

The Efficacy and Safety of Yoga in Managing Hypertension

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Key words

- hypertension
- blood pressure
- yoga

received 22.07.2015

first decision 22.07.2015

accepted 01.10.2015

Bibliography

DOI <http://dx.doi.org/10.1055/s-0035-1565062>

Published online:

November 17, 2015

Exp Clin Endocrinol Diabetes 2016; 124: 65–70

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Georg Thieme Verlag KG
Stuttgart · New York
ISSN 0947-7349

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Abstract

Hypertension is a major public health problem and one of the most important causes of premature morbidity and mortality. Yoga is a traditional Indian practice that has been adapted for use in complementary and alternative medicine and mainly includes physical postures, breathing techniques, and meditation. The impact of yoga as a complementary intervention for hypertension has been investigated in a number of randomized controlled trials; with an overall effect of about 10 mmHg reduction in systolic and about 8 mmHg reduction in diastolic blood pressure. Yoga seems to be effective only for hypertension but not for prehypertension; and only as an adjunct to antihypertensive pharmacological treatment but not as an alternative therapy. Breathing and meditation rather than physical

activity seem to be the active part of yoga interventions for hypertensive patients. These practices can increase parasympathetic activity and decrease sympathetic activity, arguably mainly by increasing GABA activity; thus counteracting excess activity of the sympathetic nervous system which has been associated with hypertension. Although yoga has been associated with serious adverse events in single case reports, population-based surveys as well as clinical trials indicate that yoga is a relatively safe intervention that is not associated with more adverse events than other forms of physical activity. Yoga can thus be considered a safe and effective intervention for managing hypertension. Given the possibly better risk/benefit ratio, it may be advisable to focus on yogic meditation and/or breathing techniques.

Introduction

Hypertension

Hypertension is a major public health problem that was listed as a primary or contributing cause of death in about 350 000 deaths in the United States in 2009 (American Heart Association, 2013). From 1999 to 2009, the death rate from high blood pressure increased by 17.1% (American Heart Association, 2013). Worldwide, hypertension is responsible for 7.6 million deaths per year; and the World Health Organization has identified hypertension as one of the most important causes of premature morbidity and mortality in both developed and developing countries (World Health Organization, 2012). It is a major risk factor for myocardial infarction, stroke, chronic heart failure, peripheral arterial disease and chronic kidney disease (Chobanian et al., 2003). The American Heart Association has

estimated the direct and indirect annual costs of hypertension as \$76.6 billion in 2010 in the USA (Lloyd-Jones et al., 2010).

Besides pharmacological treatment, lifestyle modification, mainly dietary changes and physical activity, are frequently recommended for all patients with hypertension (Woolf and Bisognano, 2011); and yoga might present such a lifestyle modification intervention that is generally well accepted and can be adapted for the use in clinical populations.

Yoga

Yoga is deeply rooted in Indian philosophy and has been a part of traditional Indian spiritual, philosophical, and psychological practice for around 3 000 years (Feuerstein, 1998). While the ultimate goal of yoga has originally been described as uniting mind, body, and spirit, it has now become a popular means to promote physi-

cal and mental well-being in Europe and the USA but also in India itself (De Michelis, 2005; Feuerstein, 1998; Iyengar, 1966). Traditionally, yoga is a complex practice that not only encompasses physical activity, but also a certain way of life, ethical and spiritual rules; comprising advice for ethical lifestyle and spiritual practice (De Michelis, 2005; Feuerstein, 1998; Iyengar, 1966). Modern yoga schools mainly refer back to Patañjali who has classified 8 so called “limbs” of yoga ranging from general ethical rules to meditative practices (De Michelis, 2005; Feuerstein, 1998) (► **Table 1**). Nowadays, yoga has been adapted for use in complementary and alternative medicine in North America and Europe (De Michelis, 2005). In the latter setting it is most often associated with physical postures (asanas), breathing techniques (pranayama), and meditation (dhyana) (De Michelis, 2005). These more physically-oriented yoga forms are gaining increased popularity as a therapeutic practice: about 14 million Americans (6.1% of the population) reported that yoga was recommended to them by a physician or other therapist (Macy, 2008). Indeed, about 80% of American yoga practitioners (more than 16 million people) reported that they had started practice explicitly to improve their health (Cramer et al., 2015d). In the US, 13.2% of the population (about 31 million people) have ever practiced yoga (Cramer et al., 2015d); European numbers are comparable. E.g., in Germany 19.4% (about 15.7 people) are currently practicing yoga or are at least interested in starting in the next 12 months (Cramer, 2015).

