] As personalized medicine continues to evolve and develop, a greater understanding of hypertension management options, exercise training, in this case, is needed.[19]

Knowledge of exercise training and its impact on hypertension management is constantly broadening with more literature. Numerous systematic reviews and meta-analyses of western exercise training are available to guide and recommend in hypertension management,[20–22] and more studies were published to assess the evidence from the Chinese exercises, including Tai Chi,[23,24] Baduanjin,[25] and Qigong.[26] This overview of the systematic reviews aims to evaluate the quality of the evidence and summarize the effectiveness of Western and Chinese exercise training in the management of hypertensive patients.

2 | METHODOLOGY

2.1 | Search strategy and selection criteria

A systematic literature search with related keywords of hypertension, blood pressure (BP), and exercise was conducted in PubMed and EMBASE from inception until April 2022. The complete syntax of the keywords used is shown in Supplementary S1. The inclusion criteria included: (1) studies published in the format of systematic review or meta-analysis; (2) studies were conducted for the subjects with hypertension; (3) exercise training as the intervention was used to compare with control groups; (4) changes of the systolic BP (SBP) or diastolic BP (DBP) were included as the outcome measures; and (5) the full text of the articles was available in English. There was no restriction on the ways of blood pressure measurement, but the measurements were required to be the same before and after exercise training. The studies were excluded if the study participants were: (1) youth/adolescent aged below 18; (2) pregnant women; (3) diagnosed

with pulmonary hypertension; (4) substantial physical disability, such as wheelchair users or subjects with spinal cord injury; (5) on cardiopulmonary exercise test intervention, which is a clinical assessment tool as an objective determination of aerobic capacity and impairment.[27] A list of exercise training was identified from the literature search, including aerobic exercises, resistance exercises, exercises mixed with different components of aerobic, resistance training, breathing techniques, and meditation, and exercises with Chinese styles of body consciousness, balance, and breathing control. Chinese exercises included Baduanjin, Tai Chi, and Qigong (Table 1). These traditional Chinese exercise trainings are an important part of traditional Chinese culture and are believed to benefit both physical and mental health. Qigong merges the theory of traditional Chinese medicine, meridians, Taoism, the theory of yin and yang, and the theory of five elements in terms of wood, fire, earth, metal, and water.[28] Baduanjin stresses mind-body integration through symmetrical body movement, breathing control, and mental focus.[29] Tai Chi is a low-intensity aerobic exercise in a semi-squat posture involving continuous body movements, with the intensity being regulated through speed and postural height.[30] If the exercise training was conducted without specific descriptions in the original systematic review, the interventions were classified as general exercises.

2.2 | Data extraction

Two reviewers (A.L., K.Y.) independently screened for the titles and abstracts of all articles from the literature databases. The abstracts were screened according to the above inclusion and exclusion criteria. The full texts of the selected articles were downloaded, and the eligibility of each article was cross-checked by a research team (A.L., K.Y., J.T., Z.H.). When there were discrepancies regarding the inclusion of studies or data extraction, either the research team would achieve a consensus, or a definitive decision was made by the supervisor (KT) if consensus was not achieved. Data extraction included: (1) searching duration of each systematic review or meta-analysis; (2) the number of individual studies included; (3) type of included studies, such as randomized controlled trial, controlled trial without specification on randomization, or observational study; (4) characteristics of the study population, including age, ethnicity, and comorbidities; (5) quality assessment used in the systematic reviews; (6) definition of hypertension used; (7) type of exercise used as intervention and/or control groups; (8) length of regular exercise; and (9) changes of SBP and DBP as the outcome measure. The changes in BP were measured as mean difference or standardized mean difference with 95% confidence intervals (CI) if provided.

2.3 | Study quality

The quality of included systematic reviews was assessed by A Measurement Tool to Assess Systematic Reviews 2 (AMSTAR-2), which evaluated various domains, including registered protocol prior to review, literature search, justification for exclusion, risk of bias of individual primary studies, meta-analytical methods, and assessment of publication bias.[31] There are seven items regarded as critical domains. The rating on quality assessment depends on the number of inadequate ratings in critical and non-critical domains, and can be summarized into four tiers of overall confidence: critically low, low, moderate, and high. Systematic reviews with high overall confidence are those with an accurate and comprehensive summary of results, while those with critically low confidence suggest that there exist critical flaws that prevent an accurate and comprehensive summary.[31] Individual studies were compared across the eligible systematic reviews to measure the potential risk of reporting bias. The proportion of included studies from the gray literature, including studies without complete reference list for included individual studies, studies without formal publication or unpublished data from the postgraduate thesis, was assessed. Overlapping of individual studies from non-gray literature was assessed using corrected covered area (CCA).[32] Interpretation of CCA is as follows: ≤5%, slight overlap; 6%–10%, moderate overlap; 11%–15%, high overlap; >15%, very high overlap.[32] This systematic review followed the guidelines for Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA).[33]

3 | RESULTS

3.1 | Literature search and study selection

A total of 1652 abstracts were identified from the databases and three potential studies were further extracted from the bibliographies of eligible studies. All titles or abstracts were screened after the removal of 654 duplicated search records. Full-text versions of two potential articles were not available and 48 full-text articles were further assessed for final eligibility. Nine studies were excluded for the following reasons: study participants included those without hypertension (n = 3); a study did not use exercise as the intervention (n = 1); a study did not have a control group (n = 1); studies did not report the literature search (n = 2); outcome measure was not related to BP (n = 2) (Figure 1). Therefore, this overview included 39 systematic reviews published from the years of 1994 to 2022.

3.2 | Study characteristics

This overview of systematic review covered 39 studies,[20–26,34–65] including 16 systematic reviews[20–22,24,34,42,45,49,53–57,59,60,63] on aerobic exercises, eight systematic reviews[20,41,47,49,51,54,57,62,66] on resistance exercises, seven systematic reviews[20,35,36,39,49,64,65] on mixed exercise approaches (such as combining aerobic and resistance exercises, dance therapy, or the aquatic exercise), 11 studies[20,24,26,37,40,48,49,56,57,60,63] on general exercises, and 15 systematic reviews[23–26,37,38,43,46,50,52,53,55,58,61,65] on Chinese exercises, including breathing exercises, Baduanjin, Tai Chi and Qigong (Table 2). Twelve systematic reviews[20,24,26,37,49,53,55–57,60,63,65] evaluated more than one type of exercises, including general exercises. Among the systematic reviews on Chinese exercise training, five of them[24,26,37,53,55]

