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The effect of yoga on hypertension: a research review

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KEY WORDS

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ABSTRACT

Background: Hypertension is a common condition in which the long-term force of the blood against the artery walls is high enough that it may eventually cause health problems. Uncontrolled hypertension (HTN) is responsible for 62% of cerebrovascular diseases and 45% of ischemic heart disease events. Yoga therapy may have a role in lowering blood pressure. This systematic review aims to synthesize the available literature for the same.

Summary: This research review was conducted on the articles published up to January 2022. The authors searched online databases like Medline/PubMed, Science Direct, Embase, PsycINFO, Cochrane Library, and Google Scholar published in English, using Yoga for hypertension (including meditation) as the intervention and having an adequate description of the intervention. The majority of studies showed that there is a significant decrease in systolic and diastolic blood pressure. This modest decrease may significantly decrease stroke mortality and coronary heart disease in the general population. The yoga intervention included breathing exercises, meditation, and postures.

Key messages: Yoga can be preliminarily recommended as an effective intervention for reducing blood pressure. This review provides an idea of the role of Yoga in hypertension and its future therapeutic implications. Additional rigorous controlled trials are warranted to investigate Yoga's potential benefits further.

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Background

Due to its high incidence and associated rise in illness risk, hypertension (HTN) is a major global public health concern. Currently, 26% of the world's population is estimated to have HTN, which translates to over 1 billion people with this disorder. Hypertension is a predisposing risk factor for stroke, myocardial infarction, heart failure, arterial aneurysms and chronic renal failure. Uncontrolled HTN is responsible for 62% of cerebrovascular diseases and 45% of ischemic heart disease events (1). As per the World Health Organization, one in every eight deaths globally is attributed to hypertension, (2). Globally, four million people die annually as a direct result of hypertension. According to recent research, those who are normotensive at age 55 have a 90% lifetime chance of becoming hypertensive (3).

Systemic vascular resistance and cardiac output combine to form blood pressure. Thus, people with arterial hypertension can have elevated systemic vascular resistance, elevated cardiac output, or both. The burden placed on the left ventricle is increased by increased vascular stiffness and systemic vascular resistance, resulting in left ventricular diastolic dysfunction and left ventricular hypertrophy. The regulation of blood pressure is mostly dependent on the Autonomic nervous system. Both elevated release and improved peripheral sensitivity to norepinephrine were observed in hypertension patients. In addition, there is an increased responsiveness to stressful stimuli (4). The systolic BP (SBP) is the maximum BP during the ventricular systole, which is 120 mmHg [Range: 110–130 mmHg] and the diastolic BP (DBP) is the minimum pressure during the ventricular diastole which is 80 mmHg [Range: 70–90 mmHg]. Pulse pressure (PP) means the difference between systolic BP and diastolic BP (5).

The brain's reciprocal connections with peripheral tissues are implicated in maintaining both physical and mental health, and an abundance of current research indicates that the fight-or-flight response, which is linked to aggressiveness, tension, anxiety, excitement, and anticipation in stressful situations, includes an increase in blood pressure. Substantial evidence also indicates that individuals who exhibit exaggerated cardiovascular responses to mental stress are at increased risk for developing HTN in subsequent years. Mind-body techniques like yoga and meditation that trigger the relaxation response, decrease sympathetic activity, and increase parasympathetic activity can help to restore autonomic balance. Additional research indicates that yoga helps individuals with diabetes and hypertension's autonomic stability (6).

Yoga is both a science and an art of healthy living. Yoga is a spiritual discipline that seeks to balance the mind and body through the application of a very delicate science. The concept of Yoga as a holistic approach is well established. Yoga brings harmony to all aspects of life. Thus, it is known for disease prevention, health promotion, and managing many lifestyle-related disorders (7). Yoga is an all-encompassing, body and mind -centered practice and encompasses all aspects of life that promote physical health and mental well-being, ultimately leading to positive thinking, contentment and tranquillity.

