Home-based yoga intervention in hypertensive patients: changes in anthropometric and blood pressure parameters Running title: Home based yoga in hypertension

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ABSTRACT

Introduction: The present study aimed to determine whether practicing yoga at home leads to significant improvements in hypertension and obesity compared to non-yoga practitioners. To compare these changes in yoga and control hypertensive patients at baseline and after invention of three months yoga program.

Materials and methods: The present study was a non-randomised controlled trial, conducted for a period of two years, from December 2021 to December 2023 at a tertiary care teaching institute in Indore. Total 300 participants were divided into four groups (two intervention and two control groups) that were followed up for three months to assess the changes in their antropometric and blood pressure parameters after yoga intervention in the intervention group.

Results: The intervention group reported a statically significant improvement in systolic blood pressure ($P < 0.01$) and diastolic blood pressure ($P < 0.05$). The quality of life was assessed based on the WHOQOL-BREF questionnaire and it was observed that the overall quality of life was perceived to be better in the intervention group which was statistically significant ($P < 0.05$).

Conclusions: Yoga's ability to lower blood pressure through stress reduction, autonomic regulation, and improved cardiovascular function makes it a promising non-pharmacological option for hypertension management

Introduction: Hypertension is a chronic medical condition characterized by consistently elevated levels of arterial blood pressure. It is a significant public health concern worldwide, affecting an estimated 1.13 billion people globally according to the World Health Organization (WHO). Hypertension is defined by sustained elevated blood pressure levels, typically classified as systolic blood pressure (SBP) of 140 mmHg or higher and/or diastolic blood pressure (DBP) of 90 mmHg or higher. The etiology of hypertension is multifactorial, involving genetic, environmental, and lifestyle factors. Primary (essential) hypertension, which accounts for approximately 90-95% of cases, has no identifiable cause but is associated with risk factors such as age, family history, obesity, physical inactivity, and high salt intake. Secondary hypertension, accounting for 5-10% of cases, results from underlying conditions such as kidney disease, endocrine disorders, or the use of certain medications.

Yoga therapy is an emerging treatment modality to control high BP. Yoga does not require much financial outlay or any special equipment and has had no reported ill effects. In everyday practice will improve health status and the need of medicine to control BP can be reduced with adequate

medical supervision. Various researches on the effectiveness of selected yoga were conducted among hypertensive patients which turn reveals the effectiveness of alternative and complementary therapies for patients with hypertension.

India is one of the fast developing economy, bringing new employment and related opportunities along with an improved life style, coupled with exposure to the Western lifestyle. There is an increasing trend of lifestyle diseases, with some reports mentioning India to be the diabetes capital of the world [1]. A recent report by World Health Organization (WHO) has revealed that nearly half of India's population is physically unfit [2].

The aim of this study was to determine whether practicing yoga at home leads to significant improvements in hypertension and obesity compared to non-yoga practitioners. To compare these changes in yoga and control hypertensive patients at baseline and after invention of 3 months yoga program.

Materials and methods: The present study was conducted in the Department of Physiology, Index Medical College and Research Institute, Indore (Madhya Pradesh), a constituent tertiary care teaching institute/ Medical College under Malwanchal University, Indore (Madhya Pradesh). The present study was a non-randomised controlled trial, conducted for a period of two years, from January 2022 to January 2024.

As per previously published estimates in the available literature, around 26% of the adult population in India is hypertensive. The population of Central India was considered to have a prevalence of hypertensive individuals similar to that of national average for the study purpose. An absolute error of 5% was accounted while estimating the sample size. The sample size was thus calculated using the appropriate sample size formula:

$N = z^2pq/ d^2$

Where z= 1.96 at 95% confidence interval, p = 0.26, q= 1 – p = 0.74, d= Absolute error set at 5%

$n= (1.96)^2 \times 0.26 \times 0.74 / (0.05)^2 = 295$

Hence, sample size = 295

Total 300 participants were further divided into four groups on the basis of the BMI at enrolment and intervention:

Group I: intervention group (practiced yoga) hypertensive with BMI≥25 kg/m2 N=75.
Group II: intervention group (practiced yoga) hypertensive with BMI≤24 kg/m2 N=75.
Group III: control group (did not perform yoga) hypertensive with BMI≥25 kg/m2 N=75.
Group IV: control group (did not perform yoga) hypertensive with BMI≤24 kg/m2 N=75.