Given that yoga comprises exercise, relaxation, and often also lifestyle advice, it seems particularly well suited as a complementary intervention for lifestyle-related conditions such as hypertension. Due to its perceived wellness character, relative ease of performance, and strong reliance on relaxation, yoga might present an attractive alternative for patients who are discouraged by the perceived rigor of conventional exercise programs and lifestyle interventions.

Yoga as a therapeutic intervention for hypertension

The investigation of yoga as a treatment for hypertension has a relatively long-standing history. Indeed, the very first randomized trial ever to be published on yoga was on hypertension: In this trial, 37 hypertensive patients were included of whom 94% were on antihypertensive treatment (Patel and North, 1975). The patients were randomly allocated to yogic relaxation, breathing, and meditation which the researchers combined with biofeedback or to simple relaxation, twice weekly for 60 min over the course of 6 weeks. At the end of the trial, the yoga group had a mean reduction of 26.1 ± 16.5 mmHg in systolic and 15.2 ± 8.1 mmHg in diastolic blood pressure, compared to 8.9 ± 14.5 and 4.2 ± 5.9 mmHg in the control group. After crossing over the formerly treated patients to the control group and vice versa, the groups did not longer differ. Although this early study

had a number of methodological short-coming, it overall was of acceptable quality (Posadzki et al., 2014). Since this first trial in the 1970s, a number of further randomized trials on this topic have been published, making hypertension one of the conditions for which the most evidence for or against effects of yoga is available to date (► **Fig. 1**).

Most of the subsequent trials managed to replicate Patel and North's (1975) initial findings (► **Table 2**): In an Indian study of 33 otherwise untreated hypertensive patients, yoga was more effective in reducing systolic and diastolic blood pressure when compared to no intervention and even when compared to physician-prescribed antihypertensive medication (Murugesan et al., 2000). These effects should however be interpreted in light of the unclear risk of bias of this study (Cramer et al., 2014a) as well as in the light of its Indian origin: it has previously been shown that randomized trials on yoga that were conducted in India have about 25 times the odds of reaching positive conclusions as those conducted elsewhere (Cramer et al., 2015b). However, other trials have found comparable effects; e.g., a trial on 61 patients with untreated hypertension from Thailand that found that an 8-week yoga intervention, 3 times a week, resulted in a stronger decrease in systolic and diastolic blood pressure than general education about hypertension (McCaffrey et al., 2005). Another more recent trial with a low risk of bias compared 2 different yogic breathing techniques to each other and to an untreated control group in 60 stage I hypertensive patients that were allowed to continue their physician-prescribed medication. The study found significantly higher reduction in blood pressure after 3 months of slow or fast yogic breathing compared to no treatment; effects were however stronger with slow yogic breathing, and only this group also showed an increase in parasympathic nervous system activity (Mourya et al., 2009). Interestingly, a number of further trials failed to show significant effects of yoga: Cohen et al. (2011) compared Iyengar Yoga including physical postures and breathing techniques to enhanced usual care, mainly consisting of education on adequate diet, in 78 pre- or stage I hypertensive patients not currently treated for high blood pressure. In this trial, no group difference for systolic or diastolic blood pressure was found. Likewise, in a group of 84 patients with pre- or stage I hypertension that were undergoing antihypertensive treatment, no group differences between Ashtanga yoga, a relatively high-intensity yoga form including postures, breathing, and meditation, and

Table 1 The 8 limbs of yoga according to Patañjali.

