Evidence Portfolio – Chronic Conditions Subcommittee, Question 3

In individuals with the cardiovascular condition of hypertension, what is the relationship between physical activity and (1) risk of co-morbid conditions, (2) physical function, (3) health-related quality of life, and (4) cardiovascular disease progression and mortality?

a. Is there a dose-response relationship? If yes, what is the shape of the relationship?
b. Does the relationship vary by age, sex, race/ethnicity, socio-economic status, weight status, or resting blood pressure level?
c. Does the relationship based on frequency, duration, intensity, type (mode), and how physical activity is measured?

Sources of Evidence: Existing Systematic Review and Meta-Analyses

Conclusion Statements and Grades

CO-MORBID CONDITIONS
Insufficient evidence is available to determine whether a relationship exists between physical activity and risk of co-morbid conditions among adults with hypertension. **PAGAC Grade: Not assignable.**

PHYSICAL FUNCTION
Insufficient evidence is available to determine whether a relationship exists between physical activity and physical function among adults with hypertension. **PAGAC Grade: Not assignable.**

HEALTH-RELATED QUALITY OF LIFE
Insufficient evidence is available to determine whether a relationship exists between physical activity and health-related quality of life among adults with hypertension. **PAGAC Grade: Not assignable.**

DISEASE PROGRESSION
Strong evidence demonstrates that physical activity reduces the risk of progression of cardiovascular disease among adults with hypertension. **PAGAC Grade: Strong.**

Strong evidence demonstrates that, among adults with hypertension, physical activity reduces the disease progression indicator of blood pressure. **PAGAC Grade: Strong.**

Moderate evidence indicates an inverse dose-response relationship between physical activity and the disease progression indicator of cardiovascular disease mortality among adults with hypertension. **PAGAC Grade: Moderate.**

Insufficient evidence is available to determine whether a dose-response relationship exists between physical activity and blood pressure among adults with hypertension. **PAGAC Grade: Not assignable.**

Insufficient evidence is available to determine whether the relationship between physical activity and the disease progression indicators of blood pressure and cardiovascular disease mortality varies by age, sex, race/ethnicity, socioeconomic status, or weight status among adults with hypertension. **PAGAC Grade: Not assignable.**

Limited evidence suggests that, among adults with hypertension, the blood pressure response to physical activity varies by resting blood pressure level, with the greatest blood pressure reductions occurring among those adults who have the highest resting blood pressure levels. **PAGAC Grade: Limited.**

Insufficient evidence is available to determine whether the relationship between physical activity and the disease progression indicators of blood pressure and cardiovascular disease mortality varies by the frequency, intensity, time, and duration of physical activity, or how physical activity is measured among adults with hypertension. **PAGAC Grade: Not assignable.**

Moderate evidence indicates the relationship between physical activity and the disease progression indicator of blood pressure does not vary by type of physical activity, with the evidence more robust for traditional types (modes, i.e., aerobic, dynamic resistance, combined) of physical activity than for other types (tai chi, yoga, and qigong) among adults with hypertension. **PAGAC Grade: Moderate.**

Description of the Evidence

The Chronic Conditions Subcommittee chose to rely exclusively on existing reviews including systematic reviews, meta-analyses, pooled analyses, and reports for this question. As determined by the Subcommittee, the search for existing reviews identified sufficient literature to answer the cardiovascular disease progression and mortality research question. The search did not provide sufficient literature on the health outcomes of (1) risk of co-morbid conditions, (2) physical function, and (3) health-related quality of life. Additional searches for original research were not conducted based on the a-priori decision to focus on existing reviews.

DISEASE PROGRESSION

Existing Systematic Review and Meta-Analyses

Overview

A total of 15 existing reviews were included: 1 systematic review[1] and 14 meta-analyses.[2-15] The reviews were published from 2006 to 2017.

The systematic review[1] included 6 studies published between 1985 and 2012.

The meta-analyses included a range of 4 to 93 studies. Most meta-analyses covered an extensive timeframe: from inception to 2003,[9] inception to 2010,[5] inception to 2012,[6] inception to 2014,[10, 14, 15] inception to 2015,[3, 7, 13] inception to 2016,[4] 1946 to 2014,[11] 1959 to 2013,[12] 1966 to 2013,[2] and 1998 to 2003.[8]

Exposures

Three of the included meta-analyses examined physical activity interventions that incorporated resistance exercise, one acute[3] and two chronic,[5, 10] one meta-analysis examined the blood pressure response to combined aerobic and resistance exercise training,[7] and one meta-analysis examined the blood pressure response to isometric resistance training.[2] Five meta-analyses examined the blood pressure response to aerobic exercise training.[4, 6, 8, 9, 13] Some studies also examined yoga,[11] tai chi,[12] Qigong,[15] and Baduanjin.[14] The systematic review assessed a range of physical activity categories—low, moderate, or high physical activity levels—as reported in individual studies, to classify general and leisure-time physical activity.[1]

Outcomes

All meta-analysis addressed disease progression, reported as change in systolic and diastolic blood pressure (mmHg), among hypertensive patients. One meta-analysis[11] addressed change in blood pressure among subjects with unclassified hypertension. Three reviews[5, 9, 14] addressed body mass index, weight, waist-to-hip ratio, glucose, and blood lipids as outcomes. Two reviews[1, 8] addressed cardiovascular and all-cause mortality as outcomes.

Populations Analyzed

The table below lists the populations analyzed in each article.

Table 1. Populations Analyzed by All Sources of Evidence

	Sex	Race/ Ethnicity	Age	Chronic Conditions
Carlson, 2014			Adults >18	Normal/Optimal blood pressure, Hypertension
Casonatto, 2016	Male, Female		Adults 18–80	Normal/Optimal blood pressure, Hypertension
Conceicao, 2016			Adults	Hypertension
Cornelissen, 2011			Adults 19–84 (>50,<50)	Normal/Optimal blood pressure, Prehypertension, Hypertension
Cornelissen, 2013	Male, Female		Adults ≥18 (<50, >50)	Normal/Optimal blood pressure, Prehypertension, Hypertension
Corso, 2016			Adults >19 (Mean 55.8)	Normal/Optimal blood pressure, Prehypertension, Hypertension
Dickinson, 2006			Adults	Hypertension
Fagard, 2007			Adults 20–83	Normal/Optimal blood pressure, Hypertension
MacDonald, 2016		White	Adults ≥19 (Mean 47.4)	Normal/Optimal blood pressure, Prehypertension, Hypertension
Park, 2017			Adults (<60; >60)	Hypertension
Rossi, 2012			Adults >18	Hypertension
Wang, 2013			Adults 35–75	Hypertension
Wen, 2017			Adults	Hypertension
Xiong, 2015a			Adults 39–72	Hypertension
Xiong, 2015b			Adults	Hypertension

Supporting Evidence

Existing Systematic Review and Meta-Analyses

Table 1. Existing Systemic Review and Meta-Analyses Individual Evidence Summary Tables

<table>
<tr><th colspan="2">Cardiovascular Disease Progression and Mortality</th></tr>
<tr><td colspan="2">Meta-Analysis
Citation: Carlson DJ, Dieberg G, Hess NC, Millar PJ, Smart NA. Isometric exercise training for blood pressure management: a systematic review and meta-analysis. Mayo Clin Proc. 2014;89(3):327-334. doi:10.1016/j.mayocp.2013.10.030.</td></tr>
<tr><td>Purpose: To quantify the effects of isometric resistance training on the change in systolic blood pressure, diastolic blood pressure, and mean arterial pressure in subclinical populations.
Timeframe: 1966–July 2013
Total # of Studies: 9
Exposure Definition: Isometric exercise training for 4 or more weeks.
Measures Steps: No
Measures Bouts: No
Examines HIIT: No
Outcomes Addressed: Systolic blood pressure, diastolic blood pressure, and mean arterial pressure.
Examine Cardiorespiratory Fitness as Outcome: No</td><td>Abstract: OBJECTIVE: To conduct a systematic review and meta-analysis quantifying the effects of isometric resistance training on the change in systolic blood pressure (SBP), diastolic blood pressure (DBP), and mean arterial pressure in subclinical populations and to examine whether the magnitude of change in SBP and DBP was different with respect to blood pressure classification. PATIENTS AND METHODS: We conducted a systematic review and meta-analysis of randomized controlled trials lasting 4 or more weeks that investigated the effects of isometric exercise on blood pressure in healthy adults (aged >/=18 years) and were published in a peer-reviewed journal. PubMed, CINAHL, and the Cochrane Central Register of Controlled Trials were searched for trials reported between January 1, 1966, and July 31, 2013. We included 9 randomized trials, 6 of which studied normotensive participants and 3 that studied hypertensive patients, that included a total of 223 participants (127 who underwent exercise training and 96 controls). RESULTS: The following reductions were observed after isometric exercise training: SBP-mean difference (MD), -6.77 mm Hg (95% CI, -7.93 to -5.62 mm Hg; P<.001); DBP-MD, -3.96 mm Hg (95% CI, -4.80 to -3.12 mm Hg; P<.001); and mean arterial pressure-MD, -3.94 mm Hg (95% CI, -4.73 to -3.16 mm Hg; P<.001). A slight reduction in resting heart rate was also observed (MD, -0.79 beats/min; 95% CI, -1.23 to -0.36 beats/min; P=.003). CONCLUSION: Isometric resistance training lowers SBP, DBP, and mean arterial pressure. The magnitude of effect is larger than that previously reported in dynamic aerobic or resistance training. Our data suggest that this form of training has the potential to produce significant and clinically meaningful blood pressure reductions and could serve as an adjunctive exercise modality.</td></tr>
<tr><td>Populations Analyzed: Adults >18, Normal/Optimal blood pressure, Hypertension</td><td>Author-Stated Funding Source: Not reported.</td></tr>
</table>

<table>
<tr><th colspan="2">Cardiovascular Disease Progression and Mortality</th></tr>
<tr><td colspan="2">Meta-Analysis
Citation: Casonatto J, Goessler KF, Cornelissen VA, Cardoso JR, Polito MD. The blood pressure-lowering effect of a single bout of resistance exercise: A systematic review and meta-analysis of randomised controlled trials. Eur J Prev Cardiol. 2016;23(16):1700-1714.</td></tr>
<tr><td>Purpose: To use the aggregate data and apply a meta-analytic approach to determine the effects of a single session of resistance exercise on office and ambulatory blood pressure (BP) in healthy adults. The second objective was to examine the effects of exercise and patient characteristics on the BP reduction induced by a single bout of resistance exercise.</td><td rowspan="5">Abstract: BACKGROUND: Current exercise guidelines recommend aerobic types of exercises on most days of the week, supplemented with dynamic resistance exercise twice weekly. Whereas the blood pressure (BP)-lowering effects of a single session of aerobic exercise have been well studied, less is known about the hypotensive effect of a single bout of resistance exercise. OBJECTIVES: To evaluate the transient effect of resistance exercise on BP by means of meta-analytic techniques. METHODS: A systematic electronic search in Medline, Scientific Electronic Library Online (SciELO), Latin American and Caribbean Health Sciences Literature (LILACS), Elton B Stephens Company (EBSCO), EMBASE and SPORTDiscus was completed in March 2015 identifying randomised controlled trials investigating the effect of a single bout of resistance exercise on resting or ambulatory BP in healthy adults. A subsequent meta-analysis was performed. RESULTS: The meta-analysis involved 30 studies, 81 interventions and 646 participants (normotensive (n = 505) or hypertensive (n = 141)). A single bout of resistance exercise elicited small-to-moderate reductions in office systolic BP at 60 minutes postexercise [-3.3 (-4.0 to -2.6)/-2.7 (-3.2 to -2.1) mmHg (CI 95%)], 90 minutes postexercise [-5.3 (-8.5 to -2.1)/-4.7 (-6.9 to -2.4) mmHg (CI 95%)] and in 24-hour ambulatory BP [-1.7 (-2.8 to -0.67)/-1.2 (-2.4 to -0.022) mmHg (CI 95%)] compared to a control session. The reduction in office BP was more pronounced in hypertensive compared to normotensive individuals ($p < 0.01$), when using larger muscle groups ($p < 0.05$) and when participants were recovering in the supine position ($p < 0.01$). CONCLUSION: A single bout of resistance exercise can have a BP-lowering effect that last for up to 24 hours. Supine recovery and the use of larger muscle groups resulted in greater BP reductions after resistance exercise.</td></tr>
<tr><td>Timeframe: Inception–March 2015</td></tr>
<tr><td>Total # of Studies: 30</td></tr>
<tr><td>Exposure Definition: Single session of conventional resistance training or circuit model exercise. Number of sets and repetition per set varied by study.
Measures Steps: No
Measures Bouts: No
Examines HIIT: No</td></tr>
<tr><td>Outcomes Addressed: Blood pressure.
Examine Cardiorespiratory Fitness as Outcome: No</td></tr>
<tr><td>Populations Analyzed: Male, Female, Adults 18–80, Normal/Optimal blood pressure, Hypertension</td><td>Author-Stated Funding Source: Brazilian Council for Research Development (CNPq), Research Foundation Flanders.</td></tr>
</table>