TABLE 1 Classification of exercise training from the literature review

Classification	Types of exercise training	Description
Aerobic Exercise	Aerobic exercise	Any activity that uses large muscle groups, can be maintained continuously and is rhythmic in nature
	Moderate-intensity continuous training (MICT)	Exercise interventions with intensity between 64% and 76% of peak heart rate performed continuously, or exercise intensity reporting percentage of maximal oxygen uptake, oxygen uptake reserve, heart rate reserve, or rating of perceived exertion equivalent to 64%–76% of peak heart rate according to American College of Sports Medicine
	High-intensity interval training (HIIT)	Repeated high-intensity interval bouts between 80% and 100% of peak heart rate interspersed with recovery periods or light exercise, or exercise intensity reporting percentage of maximal oxygen uptake, oxygen uptake reserve, heart rate reserve, or rating of perceived exertion equivalent to 80%–100% of peak heart rate according to American College of Sports Medicine.
Resistance Exercise	Resistance exercise	A form of periodic exercise whereby external weight provides progressive overload to skeletal muscles
	Isometric resistance	Muscular contraction against an immovable load, but there is no change in muscle length
	Isometric handgrip	Isometric resistance exercise is undertaken by squeezing a handgrip device
Mixed Approach	Aquatic exercise	An adaptation of land-based physical activity (i.e., walking, jogging, calisthenics, and locomotor/resistive movements) to a water medium, often performed in an upright stance
	Combined exercise	Exercise interventions with the components of aerobic and resistance exercise
	Yoga	Associated with physical postures, breathing techniques, and meditation
	Dance therapy	Rhythmic body movements with therapeutic purposes are usually performed with music
Chinese Exercise	Baduanjin	A form of gentle movement combines with meditation to improve body consciousness and balance by coordination between upper limbs and lower limbs through soft and gentle postures
	Breathing exercise	Repetitive breathing exercise, with or without an external load, using a flow-dependent resistance or a pressure threshold
	Tai chi	A traditional Chinese martial art that combines slow, fluid, weight-bearing physical movements with deep, controlled breathing exercises and relaxation techniques
	Qigong	A traditional fitness method combines the elements of body movement, mind guidance, and breath control

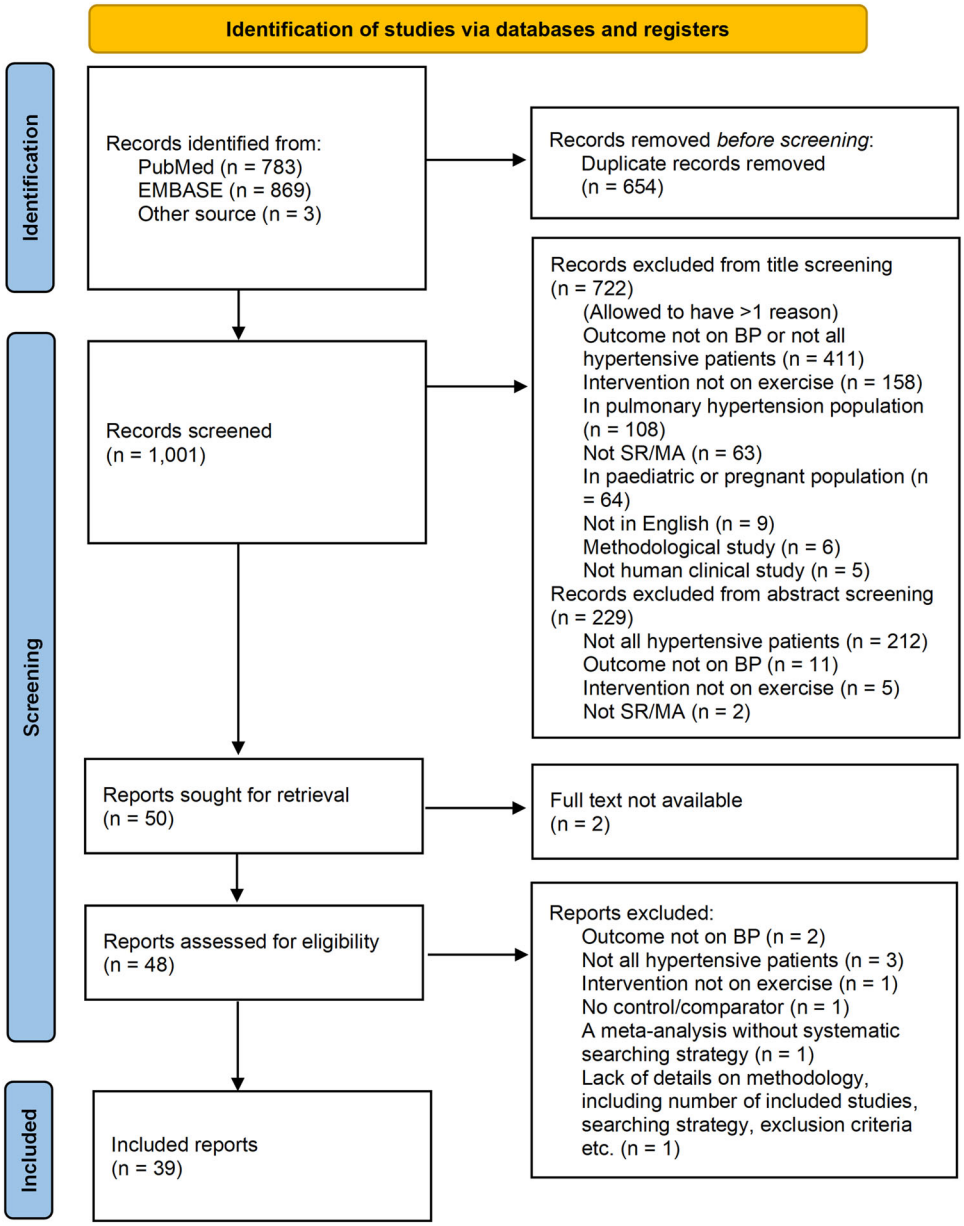

FIGURE 1 PRISMA flow chart for inclusion of studies. BP, blood pressure; MA, meta-analysis; SR, systematic review.

compared Chinese exercises with aerobic or other general exercises. There were four systematic reviews[24,37,38,48] that compared exercise training with anti-hypertensive drugs. According to the summarized data from the systematic reviews, the average age ranges of participants were from 50 to 54 years in aerobic exercise training, from 57 to 59 years in resistance exercise training, from 47 to 63 years in mixed exercise approaches, and from 51 to 70 years in Chinese exercise training. Most of the participants joined the exercise for at least 3–4 weeks, and some participants enrolled in the Chinese exercise for 5 years. All studies used the changes in both SBP and DBP as the primary outcomes, and only four studies[49,54,57,60] reported the BP levels from 24-h ambulatory BP monitoring. Most of the included studies (66.7%) used Cochrane risk of bias to assess the quality of original studies.