Yoga envisages health on the principle of 'healthy mind in a healthy body'. Core components of Hatha Yoga include—stretching exercises and physical postures (asana), breath control (pranayama) and concentration techniques (meditation) designed to promote physical, mental, emotional and spiritual well-being (8). *Yoga* is an ancient technique that evolved over thousands of years which enhances the immunity and mental efficiency and provides long lasting solution to hypertension (9).

Literature Search

For this systematic review, articles were obtained by searching Medline/PubMed, ScienceDirect, Embase, PsycINFO, Cochrane Library and Google. Thirty studies were selected and considered for initial screening for the study, (shown in Figure 1). Eleven studies fulfilled the inclusion criteria and are therefore utilized as review material.

The primary search terms included yoga, yogic postures/asana, pranayama/breathing practices, yoga nidra/relaxation, meditation combined with blood pressure, hypertension, hypertensive, systolic and diastolic, SBP and DBP.

Inclusion/Exclusion Criteria

(1) *Types of Studies* Randomized controlled trial (RCT), non-randomized controlled trial (NRCT), quasi-experimental research design. Some searches which included single sessions were included. Inclusion of searches with multiple yogic protocols for multiple sessions.

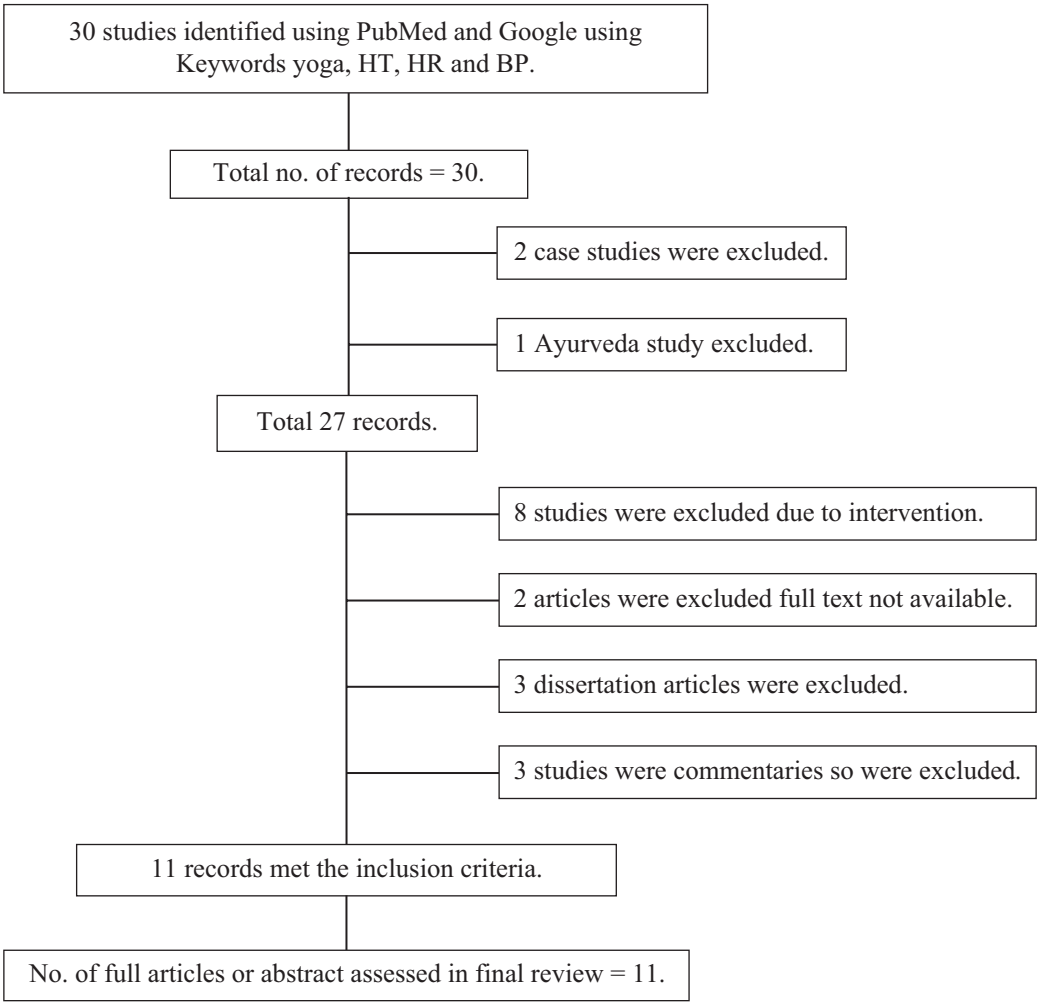

Figure 1: Schematic representation of studies searching and selection as per the criteria.

Cross-sectional, dissertations, case series, and commentaries searches were excluded. Studies in languages other than English were not included. The search was conducted without any restrictions on the date or study population, and it looked for articles published up until January 2022.

(2) *Participants* (mean age ≥ 18 years) with pre-hypertension, hypertension or no health issues were chosen irrespective of gender.

(3) *Intervention* Given the large variability in practices associated with the term "yoga", only papers that explicitly labelled the intervention as "yoga" were examined. Studies with yogic practices, including asana (postures), pranayama (breathing) and meditation were included. Searches that included yogic forms (hot yoga, etc.) other than traditional yoga (hatha yoga) were excluded. Studies that included mindfulness, transcendental meditation, and vipassana were excluded. Studies based on aromatherapy, music therapy, speech therapy and any gadget-based meditation techniques were excluded.

(4) *Outcomes* Blood Pressure (mmHg) was the primary outcome of interest (SBP and DBP). Outcomes other than BP which were considered were heart rate (HR) or pulse rate (PR) and heart rate variability (HRV). Parameters like Body mass index (BMI) and lipid profile were excluded.

Data Extraction and Quality Assessment

Blood pressure values, type of yoga intervention, type of comparison group, demographic characteristics, number of participants enrolled and completing the study, location of the study, reporting of adverse events and methods for measurement of blood pressure were gathered from each paper. An increase or decrease in SBP and DBP was noted. The values of secondary outcomes of interest were also noted and analyzed.