Cardiovascular Disease Progression and Mortality	
Meta-Analysis **Citation:** Conceição LS, Neto MG, do Amaral MA, Martins-Filho PR, Carvalho O. Effect of dance therapy on blood pressure and exercise capacity of individuals with hypertension: A systematic review and meta-analysis. *Int J Cardiol.* 2016;220:553-557. doi:10.1016/j.ijcard.2016.06.182.	
Purpose: To perform a systematic review and meta-analysis of randomized control trials to investigate the effects of dance therapy on blood pressure and exercise capacity of individuals with hypertension. **Timeframe:** Inception–February 2016 **Total # of Studies:** 4 **Exposure Definition:** Dance therapy, including body movements and stretching with slow music and fast music, aerobic exercise dancing, and Ola Hou (dance hula). Session duration varied from 45 to 60 minutes, frequency of sessions ranged from 2 to 3 times per week, and duration of therapy ranged from 4 to 12 weeks. **Measures Steps:** No **Measures Bouts:** No **Examines HIIT:** No **Outcomes Addressed:** Change in systolic and diastolic blood pressure (mmHg) and exercise capacity (Harvard step test or 6-minute walking test). **Examine Cardiorespiratory Fitness as Outcome:** Yes	**Abstract:** BACKGROUND: Dance therapy is a less conventional modality of physical activity in cardiovascular rehabilitation. We performed a systematic review and meta-analysis to investigate the effects of dance therapy in hypertensive patients. METHODS: Pubmed, Scopus, LILACS, IBECS, MEDLINE and SciELO via Virtual Health Library (Bireme) (from the earliest data available to February 2016) for controlled trials that investigated the effects of dance therapy on exercise capacity, systolic (SBP) and diastolic (DBP) blood pressure in hypertensive patients. Weighted mean differences (WMD) and 95% confidence intervals (CIs) were calculated, and heterogeneity was assessed using the I(2) test. RESULTS: Four studies met the eligibility criteria. Dance therapy resulted in a significant reduction in systolic blood pressure (WMD -12.01mmHg; 95% CI: -16.08, -7.94mmHg; P<0.0001) when compared with control subjects. Significant reduction in diastolic blood pressure were also found (WMD -3.38mmHg; 95% CI: -4.81, -1.94mmHg; P<0.0001), compared with control group. Exercise capacity showed a significant improvement (WMD 1.31; 95% CI: 0.16, 2.47; P<0.03). A moderate to high heterogeneity was observed in our analysis: I(2)=92% to SBP, I(2)=55% to DBP, and I(2)=82% to exercise capacity. CONCLUSIONS: Our meta-analysis showed a positive effect of dance therapy on exercise capacity and reduction of SBP and DBP in individuals with hypertension. However, the moderate to high heterogeneity found in our analysis limits a pragmatic recommendation of dance therapy in individuals with hypertension.
Populations Analyzed: Adults, Hypertension	**Author-Stated Funding Source:** Not reported.

Cardiovascular Disease Progression and Mortality

Meta-Analysis

Citation: Cornelissen VA, Fagard RH, Coeckelberghs E, Vanhees L. Impact of resistance training on blood pressure and other cardiovascular risk factors: a meta-analysis of randomized, controlled trials. *Hypertension*. 2011;58(5):950-958. doi:10.1161/HYPERTENSIONAHA.111.177071.

Purpose: To update the meta-analysis of the effect of resistance training (RT) on blood pressure (BP) and to assess a potential relation between different RT characteristics and the BP response; and to examine the simultaneous effect of RT on other cardiovascular risk factors.

Timeframe: Inception–June 2010

Total # of Studies: 28

Exposure Definition: Resistance training (dynamic vs. static or isometric) of at least 4 weeks duration as sole intervention. Interventions ranged between 6 and 52 weeks (median 16) for dynamic and 8–10 weeks (median 8) for isometric training. Median frequency was 3 times/week with varying intensity, number of sets (1–6), number of exercises performed (1–14) and repetitions for each set (6–30).

Measures Steps: No

Measures Bouts: No

Examines HIIT: No

Outcomes Addressed: Blood pressure, body fat, body mass index, weight, total cholesterol, high-density lipoprotein, low-density lipoprotein, triglycerides, glucose.

Examine Cardiorespiratory Fitness as Outcome: Yes

Abstract: We reviewed the effect of resistance training on blood pressure and other cardiovascular risk factors in adults. Randomized, controlled trials lasting >/=4 weeks investigating the effects of resistance training on blood pressure in healthy adults (age >/=18 years) and published in a peer-reviewed journal up to June 2010 were included. Random- and fixed-effects models were used for analyses, with data reported as weighted means and 95% confidence limits. We included 28 randomized, controlled trials, involving 33 study groups and 1012 participants. Overall, resistance training induced a significant blood pressure reduction in 28 normotensive or prehypertensive study groups [-3.9 (-6.4; -1.2)/-3.9 (-5.6; -2.2) mm Hg], whereas the reduction [-4.1 (-0.63; +1.4)/-1.5 (-3.4; +0.40) mm Hg] was not significant for the 5 hypertensive study groups. When study groups were divided according to the mode of training, isometric handgrip training in 3 groups resulted in a larger decrease in blood pressure [-13.5 (-16.5; -10.5)/-6.1(-8.3; -3.9) mm Hg] than dynamic resistance training in 30 groups [-2.8 (-4.3; -1.3)/-2.7 (-3.8; -1.7) mm Hg]. After dynamic resistance training, Vo(2) peak increased by 10.6% (P=0.01), whereas body fat and plasma triglycerides decreased by 0.6% (P<0.01) and 0.11 mmol/L (P<0.05), respectively. No significant effect could be observed on other blood lipids and fasting blood glucose. This meta-analysis supports the blood pressure-lowering potential of dynamic resistance training and isometric handgrip training. In addition, dynamic resistance training also favorably affects some other cardiovascular risk factors. Our results further suggest that isometric handgrip training may be more effective for reducing blood pressure than dynamic resistance training. However, given the small amount of isometric studies available, additional studies are warranted to confirm this finding.

Populations Analyzed: Adults 19–84 (>50,<50), Normal/Optimal blood pressure, Prehypertension, Hypertension

Author-Stated Funding Source: Research Foundation Flanders (FWO).

<table>
<tr><th colspan="2">Cardiovascular Disease Progression and Mortality</th></tr>
<tr><td colspan="2">Meta-Analysis
Citation: Cornelissen VA, Smart NA. Exercise training for blood pressure: a systematic review and meta-analysis. J Am Heart Assoc. 2013;2(1):e004473. doi:10.1161/JAHA.112.004473.</td></tr>
<tr><td>Purpose: To (1) conduct a systematic review and meta-analysis of randomized controlled trials to compare the effects of endurance training, dynamic resistance training, isometric resistance training, or combined endurance and resistance training on the magnitude of change in systolic blood pressure (SBP) and diastolic blood pressure (DBP) in subclinical populations; (2) examine whether magnitude of change in SBP and DBP was different with respect to sex, age, and blood pressure classification; and (3) examine whether magnitudes of change in SBP and DBP were related to exercise program characteristics (that is, program duration, exercise session duration, exercise intensity, exercise mode, weekly exercise duration, or weekly session frequency).</td>
<td rowspan="5">Abstract: BACKGROUND: We conducted meta-analyses examining the effects of endurance, dynamic resistance, combined endurance and resistance training, and isometric resistance training on resting blood pressure (BP) in adults. The aims were to quantify and compare BP changes for each training modality and identify patient subgroups exhibiting the largest BP changes. METHODS AND RESULTS: Randomized controlled trials lasting >/=4 weeks investigating the effects of exercise on BP in healthy adults (age >/=18 years) and published in a peer-reviewed journal up to February 2012 were included. Random effects models were used for analyses, with data reported as weighted means and 95% confidence interval. We included 93 trials, involving 105 endurance, 29 dynamic resistance, 14 combined, and 5 isometric resistance groups, totaling 5223 participants (3401 exercise and 1822 control). Systolic BP (SBP) was reduced after endurance (-3.5 mm Hg [confidence limits -4.6 to -2.3]), dynamic resistance (-1.8 mm Hg [-3.7 to -0.011]), and isometric resistance (-10.9 mm Hg [-14.5 to -7.4]) but not after combined training. Reductions in diastolic BP (DBP) were observed after endurance (-2.5 mm Hg [-3.2 to -1.7]), dynamic resistance (-3.2 mm Hg [-4.5 to -2.0]), isometric resistance (-6.2 mm Hg [-10.3 to -2.0]), and combined (-2.2 mm Hg [-3.9 to -0.48]) training. BP reductions after endurance training were greater (P<0.0001) in 26 study groups of hypertensive subjects (-8.3 [-10.7 to -6.0]/-5.2 [-6.8 to -3.4] mm Hg) than in 50 groups of prehypertensive subjects (-2.1 [-3.3 to -0.83]/-1.7 [-2.7 to -0.68]) and 29 groups of subjects with normal BP levels (-0.75 [-2.2 to +0.69]/-1.1 [-2.2 to -0.068]). BP reductions after dynamic resistance training were largest for prehypertensive participants (-4.0 [-7.4 to -0.5]/-3.8 [-5.7 to -1.9] mm Hg) compared with patients with hypertension or normal BP. CONCLUSION: Endurance, dynamic resistance, and isometric resistance training lower SBP and DBP, whereas combined training lowers only DBP. Data from a small number of isometric resistance training</td></tr>
<tr><td>Timeframe: November 2003–February 2012</td></tr>
<tr><td>Total # of Studies: 93</td></tr>
<tr><td>Exposure Definition: Exercise intervention 4–52 weeks, 1–7 times/week of varied time and intensity. Tested for differences with type of exercise (endurance training, dynamic resistance training, combined training, isometric resistance training) and for endurance training and dynamic resistance training. Subgroups: dynamic aerobic endurance training, dynamic resistance training, and combined training.
Measures Steps: No
Measures Bouts: No
Examines HIIT: No</td></tr>
<tr><td>Outcomes Addressed: Blood pressure.
Examine Cardiorespiratory Fitness as Outcome: No</td></tr>
</table>

	studies suggest this form of training has the potential for the largest reductions in SBP.
Populations Analyzed: Male, Female, Adults ≥18 (<50, >50), Normal/Optimal blood pressure, Prehypertension, Hypertension	**Author-Stated Funding Source:** Research Foundation Flanders (FWO).