Among all 39 included systematic reviews, only one review[40] was rated as having high overall confidence in the provision of an accurate and comprehensive summary of results on addressing the question of interest (Supplementary S2). Seven reviews[24,45,48,50,54,59,61] were classified as low overall confidence, while the remaining were classified as critically low confidence. Almost all reviews, except the one by Williamson et al.,[40] did not report the justification for excluding individual studies (item 7). Only 1 review[24] reported sources of funding for the included studies (item 10). Fifteen of all included systematic reviews (38.5%) were regarded as gray literature, while most of them (11/15, 73.3%) involved Chinese exercise training. Complete reference lists were available except for two of the included reviews.[48,65] Among the 37 reviews, there were 376 individual studies included, and the

TABLE 2 Demographics of included studies

Study	No. of studies	Mean age[a]	Exercise training (intervention)	Control	Outcome measures	Length of intervention	Quality assessment
Kelley et al. 1994	9	51	Aerobic exercise	No exercise	SBP, DBP	10 to 37 weeks	N/A
Lee et al. 2007	12	56	Qigong	General exercise	SBP, DBP, all-cause mortality, blood lipids	2 months to 1 year	Jadad score
Hagins et al. 2013	17	47	Yoga	No yoga	SBP, DBP	3 to 48 weeks	Cochrane Risk of Bias
Cramer et al. 2014	7	51	Yoga	No yoga	SBP, DBP	8 to 24 weeks	Cochrane Risk of Bias
Xiong et al. 2015 (a)[b]	20	54	Qigong	General exercise	SBP, DBP	8 weeks to 1 year	Cochrane Risk of Bias
Xiong et al. 2015 (b)[b]	8	61	Baduanjin	No Baduanjin	SBP, DBP, QoL, BMI, waist-to-hip ratio, blood glucose, blood lipids	3 to 12 months	Cochrane Risk of Bias
Conceição et al. 2016	4	50	Dance therapy	No dance therapy	SBP, DBP, exercise capacity	4 to 12 weeks	PEDro Scale
Williamson et al. 2016	14	42	General exercise	No exercise	SBP, DBP	3 months to 5 years	Cochrane Risk of Bias, GRADE
Farah et al. 2017	7	58	Isometric handgrip	Not specified	SBP, DBP, mean BP, BPV, pulse pressure, oxidative stress, HRV	6 to 10 weeks	TESTEX
Wen et al. 2017	13	51	Aerobic exercise	Not specified	SBP, DBP	4 weeks to 6 months	N/A
Costa et al. 2018	9	57	HIIT	MICT	SBP, DBP, VO_{2max}	4 to 16 weeks	TESTEX
Cao et al. 2019	14	51	Aerobic exercise	No exercise	SBP, DBP, HR, QoL	40 min to 6 months	Cochrane Risk of Bias
Jin et al. 2019[b]	16	61	Chinese exercise	No Chinese exercise	SBP, DBP, HR, nitric oxide, endothelin, blood lipids, QoL	6 to 48 weeks	Cochrane Risk of Bias
Guan et al. 2020 (a)	13	70	Tai Chi	No Tai Chi	SBP, DBP, blood lipids, BMI, waist circumference	6 to 48 weeks	Cochrane Risk of Bias
Guan et al. 2020 (b)[b]	12	61	Baduanjin	No exercise	SBP, DBP	4 to 48 weeks	Cochrane Risk of Bias
Leal et al. 2020	15	56	HIIT, MICT	Not specified	SBP, DBP, VO_{2max}	4 to 16 weeks	TESTEX
Lee et al. 2020[b]	37	56	Aerobic exercise	No aerobic exercise	SBP, DBP, HR	4 to 37 weeks	Cochrane Risk of Bias
Liang et al. 2020[b]	15	52	Tai Chi	No Tai Chi	SBP, DBP, QoL, blood glucose, blood lipids	6 weeks to 18 months	Cochrane Risk of Bias
Loaiza-Betancur et al. 2020	11	Nil	Isometric handgrip	Not specified	SBP, DBP, MAP	6 to 12 weeks	Cochrane Risk of Bias
Noone et al. 2020[b]	93	54	General exercise	No exercise	SBP, DBP	8 weeks	Cochrane Risk of Bias
Saco-Ledo et al. 2020	15	58	Aerobic, resistance or combined exercise	Not specified	SBP, DBP (24 h, daytime, nighttime ABP)	8 to 24 weeks	PEDro scale
Sardeli et al. 2020	17	65	Aerobic, resistance or combined exercise	Not specified	SBP, DBP	Not specified	PEDro Scale
Shao et al. 2020[b]	14	60	Baduanjin	No baduanjin	SBP, DBP, blood glucose, blood lipids	60 to 360 days	modified Cochrane Risk of Bias, GRADE

(Continues)

TABLE 2 (Continued)

Study	No. of studies	Mean age[a]	Exercise training (intervention)	Control	Outcome measures	Length of intervention	Quality assessment
Zhong et al. 2020[b]	28	58	Tai Chi	General exercise, but no Tai Chi	SBP, DBP, blood lipids	6 weeks to 5 years	Cochrane Risk of Bias
Almeida et al. 2021	6	59	Isometric handgrip	No isometric handgrip	SBP, DBP, HRV	8 to 10 weeks	Cochrane Risk of Bias, GRADE
Dai et al. 2021[b]	30	61	Chinese exercise	No Chinese exercise	SBP, DBP, nitric oxide, endothelin	8 to 260 weeks	Cochrane Risk of Bias, GRADE
Dong et al. 2021[b]	14	54	Qigong	General exercise or no exercise	SBP, DBP	8 weeks to 1 year	Cochrane Risk of Bias
Hansford et al. 2021[b]	24	Nil	Isometric resistance	Aerobic exercise or no exercise	SBP, DBP (office brachial BP, central BP, 24 h ABP)	3.4 to 24 weeks	Cochrane Risk of Bias, GRADE
Pan et al. 2021[b]	24	60	Tai Chi	No Tai Chi or aerobic exercise	SBP, DBP, BMI, QoL	12 weeks to 5 years	Cochrane Risk of Bias
Park et al. 2021	8	57	Aerobic, anaerobic, or general exercise	No exercise	SBP, DBP, HbA1c, BMI, waist circumference	2 to 36 months	Cochrane Risk of Bias
Saco-Ledo et al. 2021	37	54	Combined exercise (aerobic, resistance)	No exercise	SBP, DBP (24 h, daytime, nighttime 24 h ABP)	Single session	Cochrane Risk of Bias, TESTEX
da Silva et al. 2021	8	51	Respiratory training	No exercise	SBP, DBP	3 to 12 weeks	PEDro scale
de Barcelos et al. 2022	24	54	Aerobic exercise	No aerobic exercise	SBP, DBP	6 to 37 weeks	Cochrane Risk of Bias
Dassanayake et al. 2022	4	60	Aerobic or general exercise	No aerobic or no general exercise	SBP, DBP (24 h ABP)	8 to 16 weeks	Cochrane Risk of Bias, GRADE
Ge et al. 2022[b]	30	63	Chinese exercise	No Chinese exercise	SBP, DBP	4 to 48 weeks	PEDro scale
Igarashi 2022	17	57	Resistance exercise	No exercise	SBP, DBP, BMI	8 to 34 weeks	Cochrane Risk of Bias
Lu et al. 2022	12	56	MICT, HIIT or general exercise	No exercise	SBP, DBP, BMI, rest HR	2 to 24 weeks	Cochrane Risk of Bias
Trindade et al. 2022	4	63	Aquatic exercise	Land exercise or no exercise	SBP, DBP	Not specified	TESTEX
Zhu et al.2022[b]	46	54	Yoga, aquatic exercise, Tai Chi & qigong	No exercise	SBP, DBP	2 weeks to 16 months	Cochrane Risk of Bias