Aspect	Meaning
Yamas	Ethical Lifestyle
Niyama	Self-Discipline
Asana	Physical Postures
Pranayama	Breathing Exercises
Pratyahara	Inner Awareness
Dharana	Concentration
Dhyana	Meditation
Samadhi	Meditative Transcendence

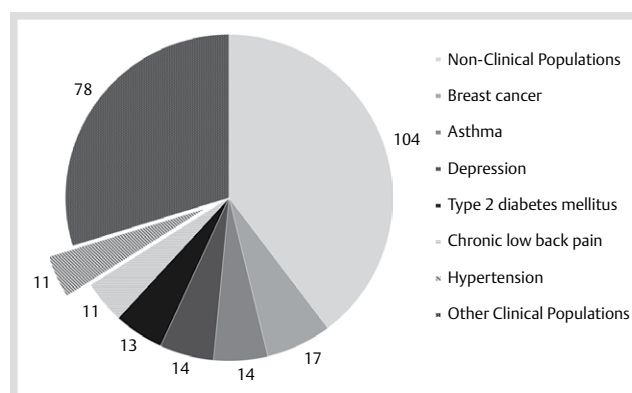


Fig. 1 Number of randomized controlled trials on yoga published until February 2014 classified according to condition in descending order. Other Clinical Populations = conditions that were studied in less than 10 trials. Adapted from Cramer et al., 2014b.

Table 2 Randomized controlled studies on yoga for hypertension. Adapted from Cramer et al., 2014a.

Author, year	Sample	Assessment of blood pressure	Treatment group	Control group	Co-medication	Results
Bhende et al., 2011	24 hypertensive patients (age range 35–50 years; 100.0 % female; ethnicity not reported)	Sphygmomanometer	Yoga (postures, breathing) 7 × 60 min/week for 12 weeks	Exercise Frequency not reported	Not reported	Group differences not reported
Cohen et al., 2011	78 pre- and stage I hypertensive patients (48.2 years; 50 % female; 47.4 % Caucasians)	Sphygmomanometer	Iyengar Yoga (postures, breathing); 2 × 70 min/week for 6 weeks + 1 × 70 min/week for 6 weeks	Enhanced usual care; 4 × 60 min/week for 12 weeks	Antihypertensive medication not allowed	No significant group differences
Hagins et al., 2014	84 pre- and stage I hypertensive patients (54.5 years; 85 % female; 3 % Caucasians)	24-h ambulatory blood pressure reading	Modified Ashtanga Yoga (postures, breathing, meditation); 2 × 55 min/week for 12 weeks + 3 × 20 min/week home practice for 12 weeks	Non-aerobic exercise, strengthening, stretching; 2 × 55 min/week for 12 weeks + 3 × 20 min/week home practice for 12 weeks	Antihypertensive medication allowed, no change of dose during the study period	Only nighttime diastolic blood pressure significantly lower in yoga
Latha et al., 1991	23 patients with essential hypertension (mean age, gender, and ethnicity not reported)	Sphygmomanometer	Yoga (postures, breathing, relaxation); 17x, twice weekly for 6 months	Usual care over 6 months	Antihypertensive medication allowed	Significant group difference for systolic but not for diastolic blood pressure
McCaffrey et al., 2005	61 hypertensive patients (56.4 years; 64.8 % female; ethnicity not reported)	Not reported	Yoga (postures, breathing, lifestyle advice); 3 × 63 min/week for 8 weeks	Usual care for 8 weeks	Antihypertensive medication not allowed	Significant group difference for systolic and diastolic blood pressure
Mourya et al., 2009	60 patients with stage I hypertension (age range 20–60 years; 48.3 % female; ethnicity not reported)	Sphygmomanometer	Yoga (breathing); 7x/week for 2 weeks + homework 2 × 15 min/day for 3 months	Usual care for 3 months	Antihypertensive medication allowed	Significant group difference for systolic and diastolic blood pressure
Murugesan et al., 2000	33 hypertensive patients (mean age, gender, and ethnicity not reported)	Sphygmomanometer	Yoga (postures, breathing, relaxation, meditation) 6 × 120 min/week for 11 weeks	1. Antihypertensive drugs for 11 weeks 2. No treatment for 11 weeks	Not reported	Significant group difference for systolic and diastolic blood pressure favoring yoga over drugs and no treatment
Patel and North, 1975	37 hypertensive patients (59.1; years; 61.8 % female; ethnicity not reported)	Sphygmomanometer	Yoga (breathing, relaxation, meditation) combined with biofeedback 2 × 30 min/week for 6 weeks	Relaxation 2 × 30 min/week for 6 weeks	Antihypertensive medication allowed	Significant group difference for systolic and diastolic blood pressure
Patil et al., 2014	57 patients with Grade-I hypertension (68.9; years; 0.0 % female; ethnicity not reported)	Sphygmomanometer	Integrated yoga module (postures, breathing, meditation) 6 × 60 min/week for 3 months	Exercise 6 × 60 min/week for 12 weeks	Antihypertensive medication not allowed	Group differences not reported
Saptharishi et al., 2009	113 pre- and hypertensive patients (22.5 years; 33.3 % female; ethnicity not reported)	Sphygmomanometer	Yoga (postures, breathing, relaxation); 5 × 30–45 min/week for 8 weeks	1. Usual care for 8 weeks 2. Exercise 4 × 50–60 min/week for 8 weeks 3. Salt intake reduction for 8 weeks	Not reported	Significant group difference for systolic and diastolic blood pressure favoring exercise over yoga; no significant group differences compared to salt intake reduction