A total of 11 articles (***Table 1***) were included in this study. Results of the included studies reveal that yoga has a significant role in lowering the blood pressure. Yoga also shows a significant effect on secondary outcomes. The intervention group showed more significant results than the control group in the studies, which divided the participants into two groups (control and intervention groups). Effect of Yogic Pranayama (breathing) such as Bhramari, Sheetali and Sitakari, left nostril breathing, alternate nostril breathing, and uni-nostril breathing showed a significant decrease in SBP, HR and decrease or no change (10) in DBP. There was a slight increase in the values of SBP, DBP, and HR at the start of the yogic intervention of asana, but the blood pressure and heart rate or pulse rate decreased significantly over the resting period. The details of the Yoga practice used in this study are shown in (***Table 2***).

- In both genders, slow Bhramari Pranayama breathing (respiratory rate 3/min) caused a decrease in SBP (Male: 116 mmHg- 111 mmHg; Female: 109 mmHg-104 mmHg) and a significant decrease in DBP (Male: 79.36 mmHg- 72.88 mmHg; Female: 73.60 mmHg-69.44 mmHg) (11).
- Due to Chandra Nadi Pranayama's practice, the data revealed evidence of a significant decrease in SBP and DBP of both sexes. Male: SBP- 132.75 ± 4.55 mmHg to 128.08 ± 4.71 mmHg, DBP- 77.91 ± 3.04 mmHg to 75.58 ± 2.99 mmHg; Female: SBP- 137.00 ± 4.46 mmHg to 132.90 ± 4.14 mm Hg just missed significance, DBP-statistically insignificant rise in DP in female participants 79.80 ± 1.33 mmHg to 81.00 ± 1.87 mm HG (12).
- In the recovery phase, there were significant intergroup differences from 2 min onward in both SBP and DBP. The plot of Δ% changes during the recovery period showed a more significant fall in SBP and DBP after all the other Asanas as compared to that following Shavasana (13).
- Blood pressure did not show any significant change during the practice of Alternate Nostril Breathing. There was a significant decrease in SBP, whereas there was no change shown in readings of DBP (10).
- There is an overall reduction in SBP and DBP due to the practice of Chandra Nadi (CN), Chandra Bhedana (CB) and NadiShoddhna (NS) Pranayama, with a concurrent increase in the same through the practice of Surya Bhedana (SB) and Surya Nadi (SN) Pranayamas (14).
- The study showed a significant difference between the two groups (control group and intervention group). Through the practice of Sheetali and Sheetkari Pranayama, the SBP and DBP were reduced significantly for the intervention group (15).
- The mean values of the pre and post-SBP are 167.8 and 153.8 mm Hg, respectively. The mean values of the pre and post-DBP are 105.8 and 99.8 mm Hg, respectively. The mean values of SBP and DBP revealed a significant decrease in their value after the practice of yogic intervention (16).

