

## Analysis and Evaluation of Effectiveness of Yogic Activities on Blood Pressure Parameters of Hypertensive Patients in Indian Population: A Systematic Review and Meta-Analysis

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### Abstract:

**Introduction:** Yoga activity has many mental and physical health benefits. There is increase in number of cases of hypertension in India. Yoga activities is emerging as potential tool to provide beneficial effect on blood pressure of hypertensive patients.

**Aims and Objectives:** To study effectiveness of yoga activity practices on blood pressure of hypertensive patients in Indian population.

**Materials and Methods:** Researchers used the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines for reporting systematic reviews and meta-analysis. Researchers searched articles on PubMed, Google scholar and by manual search. Searched articles were screened for relevancy. By use of inclusion and exclusion criteria potential articles were selected.

**Results:** Out of 291 articles, finally 10 studies composed of 382 hypertensive patients were included in current meta-analysis. Yoga activities has effect on systolic blood pressure (SBP): SMD = 1.33, 95% CI = 0.68-1.99,  $P < 0.01$  and diastolic blood pressure (DBP): SMD = 1.07, 95% CI = 0.51-1.64,  $P < 0.01$ .

**Conclusion:** Yogic activities is associated with beneficial effect on blood pressure of hypertensive patients. There is huge scope for further studies to determine beneficial effects of yoga activities.

**Keywords:** Effect, Yoga activities, Benefit, Hypertension, India.

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### Introduction

Hypertension is the main prevalent disorder in the major Indian population and it is also an important health challenge in this century [1-3]. Hypertension have been increasing among adolescents since the last more than 25 years [4-6]. The risk increases with increase in systolic blood pressure and diastolic blood pressure above the normal blood values [7,8]. Dysfunction of The autonomic nervous system has been involved in hypertension [8,9]. According to World Health Organization (WHO), hypertension is the most common cause of death in developed countries and it is increasing in developing countries[10,11].

Yoga is an ancient Indian Science which has been practiced as a healthy way of life [12]. Now in alternative medicine, yoga has been considered as an approach to health [12,13]. Yoga is gaining increasing popularity in many countries around the world, [14,15]. Yoga is a mind-body intervention which aims at not only physical but also mental and emotional wellbeing [3]. The main components of yoga include Asanas, Pranayama and Meditation

[3,16]. Yoga has shown to have a beneficial effect on body [17,18] American health care providers are suggesting yoga as a means of enhancing health [19,20] Yoga is one of the healthcare measures thought to improve blood pressure control [20-23]. Beneficial effects of yoga on aspects of hypertension are well-documented [24-27] yoga activities seem to decrease systolic blood pressure in several studies [6,28]. Guidelines from The American College of Cardiology and American Heart Association have emphasized on the importance of yoga in the effective management of hypertension [27,29]. To maintain blood pressure in the normal range has a significant importance. [18,30]. Even little reduction in blood pressure is reported to reduce the risk of myocardial infarction and stroke [27,31]. Apart from medications, modifications in lifestyle have been recommended as an equivalent first line approach for controlling hypertension [8,32].

Comparatively fewer studies have focused on Indian population for effect of yoga on blood

pressure of hypertensive patients and it seems lack of meta-analysis. So in Indian population, to what extent yoga activities have beneficial effect on blood pressure in hypertensive patients, various effects of different types of yogic activities on blood pressure in hypertensive patients remains unclear. To understand and analyse it, this study is meta-analysis to evaluate effect of yoga activities on blood pressure in hypertensive patients in Indian population.

### Materials and Methods

In the meta-analysis, researchers used the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines for reporting systematic reviews and meta-analysis [Figure 1] [33].

### Search Strategy

Relevant studies were identified by a literature search with language restriction of 'English' language in electronic database of Google Scholar and PubMed Central. Advance search with application of filter in Google scholar and PubMed Central also done to refine search and for identification of relevant studies. We used following medical words and simple words in search strategy: effect, yoga, pranayama, yoga exercise, yoga intervention, hypertension, patients. Literature search was also done directly online in google search. Reference list of filtered studies were also searched to get relevant articles.