nonaerobic stretching was found (Hagins et al., 2014). Finally, in an Indian study of 113 prehypertensive or hypertensive patients, no group differences between yoga and salt intake reduction was found while the yoga group had poorer outcomes when compared with an exercise intervention (Saptharishi et al., 2009). While 2 of the trials had a relatively high risk of bias (Saptharishi et al., 2009; Cohen et al., 2011), the third was of good methodological quality, so the effect could not be reduced to bias. Obviously, the main difference between the last 3 trials and those reported before, is the inclusion of prehypertensive patients. Prehypertension, defined as a slightly raised blood pressure ranging from 120 to 139 mmHg and from 80 to 89 mmHg for systolic and diastolic blood pressure, respectively, might be less effectively targeted by yoga simply because there is less room for benefits; i.e., a floor effect. Accordingly, a recent meta-analysis of yoga for hypertension and prehypertension (Cramer et al., 2014a) found a significant overall effect of 9.7 ± 7.2 mmHg reduction in systolic and 7.6 ± 5.6 mmHg in diastolic blood pressure; however in subgroup analyses, this effect was only present in studies that only included patients that were diagnosed with hypertension. In studies with mixed groups of hypertensive and prehypertensive patients, the effects were close to zero (● Fig. 2). Likewise, effects were only present in studies that allowed individual antihypertensive co-medication but not in trials that did not (Cramer et al., 2014). Interestingly, the same meta-analysis also compared different yoga interventions and found that only those studies had significant effects that included breathing and/or meditation techniques without using physical postures. In studies that included physical postures either alone or in conjunction with breathing or meditation, the effects were not significant (Cramer et al., 2014) (● Fig. 3).

Yoga and cardiovascular disease

Besides hypertension, yoga has also been researched as an adjunct treatment in cardiovascular disease in a small number of randomized trials – however, mainly of relatively low methodological quality (Cramer et al., 2015a). Yoga's impact on coronary artery disease has only been investigated in India (Mahajan et al., 1999; Manchanda et al., 2000; Pal et al., 2011; Pal et al., 2013). Based on the findings of these studies, yoga does not positively influence mortality while it might reduce the number of nonfatal cardiac events and improve exercise capacity (Cramer et al., 2015a). A relatively large trial also assessed the effects of yoga on blood pressure in 258 Indian coronary artery disease patients and reported a significant reduction from 130.1 ± 10.3 mmHg and 83.7 ± 8.0 mmHg to 123.1 ± 9.4 mmHg and 80.5 ± 5.1 mmHg for systolic and diastolic blood pressure, respectively, after 18 months of regular yoga including postures, breathing and relaxation; while the untreated control group did not change substantially (Pal et al., 2013). Moreover, 2 US randomized trials compared 16 sessions of Hatha Yoga including postures, breathing techniques, relaxation, and meditation to standard medical care in a total of 59 patients with chronic heart failure (Pullen et al., 2008; Pullen et al., 2010). Although the evidence was relatively weak due to methodological shortcomings of the trials (Cramer et al., 2015a), yoga significantly improved exercise capacity. Finally, in a high-quality randomized trial of yoga for 55 patients with cardioverter defibrillator-treated cardiac arrhythmia, yoga resulted in a stronger reduction in nonfatal device-treated ventricular events than standard medical care (Toise et al., 2014).