Cardiovascular Disease Progression and Mortality	
Meta-Analysis **Citation:** Corso LM, Macdonald HV, Johnson BT, et al. Is concurrent training efficacious antihypertensive therapy? a meta-analysis. *Med Sci Sports Exerc.* 2016;48(12):2398-2406.	
Purpose: To determine the efficacy of concurrent exercise training as antihypertensive therapy and to examine important potential moderators of the blood pressure response to concurrent exercise training. **Timeframe:** Inception–January 2015 **Total # of Studies:** 68 **Exposure Definition:** Concurrent exercise training (CET) that combines aerobic exercise and dynamic resistance training. On average CET performed at moderate intensity, 58 minutes/session, 2.9 times/week. Some performed aerobic and resistance training on separate days and some performed both on same day using circuit training (alternating between aerobic and resistance); majority were supervised interventions. **Measures Steps:** No **Measures Bouts:** No **Examines HIIT:** No **Outcomes Addressed:** Blood pressure. **Examine Cardiorespiratory Fitness as Outcome:** No	**Abstract:** Aerobic exercise training and, to a lesser degree, dynamic resistance training, are recommended to lower blood pressure (BP) among adults with hypertension. Yet the combined influence of these exercise modalities, termed concurrent exercise training (CET), on resting BP is unclear. PURPOSE: This study aimed to meta-analyze the literature to determine the efficacy of CET as antihypertensive therapy. METHODS: Electronic databases were searched for trials that included the following: adults (>19 yr), controlled CET interventions, and BP measured pre- and postintervention. Study quality was assessed with a modified Downs and Black Checklist. Analyses incorporated random-effects assumptions. RESULTS: Sixty-eight trials yielded 76 interventions. Subjects (N = 4110) were middle- to older-age (55.8 +/- 14.4 yr), were overweight (28.0 +/- 3.6 kg.m), and had prehypertension (systolic BP [SBP]/diastolic BP [DBP] = 134.6 +/- 10.9/80.7 +/- 7.5 mm Hg). CET was performed at moderate intensity (aerobic = 55% maximal oxygen consumption, resistance = 60% one-repetition maximum), 2.9 +/- 0.7 d.wk for 58.3 +/- 20.1 min per session for 19.7 +/- 17.8 wk. Studies were of moderate quality, satisfying 60.7% +/- 9.4% of quality items. Overall, CET moderately reduced SBP (db = -0.32, 95% confidence interval [CI] = -0.44 to -0.20, -3.2 mm Hg) and DBP (db = -0.35, 95% CI = -0.47 to -0.22, -2.5 mm Hg) versus control (P < 0.01). However, greater SBP/DBP reductions were observed among samples with hypertension in trials of higher study quality that also examined BP as the primary outcome (-9.2 mm Hg [95% CI = -12.0 to -8.0]/-7.7 mm Hg [95% CI = -14.0 to -8.0]). CONCLUSIONS: Among samples with hypertension in trials of higher study quality, CET rivals aerobic exercise training as antihypertensive therapy. Because of the moderate quality of this literature, additional randomized controlled CET trials that examine BP as a primary outcome among samples with hypertension are warranted to confirm our promising findings.
Populations Analyzed: Adults >19 (Mean 55.8), Normal/Optimal blood pressure, Prehypertension, Hypertension	**Author-Stated Funding Source:** Institute for Collaboration on Health, Intervention and Policy (InCHIP), the Office of the Vice President for Research, Research Excellence Program, University of Connecticut, and Brazilian Council for Scientific and Technological Development (CNPq).

<table>
<tr><th colspan="2">Cardiovascular Disease Progression and Mortality</th></tr>
<tr><td colspan="2">Meta-Analysis
Citation: Dickinson HO, Mason JM, Nicolson DJ, et al. Lifestyle interventions to reduce raised blood pressure: a systematic review of randomized controlled trials. J Hypertens. 2006;24(2):215-233.</td></tr>
<tr><td>Purpose: To assess the efficacy of lifestyle interventions in patients with raised blood pressure, in order to inform a national clinical guideline.</td><td rowspan="5">Abstract: PURPOSE: To quantify effectiveness of lifestyle interventions for hypertension. DATA SOURCES: Electronic bibliographic databases from 1998 onwards, existing guidelines, systematic reviews. STUDY SELECTION AND DATA ABSTRACTION: We included randomized, controlled trials with at least 8 weeks' follow-up, comparing lifestyle with control interventions, enrolling adults with blood pressure at least 140/85 mmHg. Primary outcome measures were systolic and diastolic blood pressure. Two independent reviewers selected trials and abstracted data; differences were resolved by discussion. RESULTS: We categorized trials by type of intervention and used random effects meta-analysis to combine mean differences between endpoint blood pressure in treatment and control groups in 105 trials randomizing 6805 participants. Robust statistically significant effects were found for improved diet, aerobic exercise, alcohol and sodium restriction, and fish oil supplements: mean reductions in systolic blood pressure of 5.0 mmHg [95% confidence interval (CI): 3.1-7.0], 4.6 mmHg (95% CI: 2.0-7.1), 3.8 mmHg (95% CI: 1.4-6.1), 3.6 mmHg (95% CI: 2.5-4.6) and 2.3 mmHg (95% CI: 0.2-4.3), respectively, with corresponding reductions in diastolic blood pressure. Relaxation significantly reduced blood pressure only when compared with non-intervention controls. We found no robust evidence of any important effect on blood pressure of potassium, magnesium or calcium supplements. CONCLUSIONS: Patients with elevated blood pressure should follow a weight-reducing diet, take regular exercise, and restrict alcohol and salt intake. Available evidence does not support relaxation therapies, calcium, magnesium or potassium supplements to reduce blood pressure.</td></tr>
<tr><td>Timeframe: 1998–May 2003</td></tr>
<tr><td>Total # of Studies: 105</td></tr>
<tr><td>Exposure Definition: PA interventions included 3–5 supervised sessions of aerobic exercise (brisk walking, jogging, cycling) for 30–60 minutes. Strength training was included in several trials. Combined interventions with PA and nutrition also occurred. Interventions occurred 3–5 times per week with a length between 8 and 52 weeks.
Measures Steps: No
Measures Bouts: No
Examines HIIT: No</td></tr>
<tr><td>Outcomes Addressed: Systolic and diastolic blood pressure (mmHg). Number of deaths from all causes, fatal and non-fatal myocardial infarctions, and fatal and non-fatal strokes.
Examine Cardiorespiratory Fitness as Outcome: No</td></tr>
<tr><td>Populations Analyzed: Adults, Hypertension</td><td>Author-Stated Funding Source: National Institute for Clinical Excellence.</td></tr>
</table>

Cardiovascular Disease Progression and Mortality	
Meta-Analysis **Citation:** Fagard RH, Cornelissen VA. Effect of exercise on blood pressure control in hypertensive patients. *Eur J Cardiovasc Prev Rehabil.* 2007;14(1):12-17.	
Purpose: To perform a comprehensive meta-analysis of randomized controlled trials on the effects of exercise on blood pressure, blood pressure-regulating mechanisms, and cardiovascular risk factors. **Timeframe:** Inception–December 2003 **Total # of Studies:** 72 (for dynamic aerobic endurance training) and 9 (resistance training) **Exposure Definition:** Dynamic aerobic endurance training (training programs that involve large muscle groups in dynamic activities to increase endurance performance) or resistance training (training programs that involve strength, weight, static, or isometric exercises to increase muscular strength, power, and endurance). **Measures Steps:** No **Measures Bouts:** No **Examines HIIT:** No **Outcomes Addressed:** Blood pressure, weight, body fat, waist circumference, waist-to-hip ratio, cholesterol, triglycerides, glucose, insulin. **Examine Cardiorespiratory Fitness as Outcome:** Yes	**Abstract:** Several large epidemiological studies have reported an inverse relationship between blood pressure and physical activity. However, longitudinal intervention studies are more appropriate for assessing the effects of physical activity. We performed meta-analyses of randomized controlled trials involving dynamic aerobic endurance training or resistance training. The meta-analysis on endurance training involved 72 trials and 105 study groups. After weighting for the number of trained participants, training induced significant net reductions in resting and daytime ambulatory blood pressure of, respectively, 3.0/2.4 mmHg ($P<0.001$) and 3.3/3.5 mmHg ($P<0.01$). The reduction in resting blood pressure was more pronounced in the 30 hypertensive study groups (-6.9/-4.9) than in the others (-1.9/-1.6; $P<0.001$ for all). Systemic vascular resistance decreased by 7.1% ($P<0.05$), plasma norepinephrine by 29% ($P<0.001$), and plasma renin activity by 20% ($P<0.05$). Body weight decreased by 1.2 kg ($P<0.001$), waist circumference by 2.8 cm ($P<0.001$), percentage body fat by 1.4% ($P<0.001$) and the homeostasis model assessment index of insulin resistance by 0.31 units ($P<0.01$); high-density lipoprotein cholesterol increased by 0.032 mmol/l ($P<0.05$). Resistance training has been less well studied. A meta-analysis of nine randomized controlled trials (12 study groups) on mostly dynamic resistance training revealed a weighted net reduction in blood pressure of 3.2 ($P=0.10$)/3.5 ($P<0.01$) mmHg associated with exercise. Endurance training decreases blood pressure through a reduction in systemic vascular resistance, in which the sympathetic nervous system and the renin-angiotensin system appear to be involved, and favourably affects concomitant cardiovascular risk factors. The few available data suggest that resistance training can reduce blood pressure. Exercise is a cornerstone therapy for the prevention, treatment and control of hypertension.
Populations Analyzed: Adults 20–83, Normal/Optimal blood pressure, Hypertension	**Author-Stated Funding Source:** Not reported.

Cardiovascular Disease Progression and Mortality	
Meta-Analysis **Citation:** MacDonald HV, Johnson BT, Huedo-Medina TB, et al. Dynamic resistance training as stand-alone antihypertensive lifestyle therapy: a meta-analysis. *J Am Heart Assoc*. 2016;5(10): e003231. doi:10.1161/JAHA.116.003231.	
Purpose: To provide more precise estimates regarding the efficacy of dynamic resistance training as stand-alone antihypertensive therapy, and identify potential moderators of this response to provide insight into the optimal dose of dynamic resistance training to lower blood pressure among adults with high blood pressure. **Timeframe:** Inception–January 2014 **Total # of Studies:** 64 **Exposure Definition:** Dynamic resistance training intervention varied widely by study, most were 65–70% of 1 repetition maximum for 2–3 days per week for 15 weeks. **Measures Steps:** No **Measures Bouts:** No **Examines HIIT:** No **Outcomes Addressed:** Blood pressure. **Examine Cardiorespiratory Fitness as Outcome:** No	**Abstract:** BACKGROUND: Aerobic exercise (AE) is recommended as first-line antihypertensive lifestyle therapy based on strong evidence showing that it lowers blood pressure (BP) 5 to 7 mm Hg among adults with hypertension. Because of weaker evidence showing that dynamic resistance training (RT) reduces BP 2 to 3 mm Hg among adults with hypertension, it is recommended as adjuvant lifestyle therapy to AE training. Yet, existing evidence suggests that dynamic RT can lower BP as much or more than AE. METHODS AND RESULTS: We meta-analyzed 64 controlled studies (71 interventions) to determine the efficacy of dynamic RT as stand-alone antihypertensive therapy. Participants (N=2344) were white (57%), middle-aged (47.2+/-19.0 years), and overweight (26.8+/-3.4 kg/m(2)) adults with prehypertension (126.7+/-10.3/76.8+/-8.7 mm Hg); 15% were on antihypertensive medication. Overall, moderate-intensity dynamic RT was performed 2.8+/-0.6 days/week for 14.4+/-7.9 weeks and elicited small-to-moderate reductions in systolic BP (SBP; d+=-0.31; 95% CIs, -0.43, -0.19; -3.0 mm Hg) and diastolic BP (DBP; d+=-0.30; 95% CIs, -0.38, -0.18; -2.1 mm Hg) compared to controls (Ps<0.001). Greater BP reductions occurred among samples with higher resting SBP/DBP: approximately 6/5 mm Hg for hypertension, approximately 3/3 mm Hg for prehypertension, and approximately 0/1 mm Hg for normal BP (Ps<0.023). Furthermore, nonwhite samples with hypertension experienced BP reductions that were approximately twice the magnitude of those previously reported following AE training (-14.3 mm Hg [95% CIs, -19.0, -9.4]/-10.3 mm Hg [95% CIs, -14.5, -6.2]). CONCLUSIONS: Our results indicate that for nonwhite adult samples with hypertension, dynamic RT may elicit BP reductions that are comparable to or greater than those reportedly achieved with AE training. Dynamic RT should be further investigated as a viable stand-alone therapeutic exercise option for adult populations with high BP.
Populations Analyzed: White, Adults ≥19 (Mean 47.4), Normal/Optimal blood pressure, Prehypertension, Hypertension	**Author-Stated Funding Source:** Office of the Vice President for Research, Institute for Collaboration on Health, Intervention, and Policy (InCHIP), and Brazilian Council for Scientific and Technological Development (CNPq).