Abbreviations: (for intervention) HIIT, High-intensity interval training; MICT, moderate-intensity continuous training (for outcome measures); ABP, ambulatory blood pressure; BMI, body mass index; BP, blood pressure; BPV; blood pressure variability; DBP, diastolic blood pressure; HbA1c, hemoglobin A1c; HR, heart rate; HRV, heart rate variability; i.e., Mean age; MAP, mean arterial pressure; SBP, systolic blood pressure; VO_{2max}, maximal oxygen consumption; QoL, quality of life (for quality assessment); CONSORT, consolidated standards of reporting trials; GRADE, grading of recommendations assessment, development, and evaluation; PEDro, physiotherapy evidence database; TESTEX, tool for the assessment of study quality and reporting in exercise.

aAge is derived by the mean of reported mean age from the individual primary studies in the systematic review.

[b]Gray literature includes studies without complete reference list for included individual studies, studies without formal publication or unpublished data from the postgraduate thesis.

calculated CCA was 1.40%, which implied a slight overlap of primary individual studies (Supplementary S3).

3.3 | Comparing Western exercise training with no exercise in hypertensive patients

Aerobic exercise, resistance exercise, mixed exercise approaches with both aerobic and resistance exercise, and other general exercises to promote body movement were classified as western exercises.

In aerobic exercise training, 11 systematic reviews evaluated the effectiveness of aerobic exercises, including two systematic reviews for moderate-intensity continuous training (MICT) and high-intensity intermittent training (HIIT) (Table 3a). Nine systematic reviews evaluated the effectiveness of aerobic exercise training other than dancing, MICT and HIIT, eight of them (88.9%) showed a significant reduction in both SBP ranging from −12.3 to −0.79 mmHg and DBP ranging from −8.2 to −0.63 mmHg. A systematic review that included 37 original studies with a total sample size of 1813 participants showed that aerobic exercise training can significantly reduce both SBP and DBP levels (SBP = −8.3 mmHg (95% CI = −10.1 to −6.46 mmHg) and DBP = −5.19 mmHg (95% CI = −6.24 to −4.14 mmHg).[45] Two studies compared MICT or HIIT with no exercise, and both of them showed similar findings that SBP and DBP would be reduced after 4–16 weeks of training.[44,63]

In resistance exercise training, seven systematic reviews evaluated the effectiveness of resistance exercises, including a systematic review for an isometric resistance exercise and three systematic reviews for isometric handgrip exercises (Table 3b). All five of them (71.4%) showed a significant reduction in both SBP ranging from −9.1 to −4.7 mmHg and DBP ranging from −4.0 to −2.4 mmHg. A systematic review that included 24 original studies with a total sample size of 1143 participants showed that the isometric resistance exercise can significantly reduce both central SBP and DBP levels (SBP = −7.48 mmHg (95% CI = −14.89 to −0.07 mmHg) and DBP = −3.75 mmHg (95% CI = −6.38 to −1.12 mmHg)), as well as office SBP and DBP levels (SBP = −6.97 mmHg (95% CI = −8.77 to −5.18 mmHg) and DBP = −3.86 mmHg (95% CI = −5.31 to −2.41 mmHg)).[54]

In the exercise training with a mixed approach from the components of aerobic and resistance exercises (Table 3c), two systematic reviews[20,49] failed to show the benefits of BP reduction after 8−24 weeks of training. On the other hand, a systematic review that included nine original studies on aquatic exercise with a total sample size of 387 participants showed that the aquatic exercise training can significantly reduce both SBP and DBP levels (SBP = −7.53 mmHg (95% CI = −11.4 to −3.65 mmHg) and DBP = −5.35 mmHg (95% CI = −9.00 to −1.69 mmHg)).[65] Another study evaluated the intervention effect within 24 h after aquatic exercise, and no significant benefit on BP reduction was observed (Supplementary S4).[64] Three systematic reviews evaluated the benefits of yoga exercise training. All of them showed a significant reduction in both SBP ranging from −9.65 to −4.17 mmHg and DBP ranging from −7.22 to −3.06 mmHg. In dancing therapy, a systematic review showed significant reductions in both SBP and DBP.[39]

In general exercises, seven systematic reviews evaluated the effectiveness of general exercise training (Table 3d), four of them (57.1%) showed a significant reduction in both SBP ranging from −12.8 to −4.4 mmHg and DBP ranging from −4.7 to −3.0 mmHg. However, a systematic review that included 12 original studies with a total sample size of 1057 participants demonstrated that general exercise training only showed a significant reduction in DBP = −3.19 mmHg (95% CI = −6.12 to −0.45 mmHg)), but not in SBP.[48]

3.4 | Comparing Chinese exercise training with no exercise in hypertensive patients

Exercise training with Chinese styles of body consciousness, balance and breathing control were classified as Chinese exercises, including Baduanjin, Tai Chi, Qigong or a combined version. Two systematic reviews[43,61] showed that the combined Chinese exercise training can reduce both SBP and DBP levels. However, these studies did not further elaborate on the effects of BP reduction by specific type of Chinese exercises (Table 4).

In Baduanjin exercise training, four systematic reviews evaluated the effectiveness of this training, all of them (100%) showed a significant reduction in both SBP ranging from −8.5 to −1.8 mmHg and DBP ranging from −4.7 to −1.3 mmHg. A systematic review that included 29 original studies on Baduanjin with a total sample size of 2100 participants showed that Baduanjin can significantly reduce both SBP and DBP levels (SBP = −7.0 mmHg (95% CI = −9.8 to −4.3 mmHg) and DBP = −4.5 mmHg (95% CI = −7.4 to −1.7 mmHg)).[52]

In Tai Chi exercise training, six systematic reviews evaluated the effectiveness of the Tai Chi, five of them (83.3%) showed a significant reduction in both SBP ranging from −12.5 to −1.1 mmHg and DBP ranging from −6.5 to −0.57 mmHg. However, a systematic review that included six original studies on Tai Chi with a total sample size of 890 participants demonstrated that Tai Chi did not show significant reductions in BP levels (SBP = −8.3 mmHg (95% CI = −20.4 to 3.8 mmHg) and DBP = −3.1 mmHg (95% CI = −7.0 to 0.9 mmHg)).[65]