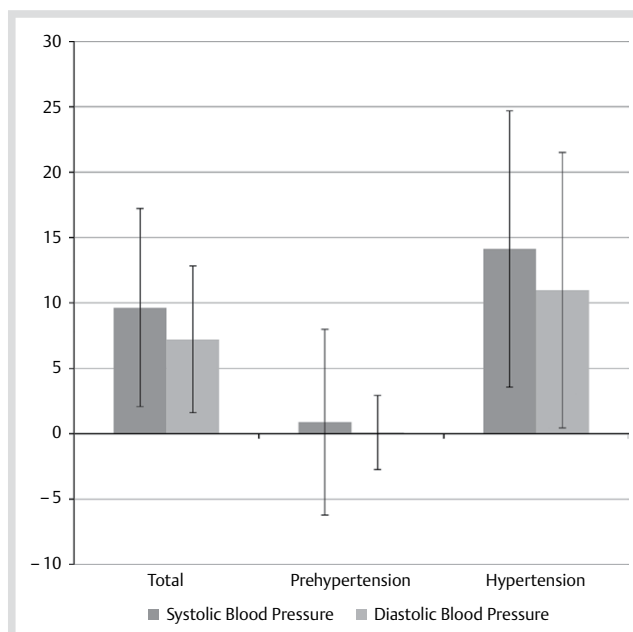


Fig. 2 Effects of yoga in hypertensive and prehypertensive patients. Effects (in mmHg) are given for the complete sample of studies (left) and for subgroups of studies including prehypertensive patients (middle) or including hypertensive patients only (right). Mean \pm 95% confidence interval.

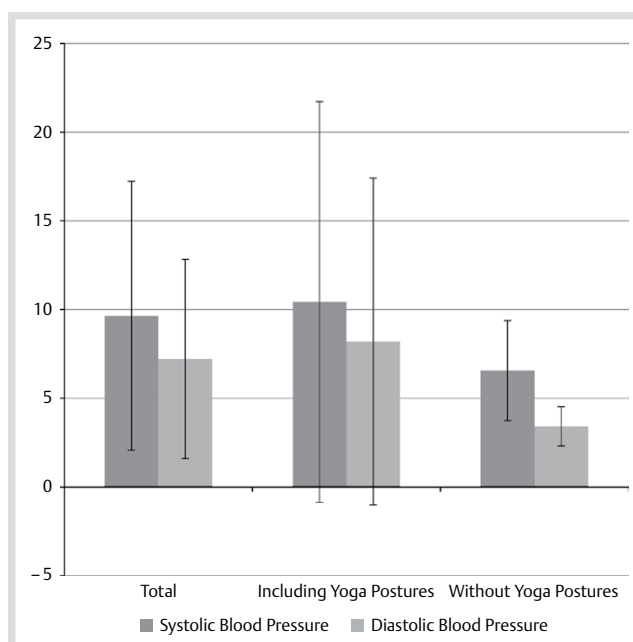


Fig. 3 Effects of yoga in hypertensive and prehypertensive patients. Effects (in mmHg) are given for the complete sample of studies (left) and for subgroups of studies including physical postures (middle) or not including physical postures (right). Mean \pm 95% confidence interval.