The results concluded that there was a significant effect on the difference in systolic and diastolic blood pressure in the control and intervention groups. There was no significant decrease in blood pressure at the beginning and at the end of the control group; this could be due to the control group not being given treatment in the form of Yoga Pranayama DhiirgaSwasam with the Sukhasana position. There was a significant decrease in the average systolic and diastolic blood pressure before and after the Yoga Pranayama DhiirgaSwasam treatment with the Sukhasana position (17).

The mean systolic blood pressure before yoga practice was (mm of Hg) 127.50, and after six months of yoga practice, SBP was lowered to a highly significant level of 120.50. The mean diastolic blood pressure before yoga was 88.60, and it was reduced significantly to 80.40 after six months of yoga practice (18).

Table 1: Summary of selected study for this systematic review:

Year and Author	State, Country	Study Design	Objective	No. of Subjects Enrolled	Duration	Results/ conclusions
(Pramanik, Pudasaini, and Prajapati 2010)	Kathmandu, India	NRCT	Immediate effect of a slow pace breathing, Bhramari pranayama on blood pressure and heart rate.	50	5 min	HR ↓ SBP ↓ DBP ↓
(Bhavanani, Sanjay, and Madanmohan 2012)	Puducherry, India	RCT	Immediate effect of chandranadi pranayama (left unilateral forced nostril breathing) on cardiovascular parameters in hypertensive patients.	22	5 min	HR ↓ SBP ↓ DBP ↓
(Bhavanani, Pushpa, et al. 2014)	Puducherry, India	NRCT	Differential effects of uninostril and alternate nostril pranayamas on cardiovascular parameters and reaction time.	20	Twice Weekly for 6 Months.	Through practice of CN, CB & NS: HR ↓ SBP ↓ DBP ↓ Through practice of SN & SB: HR ↑ SBP ↑ DBP ↑
(Bhavanani, Ramanathan, et al. 2014)	Puducherry, India	RCT	Comparison of immediate effect of different yoga asanas on heart rate and blood pressure in healthy young volunteers.	22	Thrice weekly for more than 3 months.	HR↑ during dhanurasna practice SBP↓ & DBP↓ during vakrasana (right) and janushirasana (left) In recovery phase- SBP↓ DBP↓
(Telles, Sharma, and Balkrishna 2014)	Uttarakhand, India	Multiple practices in single sessions	Blood pressure and heart rate variability during yoga-based alternate nostril breathing practice and breathe awareness.	26	25 mins for 2 days.	SBP↓ There was no change in DBP and HRV
(Shetty et al. 2017)	Karnataka, India	RCT	Effects of Sheetali and Sheetkaripranayamas on blood pressure and autonomic function in hypertensive patients.	60 Two groups: Control group = 30 Intervention group = 30	10 mins for interventi-on group and 20 mins for control group for 30 days.	Intervention group showed: SBP↓ DBP↓ HR↓ HRV improved No significant change showed in control group.
(Nivethitha, Manjunath, and Mooventhan 2017) (19)	Karnataka, India	Single practice in single session	Heart rate variability changes during and after the practice of bhramari pranayama.	16	5 mins	During practice, HR↑ After practice, HR became normal SBP↓ DBP↓
(P. Tiwari, Vajpeyi, and Savalia 2019)	Gujarat, India	NRCT	Effect of yogic intervention on high blood pressure.	30	Daily 60 mins for 12 weeks.	SBP↓ DBP↓
(Lindasari, Suhariyanti, and Margowati 2020)	Magelang, Indonesia	Quasi Experime-ntal research design	Yoga Pranayama DhiirgaSwasam with Sukhasana Position on Reducing Blood Pressure in the Elderly.	44 Divided into control and experiment-al group	3 times a week for 2 to 3 weeks.	Experimental group showed: SBP↓ DBP↓ Control group didn't experience any difference.
(Bargal et al. 2022) (20)	Mumbai, India	RCT	Evaluation of the Effect of Left Nostril Breathing on Cardiorespiratory Parameters and Reaction Time in Young Healthy Individuals.	106	6 months	SBP↓ DBP↓ HR↓
(Milli 2022)	Karnataka, India	RCT	The effect of yoga blood pressure and pluse rate variables of college women.	30	45 mins for 2 weeks.	SBP↓ DBP↓ PR↓