### Studies Selection Criteria

Studies filtered in primary search assessed for following inclusion and exclusion criteria:

#### Inclusion Criteria

- Studies conducted on Indian population
- Studies includes pre-diagnosed patients of hypertension
- Studies includes pre and post yoga effect on hypertension

#### Exclusion Criteria

- Not satisfying inclusion criteria
- Articles not relevant to hypertension
- Free full text article not available of studies
- Type of articles as letters and review articles

### Study Quality

Reviewers assessed studies independently for inclusion and exclusion criteria mentioned in study selection criteria. Reviewers analysed selected studies with following headings: Name of first author with initials, year of publication, brief detail of study population, age, gender, yoga activity, brief detail of yoga activity and detail of blood pressure measurement. During through reading confusions and queries for inclusion and exclusion

of studies was addressed and it was sort out and finally decided by discussion and arguments.

### Data Extraction

We extracted systolic blood pressure (SBP) and diastolic blood pressure (DBP) with standard deviation before and after sessions of yoga activities in individual articles. Data were verified by reviewers and any discrepancies were addressed by discussion and resolved by consensus.

### Data Analysis

Free online meta-analysis calculator [34,58] was used for analysis of all data and to construct forest plot, funnel plot (Trim and Fill method) [35-40,45], also to evaluate heterogeneity across studies and for Egger's linear regression test [41-45] for publication bias.

The standardized mean differences (SMD) for the systolic blood pressure (SBP) and diastolic blood pressure (DBP) in patients of hypertension, before and after yoga sessions of yoga activity were calculated. The principal summary measure was done with a 95% confidence interval (CI) with SMDs and funnel plot (trim and fill method) as well as a forest plot.

The Tau<sup>2</sup>, Chi<sup>2</sup> and I<sup>2</sup> test was used to measure the Statistical heterogeneity across studies [20, 44, 46-48]. Because of variability in included studies regarding types of yoga activities and among study population, a considerable degree of heterogeneity was expected. So random effects model was used for comparison. [20, 49]. Egger's linear regression test was applied to detect the potential publication bias. [41-45] and Funnel plot (Trim and Fill method) was used to get more accurate information of possible publication bias. [35-40, 45].

### Results

#### Literature search

we find 291 eligible articles by combined electronic database search and manual search. After removal of 24 duplicated studied remaining 261 studies were screened by titles and abstracts. In screening process total 138 studies were excluded with reasons as 46 studies were not relevant to topic, 45 studies were letters or review articles and free full article was not available of 46 studies. Full text articles were assessed for eligibility in remaining 129 studies after screening process. In this assessment total 119 studies were excluded with reasons as 57 studies were from other countries, 33 studies were not matching inclusion criteria and 29 studies were not relevant to hypertension. And 10 articles were identified to include in qualitative analysis. Flow diagram for studies selection process and reason for exclusion is displayed in Figure 1. Finally, 10 studies

composed of 382 hypertensive patients were included in current meta-analysis.