In Qigong exercise training, five systematic reviews evaluated the effectiveness of the Qigong, three of them (60.0%) showed a significant reduction in both SBP ranging from −17.4 to −8.9 mmHg and DBP ranging from −10.2 to −5.0 mmHg. However, two systematic reviews,[52,65] which included three and five studies on Qigong, respectively, demonstrated that Qigong did not show significant reductions in BP levels. On the other hand, a systematic review on breathing exercise training that included eight original studies with a total sample size of 270 participants showed that the breathing exercise with load training can also significantly reduce both SBP and DBP levels (SBP = −15.7 mmHg (95% CI = −18.6 to −12.8 mmHg) and DBP = −7.1 mmHg (95% CI = −9.0 to −5.1 mmHg)).[58]

TABLE 3 Studies comparing western exercise training with no exercise in hypertensive patients

	No. of Studies	Mean difference of BP (in mmHg)[c]
(a) Aerobic Exercise (n = 11)		
Kelley et at. 1994	9	**SBP** = **−7 ± 5** / **DBP** = **−6 ± 2** (changes before and after intervention) and no significant change in control
Wen et al. 2017[b]	13	**SBP** = **−0.79** (95% CI = : −1.29 to −0.28) / **DBP** = **−0.63** (95% CI = −1.14 to −0.12)
Cao et al. 2019	13	**SBP** = **−12.26** (95% CI = −15.17 to −9.34) / **DBP** = **−6.12** (95% CI = −7.76 to −4.48)
Lee et al. 2020[a]	37	**SBP** = **−8.29** (95% CI = −10.12 to −6.46) / **DBP** = **−5.19** (95% CI = −6.24 to −4.14)
Saco-Ledo et al. 2020	7 9 7	Overall: **SBP** = **−5.5** (95% CI = −8.1 to −2.8) / **DBP** = **−3.8** (95% CI = −4.9 to −2.6) Daytime: **SBP** = **−5.0** (95% CI = −7.6 to −2.3) / **DBP** = **−3.5** (95% CI = −5.1 to −1.9) Nighttime: **SBP** = **−3.8** (95% CI = −6.4 to −1.3) / **DBP** = **−2.9** (95% CI = −4.1 to −1.6)
Sardeli et al. 2020	11	**SBP** = **−12.3** (95% CI = −16.4 to −8.2) / **DBP** = **−4.3** (95% CI = −6.0 to −2.7)
Park et al. 2021	3	**SBP** = **−9.43** (95% CI = −13.63 to −5.23) / **DBP** = **−5.90** (95% CI = −7.69 to −4.11)
de Barcelos et al. 2022	12 12	Training with progression: **SBP** = **−10.7** (95% CI = −15.4 to −5.9) / **DBP** = **−5.5** (95% CI = −8.7 to −2.3) Training without progression: **SBP** = **−10.2** (95% CI = −12.2 to −8.1) / **DBP** = **−6.5** (95% CI = −9.1 to −3.9)
Dassanayake et al. 2022	4	**SBP** = **−12.1** (95% CI = −21.1 to −3.0) / **DBP** = **−8.2** (95% CI = −14.8 to −1.6)
- MICT		
Leal et al. 2020	6	**SBP** = **−3.7** (95% CI = −4.8 to −2.6) / **DBP** = **−2.4** (95% CI = −3.7 to −1.1)
Lu et al. 2022	12	**SBP** = **−7.96** (95% CI = −14.09 to −2.25) / **DBP** = **−5.04** (95% CI = −8.77 to −0.94)
- HIIT		
Leal et al. 2020	6	**SBP** = **−5.6** (95% CI = −9.6 to −1.7) / **DBP** = **−4.8** (95% CI = −6.7 to −2.9)
Lu et al. 2022	12	Low-volume HIIT: **SBP** = **−7.27** (95% CI = −11.53 to −2.51) / **DBP** = **−3.41** (95% CI = −5.99 to −0.40) High-volume HIIT: **SBP** = **−7.21** (95% CI = −14.41 to −0.14) / DBP = −3.73 (95% CI = −7.67 to 0.88)
(b) Resistance Exercise (n = 7)		
Saco-Ledo et al. 2020	3 4 3	Overall: SBP = 0.5 (95% CI = −1.1 to 2.1) / DBP = 0.5 (95% CI = −0.6 to 1.6) Daytime: SBP = 1.3 (95% CI = −2.2 to 4.8) / DBP = 0.1 (95% CI = −2.1 to 2.2) Nighttime: **SBP** = **−3.7** (95% CI = −6.4 to −0.9) / DBP = −1.9 (95% CI = −4.6 to 0.8)
Sardeli et al. 2020	8	**SBP** = **−6.8** (95% CI = −8.4 to −5.2) / **DBP** = **−3.5** (95% CI = −4.22 to −2.85)
Igarashi 2022	17	**SBP** = **−4.7** (95% CI = −6.7 to −2.8) / **DBP** = **−3.5** (95% CI = −4.9 to −2.1)
- Isometric Resistance		
Hansford et al. 2021[a]	24	Office BP: **SBP** = **−6.97** (95% CI = −8.77 to −5.18) / **DBP** = **−3.86** (95% CI = −5.31 to −2.41) Central BP: **SBP** = **−7.48** (95% CI = −14.89 to −0.07) / **DBP** = **−3.75** (95% CI = −6.38 to −1.12) 24 h ABP: SBP = −2.74 (95% CI = −6.74 to 1.25) / DBP = −2.39 (95% CI = −4.38 to −0.40)
- Isometric Handgrip		
Farah et al. 2017	5	Four of the five studies on the chronic effect of exercise showed a reduction in SBP (reduction ranges from 5-19 mmHg); one study showed a reduction in DBP (6 mmHg) but unchanged in others
Loaiza-Betancur et al. 2020	11	**SBP** = **−5.43** (95% CI = −8.47 to −2.39) / **DBP** = **−2.41** (95% CI = −4.33 to −0.48), i.e., Low intensity training
Almeida et al. 2021	6	**SBP** = **−9.10** (95% CI = −11.39 to −6.8) / **DBP** = **−4.01** (95% CI = −7.96 to −0.05)
(c) Mixed Approach (n = 6)		
- Aquatic exercise		
Zhu et al.2022[a]	9	**SBP** = **−7.53** (95% CI = −11.40 to −3.65) / **DBP** = **−5.35** (95% CI = −9.00 to −1.69)
- Combined aerobic and resistance exercise		
Saco-Ledo et al. 2020	4 3 4	Overall: SBP = −9.6 (95% CI = −20.7 to 1.5) / DBP = −4.3 (95% CI = −10.8 to 2.2) Daytime: SBP = −10.4 (95% CI = −23.7 to 2.9) / DBP = −6.0 (95% CI = −14.7 to 2.7) Nighttime: SBP = −7.3 (95% CI = −21.6 to 7.1) / DBP = −4.0 (95% CI = −11.0 to 2.9)
Sardeli et al. 2020	3	SBP = −23.47 (95% CI = −47.42 to 0.48) / **DBP** = **−8.9** (95% CI = −15.02 to −2.78)
- Yoga		
Hagins et al. 2013	17	**SBP** = **−4.17** (95% CI = −6.35 to −1.99) / **DBP** = **−3.62** (95% CI = −4.92 to −1.60)
Cramer et al. 2014	6	**SBP** = **−9.65** (95% CI = −17.23 to −2.06) / **DBP** = **−7.22** (95% CI = −12.83 to −1.62)
Zhu et al.2022[a]	10	**SBP** = **−5.09** (95% CI = −9.28 to −0.89) / **DBP** = **−3.06** (95% CI = −5.16 to −0.96)