<table>
<tr><th colspan="2">Cardiovascular Disease Progression and Mortality</th></tr>
<tr><td colspan="2">Meta-Analysis
Citation: Park SH, Han KS. Blood pressure response to meditation and yoga: a systematic review and meta-analysis. J Altern Complement Med. April 2017. doi: 10.1089/acm.2016.0234.</td></tr>
<tr><td>Purpose: To provide a scientific basis for the effectiveness of meditation and yoga in the management of hypertension based on randomized clinical trial results.</td><td rowspan="5">Abstract: OBJECTIVES: To introduce research that presents scientific evidence regarding the effects of mantra and mindfulness meditation techniques and yoga on decreasing blood pressure (BP) in patients who have hypertension. METHODS: A literature search was performed to identify all studies published between 1946 and 2014 from periodicals indexed in Ovid Medline, EMBASE, CINAHL, PsycINFO, KoreaMed, and NDSL by using the following keywords: "hypertension," "blood pressure," "psychotherapy," "relaxation therapy," "meditation," "yoga," and "mind-body therapy." The Cochrane's Risk of Bias was applied to assess the internal validity of the randomized controlled trial studies. Thirteen studies were analyzed in this meta-analysis by using Review Manager 5.3. RESULTS: Among 510 possible studies, 13 met the selection criteria. Seven examined meditation, and six examined yoga. The meta-analysis indicated that meditation and yoga appeared to decrease both systolic and diastolic BP, which were within similar baseline ranges, and the reduction was statistically significant; however, some results showed little difference. After an in-depth analysis of those results, BP range and patient age were revealed as the factors that affected the different results in some reports. In particular, meditation played a noticeable role in decreasing the BP of subjects older than 60 years of age, whereas yoga seemed to contribute to the decrease of subjects aged less than 60 years. CONCLUSIONS: While acknowledging the limitations of this research due to the differences in BP and the participants' ages, meditation and yoga are demonstrated to be effective alternatives to pharmacotherapy. Given that BP decreased with the use of meditation and yoga, and this effect varied in different age groups, scientifically measured outcomes indicate that these practices are safe alternatives in some cases.</td></tr>
<tr><td>Timeframe: Inception–February 2015</td></tr>
<tr><td>Total # of Studies: 13 (6 for yoga)</td></tr>
<tr><td>Exposure Definition: Yoga routines that ranged from 60 to 90 minutes in duration and were done up to 6 days per week.
Measures Steps: No
Measures Bouts: No
Examines HIIT: No</td></tr>
<tr><td>Outcomes Addressed: Systolic and diastolic blood pressure (mmHg).
Examine Cardiorespiratory Fitness as Outcome: No</td></tr>
<tr><td>Populations Analyzed: Adults (<60; >60), Hypertension</td><td>Author-Stated Funding Source: Soonchunhyang University Research Fund.</td></tr>
</table>

<table>
<tr><th colspan="2">Cardiovascular Disease Progression and Mortality</th></tr>
<tr><td colspan="2">Systematic Review
Citation: Rossi A, Dikareva A, Bacon SL, Daskalopoulou SS. The impact of physical activity on mortality in patients with high blood pressure: a systematic review. J Hypertens. 2012;30(7):1277-1288. doi:10.1097/HJH.0b013e3283544669.</td></tr>
<tr><td>Purpose: To present the results of prospective longitudinal studies exploring the effect of PA on mortality (cardiovascular and all-cause) in patients with high blood pressure.</td><td rowspan="5">Abstract: BACKGROUND: Physical activity has been shown to be beneficial for the prevention and management of hypertension. In the general population, physical activity has been shown to decrease mortality. PURPOSE: The purpose of this systematic review was to identify and synthesize the literature examining the impact of physical activity on mortality in patients with high blood pressure (BP). METHODS: An extensive search was conducted by two independent authors using Medline, Embase and Cochrane Library electronic databases (between 1985 and January 2012) and manual search from the reference list of relevant articles. Inclusion criteria were as follows: longitudinal design with minimum 1-year follow-up; hypertensive status of the cohort was indicated; and BP, physical activity, and mortality were measured. RESULTS: Six articles evaluating a combined total of 48 ,448 men and 47 ,625 women satisfied the inclusion criteria. Cardiovascular and/or all-cause mortality were shown to be inversely related to physical activity in all studies. For example, patients with high BP who participated in any level of physical activity had a reduced risk (by 16-67%) of cardiovascular mortality, whereas a greater than two-fold increase in risk of mortality was noted in nonactive individuals. However, activity classification and parameters, such as frequency, duration, intensity, and volume, as well as BP status, were not consistent across studies. CONCLUSIONS: Regular physical activity is beneficial for reducing mortality in patients with high BP. More research is needed to establish the impact of specific kinds of physical activity and whether any differences exist between sexes.</td></tr>
<tr><td>Timeframe: January 1985–January 2012</td></tr>
<tr><td>Total # of Studies: 6</td></tr>
<tr><td>Exposure Definition: Self-reported PA either through questionnaire or interview. General and leisure time PA were the main types considered. PA classifications varied by study (e.g., low, moderate, high activity). Occupational and commuting PA were also considered.
Measures Steps: No
Measures Bouts: No
Examines HIIT: No</td></tr>
<tr><td>Outcomes Addressed: Relative risk or hazard ratio of cardiovascular and all-cause mortality .
Examine Cardiorespiratory Fitness as Outcome: No</td></tr>
<tr><td>Populations Analyzed: Adults >18; Hypertension</td><td>Author-Stated Funding Source: Fonds de la Recherche en Santé du Québec; Canadian Institutes of Health Research.</td></tr>
</table>

<table>
<tr><th colspan="2">Cardiovascular Disease Progression and Mortality</th></tr>
<tr><td colspan="2">Meta-Analysis
Citation: Wang J, Feng B, Yang X, et al. Tai Chi for essential hypertension. Evid Based Complement Alternat Med. 2013;2013:215254. doi:10.1155/2013/215254.</td></tr>
<tr><td>Purpose: To assess the current clinical evidence of tai chi for essential hypertension.</td><td rowspan="5">Abstract: Objectives. To assess the current clinical evidence of Tai Chi for essential hypertension (EH). Search Strategy. 7 electronic databases were searched until 20 April, 2013. Inclusion Criteria. We included randomized trials testing Tai Chi versus routine care or antihypertensive drugs. Trials testing Tai Chi combined with antihypertensive drugs versus antihypertensive drugs were also included. Data Extraction and Analyses. Study selection, data extraction, quality assessment, and data analyses were conducted according to the Cochrane standards. Results. 18 trials were included. Methodological quality of the trials was low. 14 trials compared Tai Chi with routine care. 1 trial compared Tai Chi with antihypertensive drugs. Meta-analysis all showed significant effect of TaiChi in lowering blood pressure (BP). 3 trials compared Tai Chi plus antihypertensive drugs with antihypertensive drugs. Positive results in BP were found in the other 2 combination groups. Most of the trials did not report adverse events, and the safety of Tai Chi is still uncertain. Conclusions. There is some encouraging evidence of Tai Chi for EH. However, due to poor methodological quality of included studies, the evidence remains weak. Rigorously designed trials are needed to confirm the evidence.</td></tr>
<tr><td>Timeframe: 1959–April 2013</td></tr>
<tr><td>Total # of Studies: 18</td></tr>
<tr><td>Exposure Definition: Tai chi exercise program (including 12-type tai chi, 24-type tai chi, 48 type tai chi, Yang-type tai chi, and Chen-type tai chi). Interventions ranged from 2 to 60 months. Tai chi alone or combined with antihypertensive drugs compared with routine care or antihypertensive drugs.
Measures Steps: No
Measures Bouts: No
Examines HIIT: No</td></tr>
<tr><td>Outcomes Addressed: Systolic and diastolic blood pressure (mmHg).
Examine Cardiorespiratory Fitness as Outcome: No</td></tr>
<tr><td>Populations Analyzed: Adults 35–75 years, Hypertension</td><td>Author-Stated Funding Source: National Basic Research Program of China, National Natural Science Foundation Project of China.</td></tr>
</table>

<table>
<tr><th colspan="2">Cardiovascular Disease Progression and Mortality</th></tr>
<tr><td colspan="2">Meta-Analysis
Citation: Wen H, Wang L. Reducing effect of aerobic exercise on blood pressure of essential hypertensive patients: A meta-analysis. Medicine (Baltimore). 2017;96(11):e6150. doi:10.1097/MD.0000000000006150.</td></tr>
<tr><td>Purpose: To exposit the real effect of aerobic exercise on blood pressure in hypertensive patients.</td><td rowspan="4">Abstract: BACKGROUND: The comprehensive meta-analysis aimed to explore the reductive effect of aerobic exercise on blood pressure of hypertensive patients. METHODS: The related researches were selected from PubMed and Embase databases up to June 2016. Based on specific inclusive criteria, the eligible studies were selected, and the heterogeneities in their results were estimated by chi-based Q-test and I statistics. Quantitative meta-analysis was assessed by R 3.12 software, and results were presented by standardized mean difference (SMD) and their 95% confidence intervals (CIs). Outcome indicators were systolic blood pressure (SBP) and diastolic blood pressure (DBP). The publication biases were estimated by Egger test. Besides, the "leave one out" method was used for sensitivity evaluations. RESULTS: As a result, a total of 13 papers with 802 samples were included. Based on the meta-analysis results, there were no significant differences in SBP and DBP between aerobic and control groups before exercise (SMD = 0.15, 95%CI: -0.16-0.46; SMD = 0.16, 95% CI: -0.23-0.55). However, significant reductions were obviously in aerobic group after aerobics, compared with control (SMD = -0.79, 95% CI: -1.29 to -0.28; SMD = -0.63, 95% CI: -1.14 to -0.12). A significant publication bias was detected in SBP (t = -2.2314, P = 0.04549) but not in DBP (t = -1.4962, P = 0.1604). Additionally, the DBP result would be altered after the exclusion of 2 individual papers. CONCLUSION: Aerobic exercise may be a potential nonpharmacological treatment for blood pressure improvement in essential hypertensive patients.</td></tr>
<tr><td>Timeframe: Inception–June 2015</td></tr>
<tr><td>Total # of Studies: 13</td></tr>
<tr><td>Exposure Definition: Aerobic exercise training.
Measures Steps: No
Measures Bouts: No
Examines HIIT: No
Outcomes Addressed: Systolic and diastolic blood pressure (mmHg).
Examine Cardiorespiratory Fitness as Outcome: No</td></tr>
<tr><td>Populations Analyzed: Adults, Hypertension</td><td>Author-Stated Funding Source: None.</td></tr>
</table>