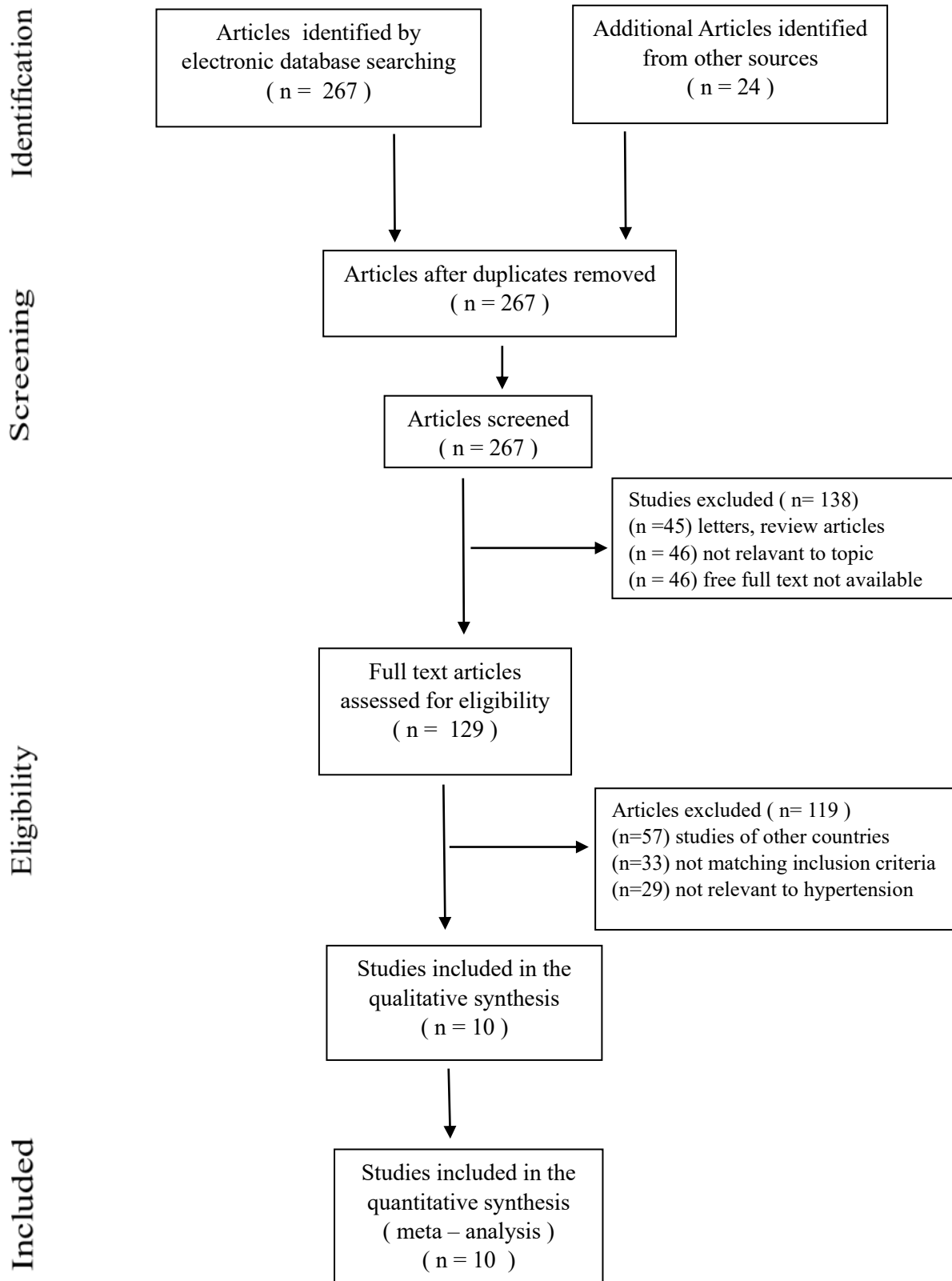


Figure 1: Flow chart article search and study selection

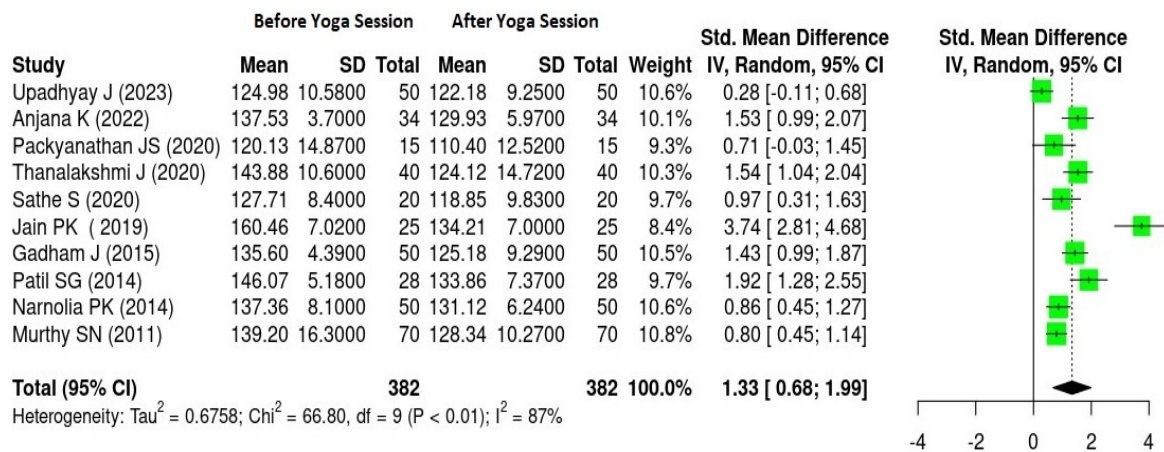
**Description of included studies**

Brief description of each study are detailed in table 1. Sample size of eligible 10 studies ranged from 15 to 70 participants. All eligible studies were published from 2011 – 2023. Out of 10 eligible included studies, 2 studies [6,18] has not provided information of gender of participants, 1 study [18] has not provided age group information of participants and 2 studies [11,15] have mentioned only male participants. In 10 included studies with 382 participants, systolic blood pressure and diastolic blood pressure was measured before and after various yogic activities for various durations. Figure 2 and Figure 3 shows systolic blood pressure and diastolic blood pressure measurement for individual studies.

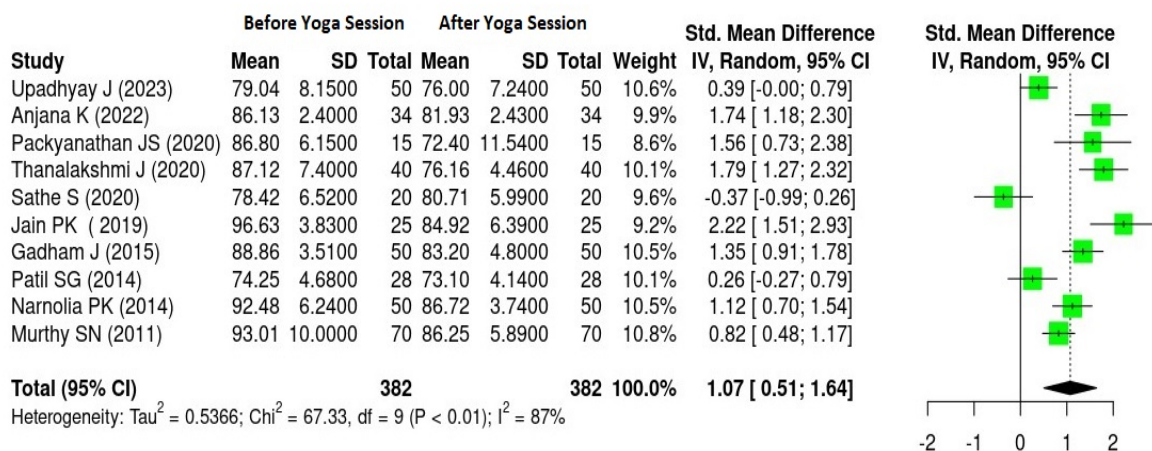
**Quantitative data synthesis**

Analysis was performed with random effect model. systolic blood pressure (SBP) :  $Tau^2 = 0.6758$ ,  $Chi^2 = 66.80$ ,  $df = 9$ ,  $P < 0.01$ ,  $I^2 = 87\%$  and diastolic

blood pressure ( DBP):  $Tau^2 = 0.5366$ ,  $Chi^2 = 67.33$ ,  $df = 9$ ,  $P < 0.01$ ,  $I^2 = 87\%$ . Our results showed that systolic blood pressure (SBP) decreased in hypertensive patients after yoga activity sessions compared to before yoga activity sessions, according to random effects pooled SMD of systolic blood pressure (SBP) before and after yoga activity sessions was:  $SMD = 1.33$ ,  $95\% CI = 0.68-1.99$  ( Figure 2). Our results also showed that diastolic blood pressure (DBP) decreased in hypertensive patients after yoga activity sessions compared to before yoga activity sessions, according to random effects pooled SMD of Diastolic blood pressure (DBP) before and after yoga activity sessions was:  $SMD = 1.07$ ,  $95\% CI = 0.51-1.64$  ( Figure 3). For systolic blood pressure (SBP) before and after yoga activity sessions, Egger’s test:  $t = 2.54$ ,  $df = 8$ ,  $p = 0.0345$  and for diastolic blood pressure (DBP) before and after yoga activity sessions, Egger’s test:  $t = 0.84$ ,  $df = 8$ ,  $p = 0.4242$ .