(Continues)

TABLE 3 (Continued)

	No. of Studies	Mean difference of BP (in mmHg)[c]
- Dance Therapy		
Conceição et al. 2016	4	**SBP = −12.01 (95% CI = −16.08 to −0.794) / DBP = −3.38 (95% CI = −4.81 to −1.94)**
(d) General Exercise (n = 7)		
Williamson et al. 2016	10 5	At 3-6 months: **SBP = −4.40** (95% CI = −5.78 to −3.01) / **DBP = −4.17** (95% CI = −5.42 to −2.93) At/beyond 12 months: SBP = −1.02 (95% CI = −2.34 to 0.29) / DBP = −0.91 (95% CI = −1.85 to 0.02)
Noone et al. 2020[a]	12	SBP = −5.51 (95% CI = = −10.63 to 0.17) / **DBP = −3.19** (95% CI = = −6.12 to −0.45)
Saco-Ledo et al. 2020	12 13 11	Overall: **SBP = −5.4** (95% CI = = −9.2 to −1.6) / **DBP = −3.0** (95% CI = = −5.4 to −0.6) Daytime: **SBP = −4.5** (95% CI = −6.6 to −2.3) / **DBP = −3.2** (95% CI = −4.8 to −1.5) Nighttime: **SBP = −4.7** (95% CI = −8.4 to −1.0) / **DBP = −3.1** (95% CI = −5.3 to −0.9)
Sardeli et al. 2020	17	**SBP = −12.8** (95% CI = −16.5 to −9.1) / **DBP = −4.7** (95% CI = −6.1 to −3.4)
Park et al. 2021	8	**SBP = −5.25** (95% CI = −8.39 to −2.12) / **DBP = −3.16** (95% CI = −4.91 to −1.30)
Dassanayake et al. 2022	4	**SBP = −9.88** (95% CI = −17.62 to −2.14) / DBP = −6.24 (95% CI = −12.56 to 0.17)
Lu et al. 2022	12	SBP = −2.78 (95% CI = −10.06 to 4.49) / DBP = −2.65 (95% CI = −6.86 to 1.93)

Note: Results with statistical significance are in **Bold**.
Abbreviations: BP, blood pressure; CI, confidence interval; DBP, diastolic blood pressure; HIIT, high-intensity intermittent training; MICT, moderate-intensity continuous training; SBP, systolic blood pressure.
[a]Gray literature.
[b]Standardized mean difference is used.
[c]Negative blood pressure value denotes lower blood pressure with intervention.

3.5 | Comparing among different types of exercise training in hypertensive patients

The above systematic reviews summarized the effectiveness of different types of exercise training against a control group. While we can appreciate a difference in effectiveness among different exercises, there were also systematic reviews reporting comparisons among various types of exercise training on BP reduction (Table 5).

Four systematic reviews compared different western exercise training, with three of them comparing HIIT to MICT. Despite the higher exercise intensity with HIIT, there was no additional benefit of HIIT compared to MICT in terms of BP reduction. The difference ranged from −1.1 to 0.77 mmHg in SBP and from −1.6 to 1.66 mmHg in DBP. The remaining systematic review compared isometric resistance to aerobic exercise training, which also suggested no difference in reducing BP between these two exercises (SBP = 3.36 mmHg (95% CI = −7.22 to 13.94 mmHg) and DBP = 2.17 mmHg (95% CI = −0.45 to 4.80 mmHg)).[54]

Five other systematic reviews compared Chinese to Western exercise training, with three focused on Qigong. Effects of Qigong training, compared to either general or aerobic exercise training, on BP ranged from −1.02 to 6.51 mmHg in SBP and from −0.44 to 1.5 mmHg in DBP. Only one systematic review showed statistically higher SBP, but not DBP, with Qigong training when compared to general exercise training (SBP = 6.51 mmHg (95% CI = 2.81 to 10.21 mmHg) and DBP = 0.67 mmHg (95% CI = −1.39 to 2.73 mmHg)).[37] Two systematic reviews evaluated effectiveness of Tai Chi compared to general or aerobic exercise training. While one systematic review[24] showed lower BP level with Tai Chi when compared to general exercise training (SBP = −7.9 mmHg (95% CI = −14.2 to −1.7 mmHg) and DBP = −3.9 mmHg (95% CI = −6.5 to −1.2 mmHg)), the other one[55] failed to show a difference when compared to aerobic exercise training (SBP = −0.4 mmHg (95% CI = −1.62 to 0.81 mmHg) and DBP = −0.11 mmHg (95% CI = −1.06 to 0.83 mmHg)).

3.6 | Comparing exercise training with anti-hypertensive drugs in hypertensive patients

Four systematic reviews evaluated effectiveness of exercise training against anti-hypertensive drugs (Supplementary S5). Noone et al. reported higher though insignificant SBP and DBP with general exercise training than with any types of anti-hypertensive drugs in a network meta-analysis with 93 studies on 32 404 participants.[48] Another meta-analysis on Baduanjin training also showed no difference in SBP and DBP when comparing to anti-hypertensive drugs.[38] However, one meta-analysis on Qigong training[37] showed significant reduction in DBP but not SBP (SBP = −7.91 mmHg (95% CI = −16.81 to 1.00 mmHg) and DBP = −6.08 mmHg (95% CI = −9.58 to −2.58 mmHg)), while another focusing on Tai Chi training[24] demonstrated significant reduction in both SBP and DBP (SBP = −9.1 mmHg (95% CI = −14.0 to −4.1 mmHg) and DBP = −5.6 mmHg (95% CI = −8.8 to −2.4 mmHg)).