<table>
<tr><th colspan="2">Cardiovascular Disease Progression and Mortality</th></tr>
<tr><td colspan="2">Meta-Analysis
Citation: Xiong X, Wang P, Li S, Zhang Y, Li X. Effect of Baduanjin exercise for hypertension: a systematic review and meta-analysis of randomized controlled trials. Maturitas. 2015a;80(4):370-378. doi:10.1016/j.maturitas.2015.01.002.</td></tr>
<tr><td>Purpose: To summarize the current evidence on the efficacy of baduanjin exercise for the treatment of hypertension.</td><td rowspan="5">Abstract: This study aims to evaluate the efficacy of Baduanjin exercise for hypertension. Cochrane Library, PubMed, EMBASE, CNKI, VIP, CBM and Wanfang databases were searched. Eight randomized controlled trials (RCTs) were identified. Baduanjin significantly lowered systolic blood pressure (SBP) (WMD=-13.00 mmHg; 95% CI: -21.24 to -4.77; P=0.002), diastolic blood pressure (DBP) (WMD=-6.13 mmHg; 95% CI: -11.20 to -1.07; P=0.02), body mass index, blood glucose, triglyceride, and low-density lipoprotein-cholesterol, and improved high-density lipoprotein-cholesterol and quality of life compared to no intervention. No significant difference between Baduanjin and antihypertensive drugs on SBP (WMD=1.05 mmHg; 95% CI: -2.07 to 4.17; P=0.51) or DBP (WMD=1.90 mmHg; 95% CI: -1.22 to 5.02; P=0.23) was identified. Baduanjin plus antihypertensive drugs significantly reduced SBP (WMD=-7.49 mmHg; 95% CI: -11.39 to -3.59; P=0.0002), DBP (WMD=-3.55 mmHg; 95% CI: -5.25 to -1.85; P<0.0001), blood glucose, and total cholesterol compared to antihypertensive drugs. Baduanjin is an effective therapy for hypertension. However, further rigorously designed RCTs are still warranted.</td></tr>
<tr><td>Timeframe: Inception–November 2014</td></tr>
<tr><td>Total # of Studies: 8</td></tr>
<tr><td>Exposure Definition: Baduanjin exercise. Sessions lasted from 20 to 45 minutes and ranged from 2 to 5 times per week. Intervention duration last for 3 to 12 months. Effect of baduanjin alone or in combination with antihypertensive drugs compared with no intervention and antihypertensive drugs only.
Measures Steps: No
Measures Bouts: No
Examines HIIT: No</td></tr>
<tr><td>Outcomes Addressed: Systolic and diastolic blood pressure (mmHg); quality of life; body mass index; waist-to-hip ratio; blood glucose; and blood lipids, including triglyceride, total cholesterol, high-density lipoprotein cholesterol, and low-density lipoprotein.
Examine Cardiorespiratory Fitness as Outcome: No</td></tr>
<tr><td>Populations Analyzed: Adults 39–72, Hypertension</td><td>Author-Stated Funding Source: National Natural Science Foundation Project of China.</td></tr>
</table>

<table>
<tr><th colspan="2">Cardiovascular Disease Progression and Mortality</th></tr>
<tr><td colspan="2">Meta-Analysis
Citation: Xiong X, Wang P, Li X, Zhang Y. Qigong for hypertension: a systematic review. Medicine (Baltimore). 2015b;94(1):e352. doi:10.1097/MD.0000000000000352.</td></tr>
<tr><td>Purpose: To evaluate the efficacy and safety of qigong for hypertension.</td><td rowspan="5">Abstract: The purpose of this review was to evaluate the efficacy and safety of qigong for hypertension.A systematic literature search was performed in 7 databases from their respective inceptions until April 2014, including the Cochrane Library, EMBASE, PubMed, Chinese Scientific Journal Database, Chinese Biomedical Literature Database, Wanfang database, and Chinese National Knowledge Infrastructure. Randomized controlled trials of qigong as either monotherapy or adjunctive therapy with antihypertensive drugs versus no intervention, exercise, or antihypertensive drugs for hypertension were identified. The risk of bias was assessed using the tool described in Cochrane Handbook for Systematic Review of Interventions, version 5.1.0.Twenty trials containing 2349 hypertensive patients were included in the meta-analysis. The risk of bias was generally high. Compared with no intervention, qigong significantly reduced systolic blood pressure (SBP) (weighted mean difference [WMD] = -17.40 mm Hg, 95% confidence interval [CI] -21.06 to -13.74, P < 0.00001) and diastolic blood pressure (DBP) (WMD = -10.15 mm Hg, 95% CI -13.99 to -6.30, P < 0.00001). Qigong was inferior to exercise in decreasing SBP (WMD = 6.51 mm Hg, 95% CI 2.81 to 10.21, P = 0.0006), but no significant difference between the effects of qigong and exercise on DBP (WMD = 0.67 mm Hg, 95% CI -1.39 to 2.73, P = 0.52) was identified. Compared with antihypertensive drugs, qigong produced a clinically meaningful but not statistically significant reduction in SBP (WMD = -7.91 mm Hg, 95% CI -16.81 to 1.00, P = 0.08), but appeared to be more effective in lowering DBP (WMD = -6.08 mm Hg, 95% CI -9.58 to -2.58, P = 0.0007). Qigong plus antihypertensive drugs significantly lowered both SBP (WMD = -11.99 mm Hg, 95% CI -15.59 to -8.39, P < 0.00001) and DBP (WMD = -5.28 mm Hg, 95% CI, -8.13 to -2.42, P = 0.0003) compared with antihypertensive drugs alone. No serious adverse events were reported.The meta-analysis suggests that qigong is an effective therapy for hypertension. However, more rigorously designed randomized controlled trials with long-term follow-up focusing on hard clinical outcomes are required to confirm the results.</td></tr>
<tr><td>Timeframe: Inception–April 2014</td></tr>
<tr><td>Total # of Studies: 20</td></tr>
<tr><td>Exposure Definition: Participation in qigong exercise program alone or in combination with antihypertensive drugs compared with no intervention, conventional exercise, and antihypertensive drugs. Intervention duration ranged from 8 weeks to 12 months. Sessions lasted from 15 to 60 minutes and the frequency ranged from 1 to 2 times per day.
Measures Steps: No
Measures Bouts: No
Examines HIIT: No</td></tr>
<tr><td>Outcomes Addressed: Systolic and diastolic blood pressure in either categorical or continuous form.
Examine Cardiorespiratory Fitness as Outcome: No</td></tr>
<tr><td>Populations Analyzed: Adults, Hypertension</td><td>Author-Stated Funding Source: National Natural Science Foundation Project of China.</td></tr>
</table>

Table 3. Existing Systematic Review and Meta-Analyses Quality Assessment Chart

AMSTARExBP: SR/MA						
	Carlson, 2014	Casonatto, 2016	Conceicao, 2016	Cornelissen, 2011	Cornelissen, 2013	Corso, 2016
Review questions and inclusion/exclusion criteria delineated prior to executing search strategy.	Yes	Yes	Yes	Yes	Yes	Yes
Population variables defined and considered in methods.	Yes	Yes	No	Yes	Yes	Yes
Comprehensive literature search performed.	Yes	Partially Yes	Yes	Yes	Yes	Yes
Duplicate study selection and data extraction performed.	No	No	Yes	No	Yes	Yes
Search strategy clearly described.	Yes	Yes	Yes	Yes	Yes	Yes
Relevant grey literature included in review.	No	No	Yes	No	No	No
List of studies (included and excluded) provided.	No	No	Yes	No	No	Yes
Characteristics of included studies provided.	Yes	Yes	Yes	Yes	Yes	Yes
FITT defined and examined in relation to outcome effect sizes.	No	Yes	No	Yes	Yes	No
Scientific quality (risk of bias) of included studies assessed and documented.	Yes	Yes	Yes	Yes	Yes	Yes
Results depended on study quality, either overall, or in interaction with moderators.	Yes	No	No	Yes	Yes	Yes
Scientific quality used appropriately in formulating conclusions.	Yes	No	Yes	Yes	Yes	Yes
Data appropriately synthesized and if applicable, heterogeneity assessed.	Yes	Yes	Yes	Yes	Yes	Yes
Effect size index chosen justified, statistically.	Yes	Yes	Yes	Yes	Yes	Yes
Individual-level meta-analysis used.	No	No	No	No	No	No
Practical recommendations clearly addressed.	Yes	Yes	Yes	Yes	No	Yes
Likelihood of publication bias assessed.	Yes	Yes	No	Yes	Yes	Yes
Conflict of interest disclosed.	No	Yes	No	Yes	Yes	Yes

AMSTARExBP: SR/MA						
	Dickinson, 2006	Fagard, 2007	MacDonald, 2016	Park, 2017	Rossi, 2012	Wang, 2013
Review questions and inclusion/exclusion criteria delineated prior to executing search strategy.	Yes	Yes	Yes	Yes	Yes	Yes
Population variables defined and considered in methods.	No	No	Yes	No	Yes	No
Comprehensive literature search performed.	Yes	No	Yes	Yes	Yes	Yes
Duplicate study selection and data extraction performed.	Yes	No	Yes	Yes	Yes	Yes
Search strategy clearly described.	Yes	No	Yes	Yes	Yes	Yes
Relevant grey literature included in review.	No	No	No	No	No	Yes
List of studies (included and excluded) provided.	Yes	No	No	No	Yes	No
Characteristics of included studies provided.	Yes	No	Yes	Yes	Yes	Yes
FITT defined and examined in relation to outcome effect sizes.	No	No	Yes	No	N/A	No
Scientific quality (risk of bias) of included studies assessed and documented.	Yes	No	Yes	Yes	Yes	Yes
Results depended on study quality, either overall, or in interaction with moderators.	Yes	N/A	Yes	No	Yes	No
Scientific quality used appropriately in formulating conclusions.	Yes	N/A	Yes	Yes	Yes	Yes
Data appropriately synthesized and if applicable, heterogeneity assessed.	Yes	No	Yes	Yes	N/A	Yes
Effect size index chosen justified, statistically.	Yes	Partially Yes	Yes	Yes	N/A	Yes
Individual-level meta-analysis used.	No	No	No	No	N/A	No
Practical recommendations clearly addressed.	Yes	Yes	Yes	Yes	Yes	Yes
Likelihood of publication bias assessed.	Yes	No	Yes	Yes	Yes	No
Conflict of interest disclosed.	Yes	No	Yes	Yes	Yes	Yes

AMSTARExBP: SR/MA			
	Wen, 2017	Xiong, 2015a	Xiong, 2015b
Review questions and inclusion/exclusion criteria delineated prior to executing search strategy.	Yes	Yes	Yes
Population variables defined and considered in methods.	No	No	No
Comprehensive literature search performed.	Yes	Yes	Yes
Duplicate study selection and data extraction performed.	No	Yes	Yes
Search strategy clearly described.	Yes	Yes	Yes
Relevant grey literature included in review.	No	Yes	Yes
List of studies (included and excluded) provided.	No	No	No
Characteristics of included studies provided.	Yes	Yes	Yes
FITT defined and examined in relation to outcome effect sizes.	No	No	No
Scientific quality (risk of bias) of included studies assessed and documented.	No	Yes	Yes
Results depended on study quality, either overall, or in interaction with moderators.	N/A	No	No
Scientific quality used appropriately in formulating conclusions.	N/A	Yes	Yes
Data appropriately synthesized and if applicable, heterogeneity assessed.	Yes	Yes	Yes
Effect size index chosen justified, statistically.	Yes	Yes	Yes
Individual-level meta-analysis used.	No	No	No
Practical recommendations clearly addressed.	Yes	Yes	Yes
Likelihood of publication bias assessed.	Yes	No	No
Conflict of interest disclosed.	Yes	Yes	Yes

Appendices

Appendix A: Analytical Framework

Topic Area
Chronic Conditions

Systematic Review Questions

In individuals with the cardiovascular condition of hypertension, what is the relationship between physical activity and (1) risk of co-morbid conditions, (2) physical function, (3) health-related quality of life, and (4) cardiovascular disease progression and mortality?

a. Is there a dose-response relationship? If yes, what is the shape of the relationship?
b. Does the relationship vary by age, sex, race/ethnicity, socio-economic status, weight status, or resting blood pressure level?
c. Does the relationship based on frequency, duration, intensity, type (mode), and how physical activity is measured?