*NRCT- Non Randomized clinical trial, RCT- Randomized clinical trial.

Table 2: Details for Yogic Packages/Modules practiced by the participants of each study:

Year and Author	Intervention	List of Yogic Practices
(Pramanik, Pudasaini, and Prajapati 2010)	*Pranayama*	Bhramari Pranayama
(Bhavanani, Sanjay, and Madanmohan 2012)	*Pranayama*	Chandra Nadi Pranayama
(Bhavanani, Pushpa, et al. 2014)	*Pranayama*	NadiShoddhna Pranayama Chandra Nadi Pranayama Chandra Bhedana Pranayama Surya Nadi Pranayama Surya Bhedana Pranayama
(Bhavanani, Ramanathan, et al. 2014)	*Asana*	*Sitting:* Janushirasana Vakrasana *Proline:* Dhanurasana *Supine:* Matsyasana Shavasana
(Telles, Sharma, and Balkrishna 2014)	*Pranayama*	AnulomVilom Pranayama Breathe Awareness
(Shetty et al. 2017)	*Pranayama*	Sheetali Pranayama Sheetkari Pranayama
(Nivethitha, Manjunath, and Mooventhan 2017)	*Pranayama*	Bhramari Pranayama
(P. Tiwari, Vajpeyi, and Savalia 2019)	*Loosening Practices* *Breathing Practices* *Yogasana* *Pranayama* *Relaxation Techniques* *Meditation*	*Loosening Practices* Loosening Practices of Finger Loosening practices of Wrist Shoulder Rotation Padasanchalana Drill Walking *Instant Relaxation Technique* *Breathing Practices* Hand In and Out Breathing Ankle Stretch Breathing Side Bend Breathing Tiger Breathing Straight Leg Breathing *Quick Relaxation Technique* *Yogasana* Vrikshasana Trikonasana Ardha- Paschimottanasana Ushtrasana Shashankasana Uttanapadasana Parvatasana Bhujangasana *Deep Relaxation Technique* *Pranayama* NadiShoddhana Pranayama Chandra Bhedana Pranayama AnulomVilom Pranayama Sheetali Pranayama Ujjayi Pranayama Bhramari Pranayama *Meditation* Nadanusandhana Om Meditation
(Lindasari, Suhariyanti, and Margowati 2020)	*Breathing Practices*	DhiirgaSwasam
(Bargal et al. 2022)	*Breathing Practices*	Left Nostril Breathing
(Milli 2022)	*Kriya Yoga*	Kriya Yoga

Discussion

When the 11 studies included in this review are combined, the results show that yoga was linked to a slight but significant drop in both systolic and diastolic blood pressure. Furthermore, the kind of yoga intervention and the comparison group had different effects on blood pressure from yoga, but the duration of yoga practice did not. Despite the relatively small overall drops brought about by yoga practice, it has been demonstrated that even slight drops in blood pressure lower the risk of stroke and coronary heart disease. The last few years have seen a significant impact of yoga on HTN. Yoga relaxes and enhances mental health while reducing toxic buildup in the head and neck area. Yoga keeps tissues flexible and stops pressure-related alterations in blood vessels. By resetting the baroreceptor reflex mechanism and raising the blood level of HDL cholesterol, yoga lowers blood pressure. It lowers blood pressure, pulse rate, and the body's conception of oxygen. The cardiac reserve is strengthened by yoga poses.