4 | DISCUSSION

Physical activities, such as aerobic, resistance and Chinese exercise training, have been shown to be effective for blood pressure

TABLE 4 Studies comparing Chinese exercise training with no exercise in hypertensive patients (n = 15)

Study	No. of Studies	Mean difference of BP (in mmHg)[c]
- Baduanjin		
Xiong et al. 2015 (b)[a]	4	**SBP** = **−7.49** (95% CI = −11.39 to −3.59) / **DBP** = **−3.55** (95% CI = −5.25 to −1.85)
Guan et al. 2020 (b)[a,b]	5	**SBP** = **−1.80** (95% CI = −2.86 to −0.73) / **DBP** = **−1.28** (95% CI = −2.00 to −0.57)
Shao et al. 2020[a]	14	**SBP** = **−8.52** (95% CI = −10.65 to −6.40) / **DBP** = **−4.65** (95% CI = −6.55 to −2.74)
Dai et al. 2021[a]	29	**SBP** = **−7.03** (95% CI = −9.80 to −4.26) / **DBP** = **−4.51** (95% CI = −7.38 to −1.65)
- Breathing Exercise		
da Silva et al. 2021	2 5	Load training: **SBP** = **−15.72** (95% CI = −18.63 to −12.81) / **DBP** = **−7.08** (95% CI = −9.03 to −5.13) Unload training: **SBP** = **−5.08** (95% CI = −7.49 to −2.66) / DBP = −1.04 (95% CI = −2.55 to 0.46)
- Tai Chi		
Guan et al. 2020 (a)	13	**SBP** = **−6.58** (95% CI = −8.14 to −5.02) / **DBP**+ = **−0.57** (95% CI = −0.77 to −0.37)
Liang et al. 2020[a]	15	**SBP** = **−12.47** (95% CI = −16.00 to −8.94) / **DBP** = **−6.46** (95% CI = −8.28 to −4.64)
Zhong et al. 2020[a]	9	**SBP** = **−14.8** (95% CI = −19.6 to −10.0) / **DBP** = **−7.0** (95% CI = −9.1 to −5.0)
Dai et al. 2021[a]	16	**SBP** = **−12.42** (95% CI = −15.29 to −9.55) / **DBP** = **−7.58** (95% CI = −10.15 to −4.96)
Pan et al. 2021[a,b]	24	**SBP** = **−1.05** (95% CI = −1.44 to −0.67) / **DBP** = **−0.91** (95% CI = −1.24 to −0.58)
Zhu et al.2022[a]	6	SBP = −8.31 (95% CI = −20.39 to 3.77) / DBP = −3.05 (95% CI = −6.96 to 0.87)
- Qigong		
Dai et al. 2021[a]	3	SBP = −4.16 (95% CI = −10.09 to 1.77) / DBP = −3.07 (95% CI = −8.61 to 2.47)
Lee et al. 2007	2	**SBP** = **−12.1** (95% CI = −17.1 to −7.0) / **DBP** = **−8.5** (95% CI = −12.6 to −4.4)
Xiong et al. 2015 (a)[a]	3 5	Without anti-hypertensive drug: **SBP** = **−17.40** (95% CI = −21.06 to −13.74) / **DBP** = **−10.15** (95% CI = −13.99 to −6.30) With anti-hypertensive drug: **SBP** = **−11.99** (95% CI = −15.59 to −8.39) / **DBP** = **−5.28** (95% CI = −8.13 to −2.42)
Dong et al. 2021[a]	10	**SBP** = **−8.90** (95% CI = −12.13 to −5.67) / **DBP** = **−5.02** (95% CI = −7.88 to −2.17)
Zhu et al.2022[a]	5	SBP = −4.34 (95% CI = −13.51 to 4.82) / DBP = −3.44 (95% CI = −7.89 to 1.01)
- Combined Chinese Exercise		
Jin et al. 2019[a]	14	**SBP** = **−13.19** (95% CI = −16.30 to −10.08) / **DBP** = **−5.47** (95% CI = −7.76 to −3.18)
Ge et al. 2022[a,b]	30	**SBP** = **−0.994** (95% CI = −1.239 to −0.748) / **DBP** = **−0.757** (95% CI = −1.009 to −0.505)

Note: Results with statistical significance are in **Bold**.

Abbreviations: BP, blood pressure; CI, confidence interval; DBP, diastolic blood pressure; HIIT, high-intensity intermittent training; MICT, moderate-intensity continuous training; SBP, systolic blood pressure.

[a]Gray literature.

[b]Standardized mean difference is used.

[c]Negative blood pressure value denotes lower blood pressure with intervention.

reduction. This overview of systematic reviews summarized the effectiveness across different types of physical activity training, including Chinese exercises, and demonstrated that exercise training with Chinese styles of body consciousness, balance and breathing control are effective in helping our patients in better management of hypertension.

Reduction in BP by exercise training can be explained by nitric oxide and prostacyclin production from vascular endothelium as a results of exercising, which results in vasodilation via relaxation of vascular smooth muscle cells and therefore lower BP.[67] Exercise also reduces muscle sympathetic nerve activity and improves sympathetic baroreflex function.[68] Chinese exercises, which stress on mind-body consciousness and breathing control, show to shift the balance of autonomic nervous system from sympathetic to parasympathetic, thus leading to lower BP.[69–71] Moreover, risk of hypertension increases with body weight. Weight reduction by lifestyle modification, including increased physical activity, was shown to reduce both SBP and DBP.[72] Therefore, weight reduction could have played a mediator role with exercise intervention in BP reduction. Two[38,56] of our included systematic reviews reported reduced body-mass index with exercise intervention as secondary outcomes, yet there was no further explanation on the relationship among exercise training, change in body weight and BP change in both systematic reviews. Another umbrella review[73] demonstrated additional benefit other than BP reduction with exercise training in hypertensive older population. It was shown that exercise training improved cardiorespiratory fitness, increased muscle strength, reduced body weight and fat mass, and also reduced triglyceride level in older adults aged above 50 years old. This implies

TABLE 5 Studies comparing among different types of exercise training in hypertensive patients

Study	No. of studies	Intervention group	Comparison group	Mean difference of BP (in mmHg)[c]
Comparison of the Western exercises				
Costa et al. 2018	8	HIIT	MICT	SBP = −0.22 (95% CI = −5.36 to 4.92) / DBP = −0.38 (95% CI = −3.31 to 2.54)
Leal et al. 2020	15			SBP = −1.1 (95% CI = −2.3 to 0.0) / **DBP = −1.6** (95% CI = −2.4 to −0.8)
Lu et al. 2022	12			Low-volume HIIT: SBP = 0.69 (95% CI = −2.86 to 5.03) / DBP = 1.66 (95% CI = −1.15 to 4.35)
				High-volume HIIT: SBP = 0.77 (95% CI = −4.63 to 6.19) / DBP = 1.37 (95% CI = −1.75 to 4.60)
Hansford et al. 2021[a]	3	Isometric resistance	Aerobic exercise	SBP = 3.36 (95% CI = −7.22 to 13.94) / DBP = 2.17 (95% CI = −0.45 to 4.80)
Comparison between Chinese and Western exercises				
Lee et al. 2007	2	Qigong	General exercise	SBP = 1.4 (95% CI = −2.6 to 5.4) / DBP = 1.5 (95% CI = −1.0 to 4.1)
Xiong et al. 2015 (a)[a]	2			**SBP = 6.51** (95% CI = 2.81 to 10.21) / DBP = 0.67 (95% CI = −1.39 to 2.73)
Dong et al. 2021[a]	3	Tai Chi	Aerobic exercise	SBP = −1.02 (95% CI = −7.71 to 5.67) / DBP = −0.44 (95% CI = −5.06 to 4.19)
Pan et al. 2021[a,b]	3			SBP = −0.4 (95% CI = −1.62 to 0.81) / DBP = −0.11 (95% CI = −1.06 to 0.83)
Zhong et al. 2020[a]	5		General exercise	**SBP = −7.9** (95% CI = −14.2 to −1.7) / **DBP = −3.9** (95% CI = −6.5 to −1.2)

Note: Results with statistical significance are in **Bold**.
Abbreviations: BP, blood pressure; CI, confidence interval; DBP, diastolic blood pressure; HIIT, high-intensity intermittent training; MICT, moderate-intensity continuous training; SBP, systolic blood pressure.
[a]Gray literature.
[b]Standardized mean difference is used.
[c]Negative blood pressure value denotes lower blood pressure with intervention.

that there are more benefits by exercise training other than BP reduction that worth considering when recommending exercise training in hypertensive subjects.