Population
Individuals of all ages with hypertension

Exposure
All types and intensities of physical activity

Comparison
Individuals with hypertension who participate in varying levels of physical activity

Endpoint Health Outcomes

- Risk of co-morbid conditions
- Physical function
- Health-related quality of life
- Disease progression

Key Definitions

- Hypertension or high blood pressure is defined as having blood pressure higher than 140/90 mmHg or being on antihypertensive medications regardless of the blood pressure level.
- Risk of co-morbid conditions: The chance of having one or more additional conditions
- Physical function: “Physical function” and “physical functioning” are regarded as synonyms that refer to: “the ability of a person to move around and to perform types of physical activity.”
    - For example, measures of physical function include measures of ability to walk (e.g., usually gait speed), run, climb stairs, carry groceries, sweep the floor, stand up, and bath oneself.
    - As measures of behavioral abilities, physical function measures do not include:
        - Physiologic measures, including measures of physiologic capacity (e.g., maximal lung capacities, maximal aerobic capacity, maximal muscle strength, bone density).
        - Measures of the environment or of the host-environmental interaction (e.g., disability accommodation).
        - Measures of what a person usually does (e.g., physical activity level) (as opposed to what a person is capable of doing).
- Health-related quality of life: “Health-related quality of life (HRQOL) is a multi-dimensional concept that includes domains related to physical, mental, emotional, and social functioning.” Source: HealthyPeople.gov https://www.healthypeople.gov/2020/topics-objectives/topic/health-related-quality-of-life-well-being
- Disease progression: A change or worsening of a disease over time.

Appendix B: Final Search Strategy

Search Strategy: PubMed (Systematic Reviews, Meta-Analyses, Pooled Analyses, and High-Quality Reports)

Database: PubMed; Date of Search: 4/7/17; 621 results

Set	Search Strategy
Limit: Language	(English[lang])
Limit: Exclude animal only	NOT ("Animals"[mh] NOT ("Animals"[mh] AND "Humans"[mh]))
Limit: Exclude subheadings	NOT (“diet therapy”[subheading] OR "epidemiology"[Subheading])
Limit: Publication Date (Systematic Reviews/Meta-Analyses)	AND ("2006/01/01"[PDAT] : "3000/12/31"[PDAT])
Limit: Publication Type Include (Systematic Reviews/Meta-Analyses)	AND (systematic[sb] OR meta-analysis[pt] OR “systematic review”[tiab] OR “systematic literature review”[tiab] OR metaanalysis[tiab] OR "meta analysis"[tiab] OR metanalyses[tiab] OR "meta analyses"[tiab] OR "pooled analysis"[tiab] OR “pooled analyses”[tiab] OR "pooled data"[tiab])
Limit: Publication Type Exclude (Systematic Reviews/Meta-Analyses)	NOT (“comment”[Publication Type] OR “editorial”[Publication Type])
Physical Activity	AND (("Aerobic endurance"[tiab] OR "Bicycl*"[tiab] OR "Endurance training"[tiab] OR "Exercise"[mh] OR "Exercise"[tiab] OR "Exercises"[tiab] OR "Free living activities"[tiab] OR "Free living activity"[tiab] OR "Functional training"[tiab] OR "Leisure-time physical activity"[tiab] OR "Lifestyle activities"[tiab] OR "Lifestyle activity"[tiab] OR "Muscle stretching exercises"[mh] OR "Physical activity"[tiab] OR "Qi gong"[tiab] OR "Recreational activities"[tiab] OR "Recreational activity"[tiab] OR "Resistance training"[tiab] OR "Running"[tiab] OR "Sedentary lifestyle"[mh] OR "Speed training"[tiab] OR "Strength training"[tiab] OR "Tai chi"[tiab] OR "Tai ji"[mh] OR "Tai ji"[tiab] OR "Training duration"[tiab] OR "Training frequency"[tiab] OR "Training intensity"[tiab] OR "Treadmill"[tiab] OR "Walking"[tiab] OR "Weight lifting"[tiab] OR "Weight training"[tiab] OR "Yoga"[mh] OR "Yoga"[tiab]) OR (("Aerobic activities"[tiab] OR "Aerobic activity"[tiab] OR "Cardiovascular activities"[tiab] OR "Cardiovascular activity"[tiab] OR "Endurance activities"[tiab] OR "Endurance activity"[tiab] OR "Physical activities"[tiab] OR "Physical

	conditioning"[tiab] OR "Sedentary"[tiab]) NOT medline[sb]))
Outcome	AND ("mean arterial"[tiab] OR "blood pressure"[tiab] OR "blood pressure"[mh] OR "blood pressures"[tiab] OR "arterial pressure"[tiab] OR "arterial pressures"[tiab] OR “hypertension”[tiab] OR “hypotension”[tiab] OR “normotension”[tiab] OR “hypertensive”[tiab] OR “hypotensive”[tiab] OR "normotensive”[tiab] OR "systolic pressure"[tiab] OR "diastolic pressure"[tiab] OR "pulse pressure"[tiab] OR "venous pressure"[tiab] OR "pressure monitor"[tiab] OR "pre hypertension"[tiab] OR "bp response"[tiab] OR "bp decrease"[tiab] OR "bp reduction"[tiab] OR "bp monitor"[tiab] OR "bp monitors"[tiab] OR "bp measurement"[tiab])

Search Strategy: CINAHL (Systematic Reviews, Meta-Analyses, Pooled Analyses, and High-Quality Reports)

Database: CINAHL; Date of Search: 4/7/17; 6 results

All terms searched in title or abstract

Set	Search Terms
Physical Activity	("Aerobic endurance" OR "Bicycl*" OR "Endurance training" OR "Exercise" OR "Exercises" OR "Free living activities" OR "Free living activity" OR "Functional training" OR "Leisure-time physical activity" OR "Lifestyle activities" OR "Lifestyle activity" OR "Muscle stretching exercises" OR "Physical activity" OR "Qi gong" OR "Recreational activities" OR "Recreational activity" OR "Resistance training" OR "Running" OR "Sedentary lifestyle" OR "Speed training" OR "Strength training" OR "Tai chi" OR "Tai ji" OR "Tai ji" OR "Training duration" OR "Training frequency" OR "Training intensity" OR "Treadmill" OR "Walking" OR "Weight lifting" OR "Weight training" OR "Yoga" OR "Aerobic activities" OR "Aerobic activity" OR "Cardiovascular activities" OR "Cardiovascular activity" OR "Endurance activities" OR "Endurance activity" OR "Physical activities" OR "Physical conditioning" OR "Sedentary")
Outcomes	AND ("mean arterial" OR "blood pressure" OR "blood pressure" OR "blood pressures" OR "arterial pressure" OR "arterial pressures" OR "hypertension" OR "hypotension" OR "normotension" OR "hypertensive" OR "hypotensive" OR "normotensive" OR "systolic pressure" OR "diastolic pressure" OR "pulse pressure" OR "venous pressure" OR "pressure monitor" OR "pre hypertension" OR "bp response" OR "bp decrease" OR "bp reduction" OR "bp monitor" OR "bp monitors" OR "bp measurement")
Systematic Reviews and Meta-Analyses	("systematic review" OR "systematic literature review" OR metaanalysis OR "meta analysis" OR metanalyses OR "meta analyses" OR "pooled analysis" OR "pooled analyses" OR "pooled data")
Limits	2006–present English language Peer reviewed Exclude Medline records Human

Search Strategy: Cochrane (Systematic Reviews, Meta-Analyses, Pooled Analyses, and High-Quality Reports)

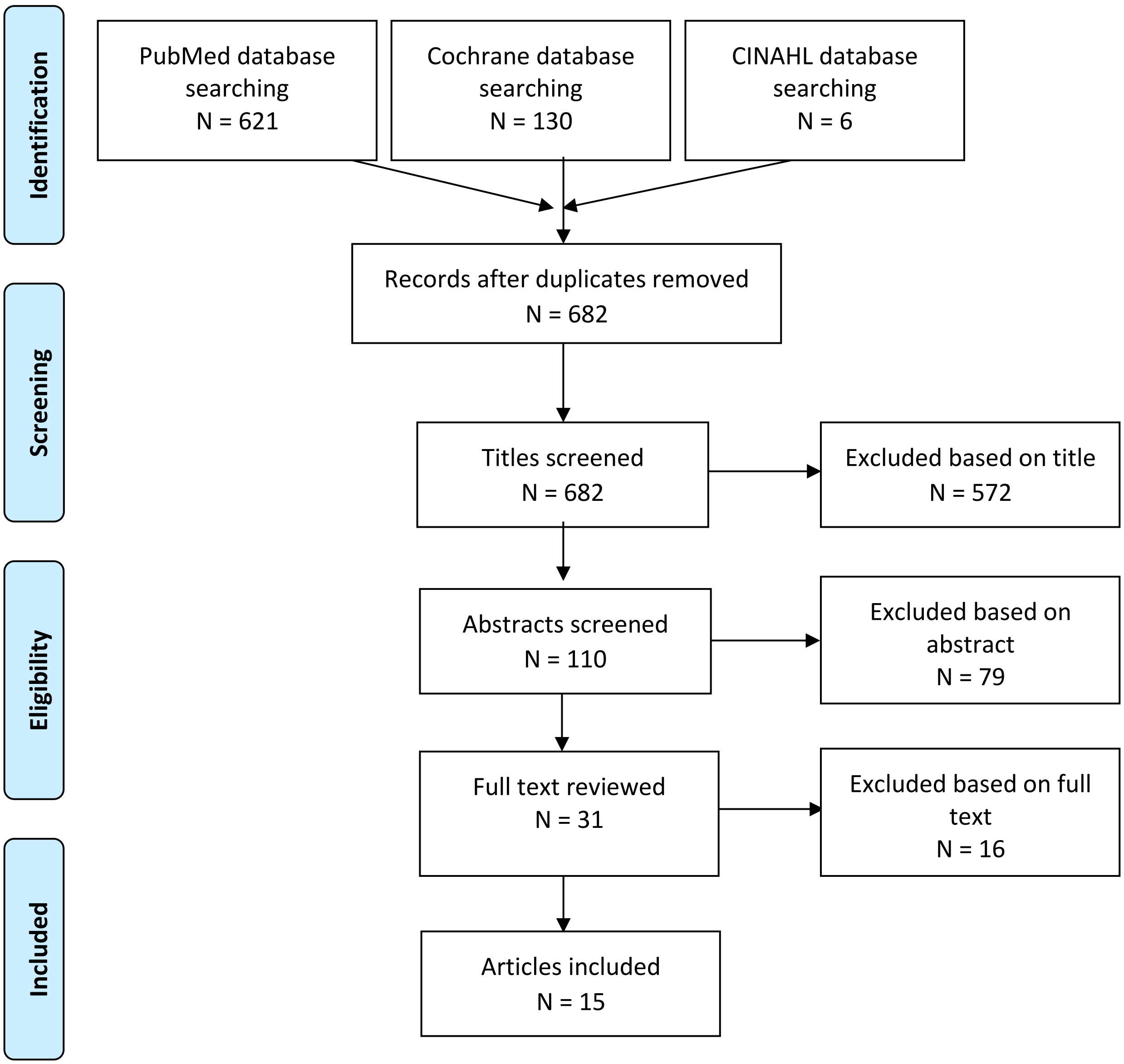
Database: Cochrane; Date of Search: 4/7/17; 130 results

All terms searched in title, abstract, or keywords

Set	Search Terms
Physical Activity	("Aerobic endurance" OR "Bicycl*" OR "Endurance training" OR "Exercise" OR "Exercises" OR "Free living activities" OR "Free living activity" OR "Functional training" OR "Leisure-time physical activity" OR "Lifestyle activities" OR "Lifestyle activity" OR "Muscle stretching exercises" OR "Physical activity" OR "Qi gong" OR "Recreational activities" OR "Recreational activity" OR "Resistance training" OR "Running" OR "Sedentary lifestyle" OR "Speed training" OR "Strength training" OR "Tai chi" OR "Tai ji" OR "Tai ji" OR "Training duration" OR "Training frequency" OR "Training intensity" OR "Treadmill" OR "Walking" OR "Weight lifting" OR "Weight training" OR "Yoga" OR "Aerobic activities" OR "Aerobic activity" OR "Cardiovascular activities" OR "Cardiovascular activity" OR "Endurance activities" OR "Endurance activity" OR "Physical activities" OR "Physical conditioning" OR "Sedentary”)
Outcomes	AND ("mean arterial" OR "blood pressure" OR "blood pressure" OR "blood pressures" OR "arterial pressure" OR "arterial pressures" OR “hypertension” OR “hypotension” OR “normotension” OR “hypertensive” OR “hypotensive” OR “normotensive” OR "systolic pressure" OR "diastolic pressure" OR "pulse pressure" OR "venous pressure" OR "pressure monitor" OR "pre hypertension" OR "bp response" OR "bp decrease" OR "bp reduction" OR "bp monitor" OR "bp monitors" OR "bp measurement")
Limits	2006–present Word variations not searched Cochrane Reviews and Other Reviews

Appendix C: Literature Tree

Existing Systematic Reviews, Meta-Analyses, Pooled Analyses, and Reports Literature Tree



Appendix D: Inclusion/Exclusion Criteria

Chronic Conditions Subcommittee

In individuals with the cardiovascular condition of hypertension, what is the relationship between physical activity and (1) risk of co-morbid conditions, (2) physical function, (3) health-related quality of life, and (4) cardiovascular disease progression and mortality?

a. Is there a dose-response relationship? If yes, what is the shape of the relationship?
b. Does the relationship vary by age, sex, race/ethnicity, socio-economic status, weight status, or resting blood pressure level?
c. Does the relationship based on: frequency, duration, intensity, type (mode), and how physical activity is measured?