**Figure 2.: Forest plot of effect of yoga activity on systolic blood pressure of hypertensive patients**



**Figure 3: Forest plot of effect of yoga activity on diastolic blood pressure of hypertensive patients**

**Table 1: Summary of Characteristics of included studies**

First Author	Year	Sample size	Brief detail of study population	Age group (Year)	Gender (Male/Female)	Yoga activity	Brief details of yoga activity	Detail of BP measurement	Reference
Upadhyay J	2023	50	Pre-diagnosed patients with hypertension, with or without antihypertensive drugs.	30 to 60	Both	Nadishodhana Pranayama	Participants performed Nadishodhana Pranayama for 20 minutes.	Blood pressure was recorded before and after the activity.	3
Anjana K	2022	34	Patients diagnosed with Hypertension, with a BP range of 130-139/80-89 mmHg. The subjects were under a hypertension diet and taking essential pharmacological therapy.	25 to 60	Both	OM chanting and Yoga nidra	They were trained to chant 'Om' 3 times per minute for a period of 5 minutes and yoga nidra, as mentioned in study, was given for 20 minutes, five days a week for 2 months.	BP assessed at baseline and 60th day.	27
Packyathan JS	2020	15	Hypertensive patients randomly selected.	30 to 60	-	"Yoga" i.e. "Asanas" (postural exercises), "Pranayamas" (breathing techniques), and "Savasana" (meditation).	study group performing "Asanas" (postural exercises), "Pranayamas" (breathing techniques), and "Savasana" (meditation), under proper guidance of the instructor.	The blood pressure of the participants was estimated twice, first time before starting their yoga activity and second time after 3 months of yoga activity.	6
Thanalak	20	40	subjects with	18	Both	Sheetali	Qualified	BP was	8

shmi J	20		primary hypertension. The recruited patients were either on beta blockers or calcium channel blocker in the form of oral tablets, depending on their response and judgment by their consultants/ treating physician.	to 60		pranayama	yoga and naturopathic doctor delivered the pranayama intervention. For Sheetali pranayama, Participants were instructed to practice for 10 rounds followed by 2 minute rest which forms one round. Patients were instructed to do a minimum of 20 rounds. The participants were advised to practice the pranayama for 30 minute daily for 4 weeks between 7:00 to 9:00 a.m. in empty stomach. Group practiced Sheetali pranayama for a period of 3 months.	measured before and after 3 months of pranayama practice	
Sathe S	20 20	20	hypertensive patients, on medication for hypertension.	More than 40	Both	Bhramari pranayama	Participants were made to relax and sit in a	Resting Blood pressure measured. After 5	50

							comfortable atmosphere on a soft mat on the floor. The breathing technique was demonstrated to the patients. Group performed Bhramari Pranayama for 5 minutes.	minutes of practising Bhramari pranayama, blood pressure measured.	
Jain PK	20 19	25	Patients has hypertension, not taking any drug other than antihypertensive medicine	30 to 45	Both	Yoga training includes Surya Namaskar, Bhramari Pranayama, Sukha Pranayama, Nadisodhan (Anulom Vilom), Chandra nadi Pranayama and 'OM' meditation.	40days Yoga Training was given to the subjects in the morning hrs for 45min at 8:00 A.M to 8:45 A.M and two times in a week.	Blood pressure was measured before and after 40 days of yoga training.	51
Gadham J	20 15	50	Adult patients suffering from obesity, hypertension and dyslipidemia either singly or in combination, two or all the three, have been included in this study.	35 to 55	Male	Pranayama and other Asana	The subjects were asked to perform Yoga, which includes pranayama for 30 minute and Yogic Asana for another 30 minute every day. They were subjected to Pranayama and other Asana's for a	Blood pressure was measured before and after 3 months of yoga intervention.	15