The effect of meditation and exercise training on BP management have been reported in many studies.[65,74] Chinese exercise consists of a series of exercises, such as meditation, breathing, rhythmical movements, and focus of intention. Tai Chi is good for the elders to enhance body balance and awareness.[75] Qigong, similar to Tai Chi, further trains up internal energy, that is, Qi, through the body.[76] The concept of Qi is similar to the breathing training in the western exercise. Therefore, a systematic review that evaluated breathing exercise was also included as part of the Chinese exercise.[58] A network meta-analysis of 19 randomized controlled trials showed that Qigong might be the optimal exercise for lowering SBP and DBP in hypertensive patients.[77] Similar findings are observed in this study, but Tai Chi and Baduanjin demonstrated a stronger benefit of reducing BP levels. However, the definitions of Qigong were not clearly stated across the studies, so the literature showed inconsistent conclusions. Regular exercise with Tai Chi, compared with the use of anti-hypertensive medications, demonstrated a significant reduction in both SBP and DBP.[24] Included studies covered both stage 1 and stage 2 hypertensive patients. A further subgroup analysis suggested the BP reduction against anti-hypertensive drugs was consistent across patients aged under and above 50 years old.

Aerobic exercise and resistance training had already been demonstrated to be effective for lowering SBP and DBP in hypertensive treatment.[21,62,65] In this overview, there were more studies on aerobic exercise training that demonstrated BP levels reduction than studies on resistance training. The training details of resistance exercises were inconsistent, resulting in different conclusions across the systematic reviews. Therefore, a standardized resistance exercise protocol with considerations of the muscle resistance level and training duration is recommended. Yoga is an exercise that incorporates postures, breath control, and meditation.[78] Aquatic exercise is a low-impact activity that takes the pressure off your bones, joints and muscles. Water also offers natural resistance, which can help strengthen muscles.[79] Both exercises were treated as a combined approach with standardized training formats that showed benefits in reducing BP levels.

Within the aerobic exercise, comparable BP benefit was shown with MICT and HIIT. By its definition, HIIT comprises bouts of high intensity exercises which are typically lasting for seconds to minutes. In a scoping review[80] on the impact of HIIT in elderly population, it was demonstrated that HIIT is tolerable and feasible in the older population, with greater benefit on cardiorespiratory fitness, such as peak oxygen uptake, when compared to MICT. Despite the comparable impact on blood pressure between MICT and HIIT, HIIT could also be considered as choice of exercise training with additional benefit in cardiorespiratory fitness.[80]

This overview of systematic reviews included a relatively large sample size comparing evidence of 14 types of physical exercises from 39 studies. However, this study still has several limitations. First, the definitions of exercises, length of follow-up, and duration of the training were heterogeneous across the systematic reviews. Frequency, intensity, time and type (FITT) of exercise training has shown to be associated with the effect size of BP reduction.[81] One review[82] evaluated the methodological quality of meta-analyses relating to exercise training and BP reduction, and discussed the importance of considering FITT in exercise training reducing BP. Similarly, within the type of resistance exercise training, Igarashi[62] attempted to explore the relationship of BP and resistance training-related variables. It was demonstrated from a meta-regression analysis that increase in percentage 1 repetition maximum was associated with decrease in SBP, which was suggestive that moderate to heavy loads may be more beneficial than light loads in regular resistance training. Although the intensity and volume of the exercise training are important to demonstrate the exercise efficiency, they were not available in this secondary analysis of published articles. We also explored a sensitivity analysis on studies with at least 4 weeks of follow-up, the overall conclusion remained the same. Second, some systematic reviews included both randomized and non-randomized studies. Non-randomized studies might induce selection bias, when the participants had a personal preference in selecting intervention. Third, some Chinese exercises studies were collected from papers in Chinese journals, while some were collected from postgraduate thesis. Despite the comprehensive quality assessment with AMSTAR-2, there is not an item on assessing the individual quality of included studies in the systematic review, such as inclusion of gray literature. Assessment on gray literature should be considered in future review and amendment of AMSTAR-2. Fourth, original studies might be included several times in different systematic reviews. Consequently, results from some individual studies might be included twice. Therefore, the references of systematic reviews were cross-checked and 104 studies (out of 376 individual primary studies, 28%) were cited more than once. We also adopted CCA for reporting overlapping of individual studies[83] and concluded that there was only a slight overlap of individual studies in included reviews. Furthermore, not all systematic reviews controlled for other confounding factors, such as dietary restriction or standardization of antihypertensive drug use. Finally, although most of the systematic reviews were published in recent years, some original articles might still be missed if they are published after the systematic reviews.

This overview of systematic reviews summarized the effectiveness of physical exercise training for hypertension management. Besides aerobic and resistance exercises, exercises with Chinese styles of body consciousness, balance and breathing control are also shown to be beneficial for BP reduction. Personalized healthcare management requires the development of exercise training protocols with the consideration of exercise frequency and duration. Chinese exercises, such as Qigong and Tai Chi, can be treated as lower-intensity aerobic exercises that may be more suitable for the middle-aged and elderly population. In the current article, Chinese exercises were mainly enrolled in the Asian population. Future studies are recommended to investigate the benefits of Chinese exercises in the Western population.

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CONFLICT OF INTEREST

The authors have no competing interests.

ORCID

Kelvin Tsoi BSc, PhD https://orcid.org/0000-0001-5580-7686
Joshua Tran MD https://orcid.org/0000-0001-6756-7288
Yook-Chin Chia MBBS, FRCP https://orcid.org/0000-0003-1995-0359
Yuda Turana MD, PhD https://orcid.org/0000-0003-4527-0285
Saulat Siddique MBBS, MRCP (UK), FRCP (Lon) https://orcid.org/0000-0003-1294-0430
Yuqing Zhang MD https://orcid.org/0000-0001-8142-8305
Kazuomi Kario MD, PhD https://orcid.org/0000-0002-8251-4480

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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