Yogic practices prevent the formation of lactic acid, which prevents muscle fatigue. There is no varicose vein development and a higher venous return. An increase in heart pumping efficiency leads to an improvement in cardio-vascular endurance. Yogasana calms the body and lessens heart palpitations. The cardiac muscle and the septum are stimulated by the gradual increase in intra-thoracic pressure, which improves the quality of blood pumped out. Through inverted yoga poses, the entire musculature, including the legs, receives rest from the constant pull of gravity and the effort required to pump blood upward to the heart. There is only one primary law of physiology that applies to all inverted poses: Laplace's law. This says that the heart must pump the same amount of blood, regardless of how much it receives. The heart's contractility increases in inverted poses because of the increased venous return.

Our yoga intervention includes poses from the forward bend, supine, sitting, and some basic inversion groups. Forward bends, on the other hand, are the essential asanas to practice in order to lower elevated blood pressure because they relax the tongue, nose, eyes, throat, and sympathetic nervous system, which in turn calms the parasympathetic nervous system. Yogic breathing involves controlling the breathing rate, such as by pacing or slowing down, adjusting the nostrils, chanting humming sounds, holding your breath, etc. Yoga helps to control hypertension by increasing arterial flexibility, decreasing arterial rigidity, and promoting blood flow freely through the arteries. The study of concentration is meditation. The body and mind are closely intertwined. The body rests fully when the mind is completely relaxed. When under physical or mental stress, using meditation techniques reduces blood pressure and helps control the fight-or-flight reaction to negative stress.

A yoga protocol is devised using the research review and recommended for the management of Hypertension is shown in (***Table 3***).

Table 3: Recommended Yogic Practices (Protocol) for Hypertension.

Interventions	List of Yogic Practices
Loosening Practices (SukshmaVyayama)	Loosening Practice for finger Loosening Practice for wrist Shoulder rotation Padasanchalana Drill walking
Standing Asanas	Trikonasana Vrikshasana
Sitting Asanas	Ardha- Paschimottanasana Ushtrasana Shashankasana Janushirasana Vakrasana
Prone Asanas	Parvatasana Bhujangasana Dhanurasana
Supine Asanas	Uttanapadasana Matsyasana Shavasana
Pranayama	NadiShoddhana Pranayama Chandra Nadi Pranayama Bhramari Pranayama Sheetali Pranayama Sheetkari Pranayama
Meditation	Om Meditation Nadanusandhana Quick Relaxation Technique Instant Relaxation Technique

Limitations

This study only includes RCT, NRCT, and quasi-experimental research designs. Only articles written in English were included. Mean age ≥ 18 years was the age group included. Ayurvedic and other interventions, including exercises other than yoga, were excluded. Traditional yoga therapy was included.

Conclusion

This analysis of 11 studies implies that yoga exerts a favorable influence on hypertension. In addition to BP, the yogic interventions have an impact on HR, PR, and HRV. Each study's participants underwent meditation techniques, yoga asanas, pranayama, and loosening practices. The risk of coronary heart disease and stroke may be significantly reduced by this small change in blood pressure. According to estimates, lowering SBP in the general population by just 3 mm Hg can cut the death rate from stroke by 8% and coronary heart disease by 5%.

It is evident that incorporating yogic exercises as adjunctive medical procedures can have a beneficial impact on reducing blood pressure.

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Authors' contribution

MK: Conceptualization, Writing and editing; E: Conceptualization, editing and overall supervision.

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Conflict of interest

No conflict of interest.

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