							period of 3 months.		
Patil SG	20 14	28	Elderly male hypertensive subjects	60 to 80	Male	The integrated yoga module for intervention includes: Opening prayer Sukshma Vyayama, Breathing practices, Padhastasana, Ardachakrasana, Shashankasana, Ardha Ustrasana, Bhujangasana, Ardha Salabasana and Trikonasana, Anuloma Viloma Pranayama, Brahmari Pranayama and other activities	group was assigned for yoga practice under the supervision of yoga instructor for six days in a week for one hour daily in the morning from 06:00 to 07:00 hours for three months.	BP recorded twice, one at baseline and another after three months of yoga intervention	11
Narnolia PK	20 14	50	patients of hypertension. All the patients were on prescribed antihypertensive medications.	30- 70	Both	Sudarshan Kriya Yoga	group was asked to do 'Sudarshan Kriya Yoga' one hour daily or at least five times a week for continuous three months after proper training.	BP measured before and after three months of practice	12
Murthy SN	20 11	70	Patients who were known hypertensive and on treatment to manage their hypertension with antihypertens	-	-	Yogic treatment : Yogic kriyas and yoga asanas. Savasana, Makarasana Pranayama.	The study intervention consisted of a 21 day inpatient treatment. Yogic	Blood pressure measured on admission and upon discharge.	18



		five drugs were screened.				kriyas and yoga asanas were performed for 30minute		
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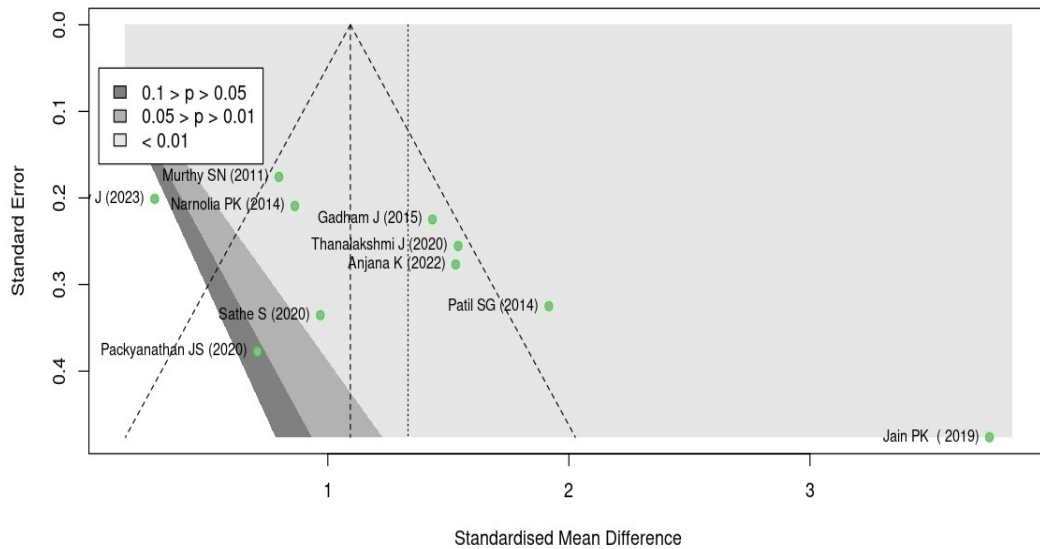


Figure 4: Funnel plot (Trim and Fill ) for yoga activity efficacy on systolic blood pressure of hypertensive patients