Category	Inclusion/Exclusion Criteria	Notes/Rationale
Publication Language	**Include:** • Studies published with full text in English	
Publication Status	**Include:** • Studies published in peer-reviewed journals • Reports determined to have appropriate suitability and quality by PAGAC **Exclude:** • Grey literature, including unpublished data, manuscripts, abstracts, conference proceedings	
Research Type	**Include:** • Original research • Meta-analyses • Systematic reviews • Reports determined to have appropriate suitability and quality by PAGAC	
Study Subjects	**Include:** • Human subjects	
Age of Study Subjects	**Include:** • People of all ages	
Health Status of Study Subjects	**Include:** • Studies of people with hypertension **Exclude:** • Studies which include people with hypertension as part of the study sample, but do not analyze results separately for people with hypertension only. • Studies with people who are prehypertensive. • Studies with people who have pulmonary hypertension.	
Comparison	**Include:**	

	• Adults who participate in varying levels of physical activity, including acute or chronic exercise or no reported physical activity • Recreational athletes (marathons ok as long as the study looks at a diverse group of runners—not just the elites) **Exclude:** • High performance athletes • Studies comparing athletes to non-athletes • Studies comparing athlete types (e.g., comparing runners to soccer players)	
Date of Publication	**Include:** • Systematic reviews, meta-analyses, pooled analyses, and reports published from 2011 to 2016	
Study Design	**Include:** • Systematic reviews • Meta-analyses • Pooled analyses • PAGAC-approved reports **Exclude:** • Randomized controlled trials • Prospective cohort studies narrative reviews • Commentaries • Editorials • Non-randomized controlled trials • Retrospective cohort studies • Case-control studies • Cross-sectional studies • Before-and-after studies	
Intervention/ Exposure	**Include studies in which the exposure or intervention is:** • All types and intensities of physical activity • Acute or chronic exercise • Rehabilitation or therapy for hypertension **Exclude:** • Studies that do not include physical activity • Studies where physical activity is used solely as a confounding variable • Studies of multimodal interventions that do not present data on physical activity alone • Studies with measures of physical fitness as the exposure	
Outcome	**Include studies in which the outcome is:**	

	• Risk of co-morbid conditions • Physical function • Health-related quality of life • Disease progression	

Appendix E: Rationale for Exclusion at Abstract or Full-Text Triage for Existing Systematic Reviews, Meta-Analyses, Pooled Analyses, and Reports

The table below lists the excluded articles with at least one reason for exclusion, but may not reflect all possible reasons.

Citation	Outcome	Population	Study Design	Exposure	Not ideal fit for replacement of de novo search	Other
Ahmad S, Shanmugasegaram S, Walker KL, Prince SA. Examining sedentary time as a risk factor for cardiometabolic diseases and their markers in South Asian adults: a systematic review. *Int J Public Health.* 2017;62(4):503-515. doi:10.1007/s00038-017-0947-8.		X				
Ashor AW, Lara J, Siervo M, Celis-Morales C, Mathers JC. Effects of exercise modalities on arterial stiffness and wave reflection: a systematic review and meta-analysis of randomized controlled trials. *PLoS One.* 2014;9(10):e110034. doi:10.1371/journal.pone.0110034.		X				
Baena CP, Olandoski M, Younge JO, et al. Effects of lifestyle-related interventions on blood pressure in low and middle-income countries: systematic review and meta-analysis. *J Hypertens.* 2014;32(5):961-973. doi:10.1097/HJH.0000000000000136.				X		
Barrows JL, Fleury J. Systematic review of yoga interventions to promote cardiovascular health in older adults. *West J Nurs Res*. 2016;38(6):753-781. doi:10.1177/0193945915618610.		X				
Batacan RB, Duncan MJ, Dalbo VJ, et al. Effects of high-intensity interval training on cardiometabolic health: a systematic review and meta-analysis of intervention studies*. Br J Sports Med.* 2017;51(6):494-503.		X				
Batacan RB, Duncan MJ, Dalbo VJ, et al. Effects of light intensity activity on CVD risk factors: a systematic review of intervention studies. *Biomed Res Int.* 2015;2015:596367. doi:10.1155/2015/596367.		X				
Bento VF, Albino FB, de Moura KF, et al. Impact of physical activity interventions on blood pressure in Brazilian populations. *Arq Bras Cardiol.* 2015;105(3):301-308. doi:10.5935/abc.20150048.		X				
Chandrasekaran B, Arumugam A, Davis F, et al. Resistance exercise training for hypertension. *Cochrane Database Syst Rev.* 2010;(11):CD008822. doi:10.1002/14651858.CD008822.			X			
Chiang CE, Wang TD, Li YH, et al; Hypertension Committee of the Taiwan Society of Cardiology. 2010 guidelines of the Taiwan Society of Cardiology for the management of hypertension. *J Formos Med Assoc.* 2010;109(10):740-773. doi:10.1016/S0929-6646(10)60120-9.					X	
Chrysant SG. Current evidence on the hemodynamic and blood pressure effects of			X			

Citation	Outcome	Population	Study Design	Exposure	Not ideal fit for replacement of de novo search	Other
isometric exercise in normotensive and hypertensive persons. *J Clin Hypertens (Greenwich).* 2010;12(9):721-726. doi:10.1111/j.1751-7176.2010.00328.x						
Collins P, Rosano G, Casey C, et al. Management of cardiovascular risk in the peri-menopausal woman: a consensus statement of European cardiologists and gynaecologists. *Eur Heart J.* 2007;28(16):2028-2040.				X		
Cornelissen VA, Buys R, Smart NA. Endurance exercise beneficially affects ambulatory blood pressure: a systematic review and meta-analysis. *J Hypertens.* 2013;31(4):639-648. doi:10.1097/HJH.0b013e32835ca964.		X				
Cornelissen VA, Goetschalckx K, Verheyden B, et al. Effect of endurance training on blood pressure regulation, biomarkers and the heart in subjects at a higher age. *Scand J Med Sci Sports*. 2011;21(4):526-534. doi:10.1111/j.1600-0838.2010.01094.x.			X			
Cramer H, Haller H, Lauche R, et al. A systematic review and meta-analysis of yoga for hypertension. *Am J Hypertens.* 2014;27(9):1146-1151. doi:10.1093/ajh/hpu078.		X				
Cramer H, Langhorst J, Dobos G, Lauche R. Yoga for metabolic syndrome: a systematic review and meta-analysis. *Eur J Prev Cardiol.* 2016;23(18).		X				
de Rezende LF, Rodrigues Lopes M, Rey-Lopez JP, Matsudo VK, Luiz Odo C. Sedentary behavior and health outcomes: an overview of systematic reviews. *PLoS One.* 2014;9(8):e105620. doi:10.1371/journal.pone.0105620.		X				
Ebireri J, Aderemi AV, Omoregbe N, Adeloye D. Interventions addressing risk factors of ischaemic heart disease in sub-Saharan Africa: a systematic review. *BMJ Open.* 2016;6(7):e011881. doi:10.1136/bmjopen-2016-011881.			X			
Ebrahim S, Taylor F, Ward K, Beswick A, Burke M, Davey Smith G. Multiple risk factor interventions for primary prevention of coronary heart disease. *Cochrane Database Syst Rev.* 2011;1:CD001561. doi:10.1002/14651858.CD001561.pub3.				X		
Eckel RH, Jakicic JM, Ard JD, et al. 2013 AHA/ACC guideline on lifestyle management to reduce cardiovascular risk: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines. *Circulation*. 2014;129(25 Suppl 2):S76-S99. doi:10.1161/01.cir.0000437740.48606.d1.					X	
Erdine S, Ari O, Zanchetti A, et al. ESH-ESC guidelines for the management of hypertension. *Herz*. 2006;31(4):331-338.				X		

Citation	Outcome	Population	Study Design	Exposure	Not ideal fit for replacement of de novo search	Other
Fagard RH. Exercise is good for your blood pressure: effects of endurance training and resistance training. *Clin Exp Pharmacol Physiol.* 2006;33(9):853-856.			X			
Fazzi C, Saunders DH, Linton K, Norman JE, Reynolds RM. Sedentary behaviours during pregnancy: a systematic review. *Int J Behav Nutr Phys Act.* 2017. 14(1):32. doi:10.1186/s12966-017-0485-z.		X				
Ghadieh AS, Saab B. Evidence for exercise training in the management of hypertension in adults. *Can Fam Physician*. 2015;61(3):233-239.			X			
Gilbert JS. From apelin to exercise: emerging therapies for management of hypertension in pregnancy. *Hypertens Res.* 2017. doi:10.1038/hr.2017.40.		X				
Goessler K, Polito M, Cornelissen VA. Effect of exercise training on the renin-angiotensin-aldosterone system in healthy individuals: a systematic review and meta-analysis. *Hypertens Res.* 2016;39(3):119-126. doi:10.1038/hr.2015.100.		X				
Gomes Anunciacao P, Doederlein Polito M. A review on post-exercise hypotension in hypertensive individuals. *Arq Bras Cardiol.* 2011;96(5):e100-109.			X			
Groeneveld IF, Proper KI, van der Beek AJ, Hildebrandt VH, van Mechelen W. Lifestyle-focused interventions at the workplace to reduce the risk of cardiovascular disease--a systematic review. *Scand J Work Environ Health.* 2010;36(3):202-215		X				
Guo X, Zhou B, Nishimura T, Teramukai S, Fukushima M. Clinical effect of qigong practice on essential hypertension: a meta-analysis of randomized controlled trials. *J Altern Complement Med.* 2008;14(1):27-37. doi:10.1089/acm.2007.7213.						X
Hackam DG, Khan NA, Hemmelgarn BR, et al; Canadian Hypertension Education Program. The 2010 Canadian Hypertension Education Program recommendations for the management of hypertension: part 2 - therapy. *Can J Cardiol.* 2010;26(5):249-258.					X	
Hackam DG, Quinn RR, Ravani P, et al; Canadian Hypertension Education Program. The 2013 Canadian Hypertension Education Program recommendations for blood pressure measurement, diagnosis, assessment of risk, prevention, and treatment of hypertension. *Can J Cardiol.* 2013;29(5):528-542. doi:10.1016/j.cjca.2013.01.005.					X	