The study participants were enrolled on the basis of the following inclusion criteria:

- Age group: 20 to 70 years.
- BP criteria: SBP of 130 to 159 mm Hg or DBP of 85 to 99mm Hg.
- Three months or more of prescribed antihypertensive medication or without previously prescribed anti-hypertensive medications.

Participants with the following characteristics were excluded from the study:

- Participants with a medical history of any other disease known to affect the autonomic cardiac function, neurological diseases, metabolic disorders, or endocrine disorders.
- Pregnant women to avoid any pregnancy related risks.
- Known secondary cause of hypertension (self-reported).
- Hypertension (SBP ≥160 mm Hg or DBP ≥100 mm Hg).
- Those who were already engaged in practicing any type of relaxation technique/ Yoga or physical exercise.

Intervention

The intervention was divided into two parts: a) two-hour yoga training for five days, and b) 90 days of at-home self-practice of yoga (with a 30-minute session each day). Group I and Group II,

the participants in the treatment arm, got both intervention components, while Group III and Group IV, the control group, did not.

A structured yoga program that can be done at home includes breathing techniques, yoga poses, and meditation. It takes 30 minutes to complete each yoga session. Om recitation took place first, followed by five minutes of warm-up exercises, four minutes of postures, three minutes of relaxation, eight minutes of breathing, and nine minutes of meditation.

Over the course of five days, the study participants received two hours of yoga instruction. Following instruction, members of the treatment group were asked to carry out the practice once a day for the next ninety days at home. Once every 30 days, they received an invitation to the centres for the routine follow-up. To track their progress and promote accountability, participants were encouraged to use a calendar sheet to note how many days they practise yoga. Each follow-up day included a qualitative evaluation of home-based practice and outcome measurements (BMI and blood pressure).

Cardiovascular parameters like SBP, DBP and pulse rate (PR) and other anthropometric parameters such as weight, body mass index (BMI), waist circumference (WC), waist to hip ratio (WHR) were recorded after following all standard precautions at the time of initiation of study and at end of every month till completion of study using digital weighing scale, sphygmomanometer, measuring tape or height measure.

Recruited subjects were recommended to refrain from exercising for at least 24 hours before the assessment and to forgo caffeinated food and beverages on the day of the evaluation. This analysis was conducted in morning after 2h of light breakfast. Subjects were encouraged to void urine before commence of recording. Cardio Autonomic Parameters as Resting Heart rate (HR), Resting Systolic Blood Pressure (SBP), Resting Diastolic Blood Pressure (DBP) were assessed among the groups.

Resting Heart Rate: It represents the number of heart beats per minute. Subject were asked to lie down in a supine position for 10-15 minutes. ECG electrodes were connected. The resting heart rate was calculated from continuous ECG (BPL CARDIART 108T-DIGI) from lead II by counting number of R waves within one minute period.

Resting Blood Pressure: Blood pressure (SBP and DBP mm of Hg) was recorded in supine position in the right upper limb by using mercury sphygmomanometer after rest for 5 minutes. Three readings were taken at an interval of 5 minutes each and average of the three values calculated.

Participants were also assessed for their quality of life, health and other areas of life by WHO Quality of Life questionnaire (WHOQoL-BREF) [3] at the time of beginning of the study and at every month till completion of study. Regular follow up of study was done by regular phone calls at interval of 15 days. Assessment of blood pressure profile and quality of life were done at Physiology Department regularly at the end of month for the next three months.