Proposed mechanisms of yoga in hypertension

In healthy individuals, blood pressure is regulated by the autonomic nervous system. An imbalance between the sympathetic and parasympathetic nervous system activity, namely an excess activity of the sympathetic branch of the autonomous nervous system can increase blood pressure and contribute to the development of hypertension (Brook and Julius, 2000; Esler, 2000; Mark, 1996). This imbalance in autonomous nervous system is

Table 3 Proposed mechanisms of yoga. Adapted from Streeter et al., 2011.

	Stress	Yoga
Sympathetic Nervous System	↑	↓
Parasympathetic Nervous System	↓	↑
Hypothalamic-Pituitary-Adrenal axis	↑	↓
GABA Activity	↓	↑

often associated with chronic subjective stress, and may result in vascular hypertrophy, leading to progressive increases in peripheral resistance and blood pressure (Oparil et al., 2003). Increasing parasympathetic activity and decreasing the activation of the sympathetic nervous system has been proposed as a major mechanism of yoga as a therapeutic intervention (Streeter et al., 2012). Specifically, yoga can activate the gamma amino-butyric acid (GABA) system, the primary inhibitory neurotransmitter system, and thus increase parasympathetic nervous system (Streeter et al., 2012), counteracting the stress-induced excess activity of the sympathetic nervous system (Streeter et al., 2012) (• Table 3).

Specifically slow yogic breathing, relaxation, and meditation seems to appropriately increase parasympathetic activity (Markil et al., 2012; Mourya et al., 2009; Telles et al., 2013). Adding yogic postures to yogic relaxation however does not further increase the shift in autonomic balance to the parasympathetic branch of the autonomic nervous system (Markil et al., 2012). In line with the findings of the available studies (Cramer et al., 2014), it might thus be concluded that breathing and meditation are the active part of yoga interventions for hypertensive patients; however, direct comparisons in head-to-head trials of posture-based and meditation-based yoga styles are needed to draw definite conclusions.

Safety

A major limitation of the available evidence for yoga as a therapeutic intervention for hypertension and other cardiovascular conditions is the generally poor reporting of safety-related data (Cramer et al., 2014a; Cramer et al., 2015a; Posadzki et al., 2014). Only few of the available trials on yoga for hypertension have reported on adverse events (Cohen et al., 2011; Hagins et al., 2014). Although those trials reported yoga to be generally safe in this patient population, the lack of safety data in the remaining trials makes it difficult to conclusively judge yoga's risk/benefit ratio for hypertensive patients. A number of serious adverse events have been associated with yoga practice including stroke (Hanus et al., 1977; Nagler, 1973), neuropathy (Chusid, 1971; Dacci et al., 2013; Vogel et al., 1991; Walker et al., 2005) and worsening of glaucoma (Bertschinger et al., 2007; Fahmy and Fledelius, 1973; Gallardo et al., 2006; Rice and Allen, 1985). It should however be kept in mind that these single cases were most often associated with unusual intense practice and/or medical preconditions (Cramer et al., 2013). In clinical trials, only about 2.2% of participants have experienced yoga-related adverse events; with only 0.6% experiencing serious adverse events (Cramer et al., 2015c). These numbers are comparable to comparison groups receiving usual care or exercising: across all available randomized trials comparing yoga to other exercise, 16 out of 420 participants in the yoga groups experienced intervention-related adverse events, compared to 15 out of 404 in the exercise groups (Cramer et al., 2015c). The risk of yoga-associated injuries has been estimated as 1.45 injuries per 1000 h of yoga practice.

Conclusion

There is emerging evidence that yoga, especially yogic meditation and yogic breathing, can be a safe and useful adjunct intervention in the management of hypertension – but not of prehypertension. Yoga should be considered as an adjunct intervention only and not be regarded as an alternative to antihypertensive medication. Given the possibly better risk/benefit ratio, it may be advisable to focus on yogic meditation and/or breathing techniques for hypertension management. Although still a matter of investigation, increases in parasympathetic activity and decreases in excess sympathetic activity seem to be key mechanisms by which yogic breathing, meditation and perhaps postures counteract hypertension.

Conflict of interest: None.

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