Citation	Outcome	Population	Study Design	Exposure	Not ideal fit for replacement of de novo search	Other
Hagins M, States R, Selfe T, Innes K. Effectiveness of yoga for hypertension: systematic review and meta-analysis. *Evid Based Complement Alternat Med.* 2013;2013:649836. doi:10.1155/2013/649836.		X				
Hamer M, Taylor A, Steptoe A. The effect of acute aerobic exercise on stress related blood pressure responses: a systematic review and meta-analysis. *Biol Psychol.* 2006;71(2):183-190.		X				
Hammami A, Chamari K, Slimani M, et al. Effects of recreational soccer on physical fitness and health indices in sedentary healthy and unhealthy subjects. *Biol Sport.* 2016;33(2):127-137. doi:10.5604/20831862.1198209.		X				
Hanson S, Jones A. Is there evidence that walking groups have health benefits? A systematic review and meta-analysis. *Br J Sports Med.* 2015;49(11):710-715. doi:10.1136/bjsports-2014-094157.		X				
Hartley L, Flowers N, Lee MS, Ernst E, Rees K. Tai chi for primary prevention of cardiovascular disease. *Cochrane Database Syst Rev.* 2014;(4):Cd010366. doi:10.1002/14651858.CD010366.pub2.		X				
Huai P, Xun H, Reilly KH, Wang Y, Ma W, Xi B. Physical activity and risk of hypertension: a meta-analysis of prospective cohort studies. *Hypertension*. 2013;62(6):1021-1026. doi:10.1161/HYPERTENSIONAHA.113.01965.		X				
Huang G, Shi X, Gibson CA, Huang SC, Coudret NA, Ehlman MC. Controlled aerobic exercise training reduces resting blood pressure in sedentary older adults. *Blood Press.* 2013;22(6):386-394. doi:10.3109/08037051.2013.778003.		X				
Inder JD, Carlson DJ, Dieberg G, McFarlane JR, Hess NC, Smart NA. Isometric exercise training for blood pressure management: a systematic review and meta-analysis to optimize benefit. *Hypertens Res.* 2016;39(2):88-94. doi:10.1038/hr.2015.111.		X				
Johnson BT, MacDonald HV, Bruneau ML, et al. Methodological quality of meta-analyses on the blood pressure response to exercise: a review. *J Hypertens.* 2014;32(4):706-723. doi:10.1097/HJH.0000000000000097.					X	
Katzmarzyk PT, Lear SA. Physical activity for obese individuals: a systematic review of effects on chronic disease risk factors. *Obes Rev.* 2012;13(2):95-105. doi:10.1111/j.1467-789X.2011.00933.x.		X				
Kelley GA, Kelley KS. Efficacy of aerobic exercise on coronary heart disease risk factors. *Prev Cardiol*. 2008;11(2):71-75.		X				

Citation	Outcome	Population	Study Design	Exposure	Not ideal fit for replacement of de novo search	Other
Kelley GA, Kelley KS. Isometric handgrip exercise and resting blood pressure: a meta-analysis of randomized controlled trials. *J Hypertens.* 2010;28(3):411-418. doi:10.1097/HJH.0b013e3283357d16.		X				
Kingsley JD, Figueroa A. Acute and training effects of resistance exercise on heart rate variability. *Clin Physiol Funct Imaging.* 2016;36(3):179-187. doi:10.1111/cpf.12223.	X					
Le VV, Mitiku T, Sungar G, Myers J, Froelicher V. The blood pressure response to dynamic exercise testing: a systematic review. *Prog Cardiovasc Dis.* 2008;51(2):135-160. doi:10.1016/j.pcad.2008.07.001.		X				
Lee LL, Watson M, Mulvaney C, Salzwedel DM, Chan ES. Walking for hypertension. *Cochrane Database Syst Rev.* 2010;(11). doi:10.1002/14651858.CD008823.			X			
Lee LL, Watson MC, Mulvaney CA, Tsai CC, Lo SF. The effect of walking intervention on blood pressure control: a systematic review. *Int J Nurs Stud.* 2010;47(12):1545-1561. doi:10.1016/j.ijnurstu.2010.08.008.		X				
Lee MS, Lee EN, Kim JI, Ernst E. Tai chi for lowering resting blood pressure in the elderly: a systematic review. *J Eval Clin Pract.* 2010;16(4):818-824. doi:10.1111/j.1365-2753.2009.01210.x.		X				
Lee MS, Pittler MH, Guo R, Ernst E. Qigong for hypertension: a systematic review of randomized clinical trials. *J Hypertens.* 2007;25(8):1525-1532.		X				
Lee PH, Wong FK. The association between time spent in sedentary behaviors and blood pressure: a systematic review and meta-analysis. *Sports Med.* 2015;45(6):867-880. doi:10.1007/s40279-015-0322-y.		X				
Lemes IR, Ferreira PH, Linares SN, Machado AF, Pastre CM, Junior JN. Resistance training reduces systolic blood pressure in metabolic syndrome: a systematic review and meta-analysis of randomised controlled trials. *Br J Sports Med.* 2016. doi:10.1136/bjsports-2015-094715.		X				
Li Y, Hanssen H, Cordes M, Rossmeissl A, Endes S, Schmidt-Trucksäss A. Aerobic, resistance and combined exercise training on arterial stiffness in normotensive and hypertensive adults: a review. *Eur J Sport Sci.* 2015;15(5):443-457. doi:10.1080/17461391.2014.955129.	X					
Lin CH, Chiang SL, Tzeng WC, Chiang LC. Systematic review of impact of lifestyle-modification programs on metabolic risks and patient-reported outcomes in adults with metabolic syndrome. *Worldviews Evid Based Nurs*. 2014;11(6):361-368.				X		

Citation	Outcome	Population	Study Design	Exposure	Not ideal fit for replacement of de novo search	Other
Liu X, Zhang D, Liu Y, et al. Dose-response association between physical activity and incident hypertension: a systematic review and meta-analysis of cohort studies. *Hypertension*. 2017;69(5):813-820. doi:10.1161/HYPERTENSIONAHA.116.08994.		X				
Mancia G, Fagard R, Narkiewicz K, et al. 2013 ESH/ESC guidelines for the management of arterial hypertension: the Task Force for the Management of Arterial Hypertension of the European Society of Hypertension (ESH) and of the European Society of Cardiology (ESC). *Eur Heart J.* 2013;34(28):2159-2219. doi:10.1093/eurheartj/eht151.					X	
McCauley KM. Modifying women's risk for cardiovascular disease. *J Obstet Gynecol Neonatal Nurs.* 2007;36(2):116-124.	X					
Millar PJ, McGowan CL, Cornelissen VA, et al. Evidence for the role of isometric exercise training in reducing blood pressure: potential mechanisms and future directions. *Sports Med.* 2014;44(3):345-356. doi:10.1007/s40279-013-0118-x.					X	
Montero D, Roberts CK, Vinet A. Effect of aerobic exercise training on arterial stiffness in obese populations: a systematic review and meta-analysis. *Sports Med.* 2014;44(6):833-843. doi:10.1007/s40279-014-0165-y.		X				
Montero D, Roche E, Martinez-Rodriguez A. The impact of aerobic exercise training on arterial stiffness in pre- and hypertensive subjects: a systematic review and meta-analysis. *Int J Cardiol.* 2014;173(3):361-368. doi:10.1016/j.ijcard.2014.03.072.	X					
Murphy MH, Nevill AM, Murtagh EM, Holder RL. The effect of walking on fitness, fatness and resting blood pressure: a meta-analysis of randomised, controlled trials. *Prev Med.* 2007;44(5):377-385.		X				
Murtagh EM, Nichols L, Mohammed MA, et al. The effect of walking on risk factors for cardiovascular disease: an updated systematic review and meta-analysis of randomised control trials. *Prev Med.* 2015;72:34-43. doi:10.1016/j.ypmed.2014.12.041.		X				
Okonta NR. Does yoga therapy reduce blood pressure in patients with hypertension? An integrative review. *Holist Nurs Pract*. 2012;26(3):137-141. doi:10.1097/HNP.0b013e31824ef647.			X			
Oliveros MJ, Gaete-Mahn MC, Lanas F, Martinez-Zapata MJ, Seron P. Interval training exercise for hypertension. *Cochrane Database Syst Rev.* 2017;(1). doi:10.1002/14651858.CD012511.			X			
Owen A, Wiles J, Swaine I. Effect of isometric exercise on resting blood pressure: a meta		X				

Citation	Outcome	Population	Study Design	Exposure	Not ideal fit for replacement of de novo search	Other
analysis. *J Hum Hypertens*. 2010;24(12):796-800. doi:10.1038/jhh.2010.13.						
Pal S, Radavelli-Bagatini S, Ho S. Potential benefits of exercise on blood pressure and vascular function. *J Am Soc Hypertens*. 2013;7(6):494-506. doi:10.1016/j.jash.2013.07.004.		X				
Pascoe MC, Bauer IE. A systematic review of randomised control trials on the effects of yoga on stress measures and mood. *J Psychiatr Res.* 2015;68:270-282. doi:10.1016/j.jpsychires.2015.07.013.			X			
Pattyn N, Cornelissen VA, Eshghi SR, Vanhees L. The effect of exercise on the cardiovascular risk factors constituting the metabolic syndrome: a meta-analysis of controlled trials. *Sports Med.* 2013;43(2):121-133. doi:10.1007/s40279-012-0003-z.		X				
Pedersen BK, Saltin B. Exercise as medicine—evidence for prescribing exercise as therapy in 26 different chronic diseases. *Scand J Med Sci Sports.* 2015;25(suppl 3):1-72. doi:10.1111/sms.12581.				X		
Perk J, De Backer G, Gohlke H, et al; European Association for Cardiovascular Prevention & Rehabilitation (EACPR); ESC Committee for Practice Guidelines (CPG). European Guidelines on cardiovascular disease prevention in clinical practice (version 2012). The Fifth Joint Task Force of the European Society of Cardiology and Other Societies on Cardiovascular Disease Prevention in Clinical Practice (constituted by representatives of nine societies and by invited experts). *Eur Heart J.* 2012;33(13):1635-1701.					X	
Pescatello LS, MacDonald HV, Ash GI, et al. Assessing the existing professional exercise recommendations for hypertension: a review and recommendations for future research priorities. *Mayo Clin Proc.* 2015;90(6):801-812.					X	
Posadzki P, Cramer H, Kuzdzal A, Lee MS, Ernst E. Yoga for hypertension: a systematic review of randomized clinical trials. *Complement Ther Med.* 2014;22(3):511-522. doi:10.1016/j.ctim.2014.03.009.		X				
Punia S, Kulandaivelan S, Singh V, Punia V. Effect of aerobic exercise training on blood pressure in Indians: systematic review. *Int J Chronic Dis.* 2016;2016:1370148. doi:10.1155/2016/1370148.						X
Ramoa Castro A, Oliveira NL, Ribeiro F, Oliveira J. Impact of educational interventions on primary prevention of cardiovascular disease: a systematic review with a focus on physical activity. *Eur J Gen Pract.* 2017;23(1):59-68. doi:10.1080/13814788.2017.1284791.				X		

Citation	Outcome	Population	Study Design	Exposure	Not ideal fit for replacement of de novo search	Other
Ramos JS, Dalleck LC, Tjonna AE, Beetham KS, Coombes JS. The impact of high-intensity interval training versus moderate-intensity continuous training on vascular function: a systematic review and meta-analysis. *Sports Med.* 2015;45(5):679-692. doi:10.1007/s40279-015-0321-z.			X			
Redon J, Cifkova R, Laurent S, et al; Scientific Council of the European Society of Hypertension. The metabolic syndrome in hypertension: European society of hypertension position statement. *J Hypertens.* 2008;26(10):1891-1900. doi:10.1097/HJH.0b013e328302ca38.		X				
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Citation	Outcome	Population	Study Design	Exposure	Not ideal fit for replacement of de novo search	Other
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Citation	Outcome	Population	Study Design	Exposure	Not ideal fit for replacement of de novo search	Other
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