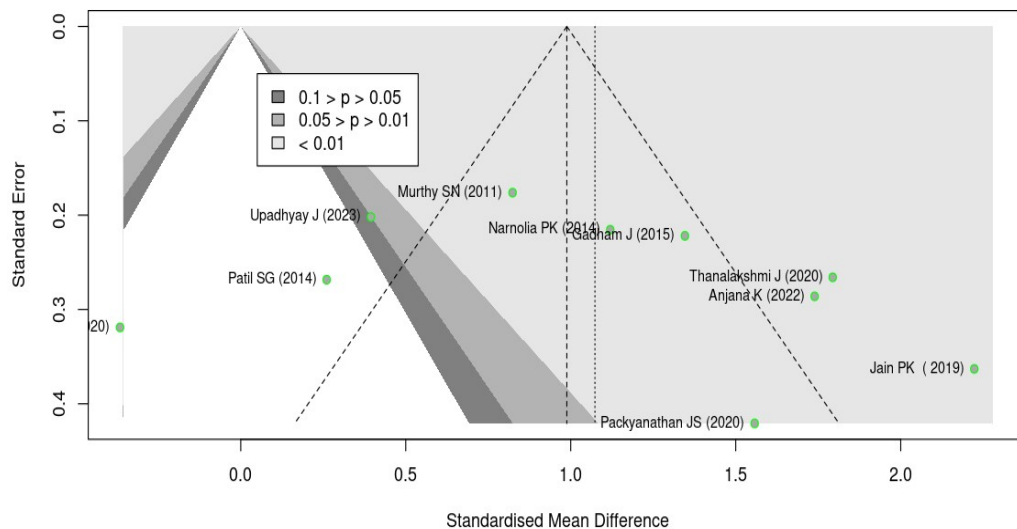


Figure 4: Funnel plot (Trim and Fill ) for yoga activity efficacy on diastolic blood pressure of hypertensive patients

**Discussion**

This meta-analysis was conducted to explore the association between yoga activities and blood pressure measurement in hypertensive patients. The meta-analysis examined whether yoga activities provide beneficial effects in reducing blood pressure in hypertensive patients. Findings showed that systolic blood pressure (SBP) and diastolic blood pressure (DBP) decreased in hypertensive patients after yoga activity sessions compared to before yoga activity sessions. In meta-analysis we

have included studies which are conducted in india only. So it was tried to focus on specific study population.

Finding of this study are consistent with previous study [20]. The overall prevalence of hypertension in India is 10% in rural population and 25% in urban population [12,52]. In today’s modern lifestyle stress has become part of life and stress related disorder would affect quality of life. [12,53]. Yogic activities is method of balancing the autonomic nervous system and affecting stress

related disorders [12,54]. Access to healthcare services and medicines is poor in developing countries [3,55,56]. Yogic activities are in one sense free of cost as a person can perform at his home [27]. Hypertension is associated with cardiovascular morbidity and mortality [3,57]. Thus, it seems beneficial to focus on benefits of yogic activities on blood pressure with parallel to medications [27]

### Validity

Participants in the studies were from both gender and were hypertensive patients. Participants in studies were from different age group so collectively all age group was covered in different selected studies. So, findings of study can be applied to generalized population. Indian population is well familiar with yogic activities, certain activities like "surya-namaskar" are being performed in school life also. Yogic activities practiced in studies are also simpler and were not required expert coaching or regular expert observation. These activities were easy to learn and person can perform at their home without assistance. This is the major benefit of this activities.

Studies included in meta-analysis has various yogic activities in a single study. Even in single study, instead of focusing only on single yogic activity, multiple yogic activities were performed by participants. So ultimately the result obtained was having collective effect of whole yoga programmed activities. In the studies of global health problem like hypertension, sample size was also comparatively small in selected studies. Few studies also have not mentioned regarding coaching by expert yoga trainer. Few studies have also not mentioned regarding blood pressure measurement technique, so it is difficult to do analysis for standardization of measurement method.

### Strength

In this study we have mainly focused for studies conducted on Indian population. We have included studies in duration of last 12 years.

In screening of studies, we examined studies of different years. During inclusion and exclusion process we did analysis of articles having different types of yoga activities. So, in this study collective analysis of various yogic activities is done. Which may be unique in its own way. Moreover, study population of all age group is covered in selected studies, so final conclusive findings may be easily applicable to all.

**Limitation:** In this study main focus is given on effect of yogic activities on hypertension. So primary focus of selected studies was on pre yoga activity effect and post yoga activity effect. Other parameters for yogic activities like duration of this

activities, individual effect of yogic activities, activities which requires yoga trainer is not given much focus. Other limitation in search strategy was English language and articles which were not freely available also decreased scope of articles.

Selection process of studies is done by electronic data base. Studies of electronic data base which is not screened is likely to be missed. And applying filter of specific words during search in electronic data base also may exclude certain potential studies. This increases selection bias.

### Recommendations for future

For more precise analysis, studies in future should focus on specific yoga activities with defined duration and with standardized outcome measurement.

### Conclusion

The present meta-analysis study focused on effect of yogic activities on blood pressure of hypertensive patients in the Indian population. Overall, findings of this study suggest yogic activities is associated with reduction in blood pressure of hypertensive patients. However properly designed RCTs are required to examine these effects in precise, with good quantitative outcome measures.

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