Results: A total of 300 study participants were enrolled into four groups as described in the methodology based on which it was observed after a 90 day follow up that the study participants in group 1 and group 2, i.e. the intervention group reported a significant improvement in various metabolic and cardiovascular parameters during the course of the study. The intervention group reported a statically significant improvement in systolic blood pressure (P <0.01) and diastolic blood pressure (P <0.05). The results are summarized in **table 1** and **table 2**.

Table 1: Changes in anthropometric and cardiovascular profile of participants from Group-I and II (intervention groups)

Parameter	Baseline	Day 90	*P*-value	Baseline	Day 90	*P*-value
	G1			G2		
BMI	28.2	27.6	0.936	23.9	23.2	0.977
Weight	76.3	73.4	0.569	66.4	64.4	0.852
Waist circumfer-ence	88.2	85.4	0.626	83	80.6	0.383
Waist to hip ratio	0.78	0.76	0.951	0.72	0.70	0.894
Systolic BP	152	141	<0.01	149	138	<0.01
Diastolic BP	96	89	<0.05	94	87	<0.05
Heart Rate	95	91	0.872	92	88	0.426

Table 2: Changes in anthropometric and cardiovascular profile of participants from Group-III and IV (control groups)

Parameter	Baseline	Day 90	*P*-value	Baseline	Day 90	*P*-value
	G3			G4		
BMI	29.3	29.2	0.925	23.2	23.2	0.961
Weight	81.4	82.1	0.943	64.3	63.8	0.912
Waist circumfer-ence	87.8	88.2	0.937	82.2	80.2	0.924
Waist to hip ratio	0.74	0.75	0.959	0.74	0.74	0.989
Systolic BP	154	151	0.942	146	145	0.972
Diastolic BP	94	95	0.961	94	95	0.986
Heart Rate	96	96	0.984	87	86	0.967

The quality of life was assessed based on the WHOQoL-BREF questionnaire and it was observed that the overall quality of life was perceived to be better in the intervention group which was statistically significant (P <0.05) as shown in **table 3** and **table 4**.

Table 3: Comparison of assessment of WHOQOL-BREF of study participants from baseline on follow up at day 90 from Group-I and II (intervention group)

G1	0	90	*P*-value	G2	0	90	*P*-value
A1	2.6	4.1		**A1**	2.5	4.2	
A2	2.5	4.0		**A2**	2.5	4.3	
B1	2.4	3.6		**B1**	2.5	3.6	
B2	2.6	3.5		**B2**	2.5	3.5	
B3	2.5	3.5		**B3**	2.5	3.5	
B4	2.5	3.5		**B4**	2.5	3.5	
B5	2.5	3.5		**B5**	2.6	3.6	
B6	2.5	3.5		**B6**	2.5	3.5	
B7	2.5	3.5		**B7**	2.5	3.5	
C1	2.5	3.5		**C1**	2.5	3.5	
C2	2.5	3.5		**C2**	2.4	3.6	
C3	2.4	3.5		**C3**	2.5	3.5	
C4	2.5	3.6	<0.05	**C4**	2.6	3.6	<0.05
C5	2.5	3.4		**C5**	2.5	3.4	
C6	2.5	3.5		**C6**	2.5	3.5	
D1	2.4	3.6		**D1**	2.5	3.6	
D2	2.5	3.6		**D2**	2.5	3.6	
D3	2.4	3.5		**D3**	2.5	3.5	
E1	2.5	3.5		**E1**	2.5	3.5	
E2	2.6	3.5		**E2**	2.5	3.5	
E3	2.5	3.5		**E3**	2.5	3.5	
E4	2.6	3.5		**E4**	2.5	3.5	
E5	2.5	3.5		**E5**	2.5	3.5	
E6	2.5	3.6		**E6**	2.6	3.6	
E7	2.5	3.5		**E7**	2.4	3.5	

E8	2.5	3.5		**E8**	2.6	3.5	

Table 4: Comparison of assessment of WHOQOL-BREF of study participants from baseline on follow up at day 90 from Group-III and IV (control group)

G3	**0**	**90**	***P*-value**	**G4**	**0**	**90**	***P*-value**
A1	3.7	3.7		**A1**	3.9	3.9	
A2	4.0	3.9		**A2**	3.9	4.0	
B1	4.0	3.9		**B1**	4.0	4.0	
B2	3.8	3.9		**B2**	3.9	4.0	
B3	3.8	3.8		**B3**	3.8	3.9	
B4	3.8	3.8		**B4**	3.8	3.9	
B5	3.9	3.9		**B5**	4.0	4.0	
B6	3.8	3.8		**B6**	3.9	3.9	
B7	3.9	3.8		**B7**	3.9	3.9	
C1	3.8	3.8		**C1**	3.9	4.0	
C2	3.8	3.8		**C2**	3.9	3.9	
C3	3.8	3.8	0.947	**C3**	3.8	3.9	0.873
C4	3.9	3.8		**C4**	3.9	3.9	
C5	3.8	3.8		**C5**	3.7	3.8	
C6	3.8	3.7		**C6**	3.9	3.9	
D1	3.8	3.9		**D1**	3.9	3.9	
D2	3.8	3.8		**D2**	3.9	3.9	
D3	3.8	3.8		**D3**	3.9	4.0	
E1	3.9	3.9		**E1**	3.9	4.0	
E2	3.8	3.8		**E2**	3.9	4.0	
E3	3.8	3.7		**E3**	3.9	3.9	
E4	3.7	3.7		**E4**	3.8	3.9	
E5	3.7	3.7		**E5**	3.8	3.8	
E6	3.9	3.9		**E6**	4.0	4.1	

E7	3.8	3.8	**E7**	3.9	3.9
E8	3.8	3.7	**E8**	3.9	4.0

Discussion: This study sought to determine the effects of yoga on hypertension patients' blood pressure and quality of life. SBP and DBP significantly decreased in patients who practiced yoga compared to the control group (p 0.05). Furthermore, compared to the control group, the yoga at home group saw a greater improvement in quality of life (p 0.05).

Comparing the intervention groups to the control group, where individuals did not alter their lifestyle, revealed a statistically significant improvement in quality of life. Both the physical and psychological states of health as well as the overall quality of life were reported to have improved by the participants. Improvements in work capability, sleep quality, and energy for daily living were reported.

Participants in the intervention group reported that they were enjoying a better life and finding their lives more meaningful. A positive change in acceptance of body appearance was also observed, especially in the intervention group 1 with BMI more than 25, after 12 weeks of yoga intervention. Practicing yoga also reduces negative feelings such as anxiety, depression and/ or despair. This data is in accordance with the previously published studies that found a positive correlation with the practice of yoga and the perceived increments in quality of life.

Of particular interest are the non-association of yoga with certain study parameters such as body mass index, weight and heart rate/ pulse rate In many other studies conducted previously, the authors have reported a change in weight/body mass index and pulse rate, with most studies showing a mild to significant improvement (reduction) in weight/body mass index and pulse rate. A lower weight as well as lower pulse rate are signs of better metabolic and cardiovascular health respectively. In the present study, the lack of such association could be because of lesser duration of follow up or because the yoga intervention was not coupled with other interventions such as diet control and nutitional counselling.

Over 26% of people worldwide suffer from hypertension, making it one of the most common conditions [4]. Persistent hypertension increases the risk of heart failure, coronary heart disease, stroke, and other cardiovascular conditions. In primary care, hypertension is a common diagnosis, and both the consequences of hypertension and the costs to society of screening for and treating it are substantial [5].

Only over one-third of patients treated in Europe reach their target blood pressure (BP) of 140/90, even with the availability of numerous antihypertensive medications [6]. Therefore, as alternative methods to control blood pressure, lifestyle changes like more yoga practice, exercise, weight loss, better nutrition, stress reduction, and a reduction in alcohol and nicotine use have been studied [7]. Previous studies have also shown that yoga lowers blood pressure [8]. In these studies, relative to baseline, systolic blood pressure (SBP) decreased by up to 6 mmHg and diastolic blood pressure (DBP) decreased by up to 5 mmHg [9]. The clinical significance of these observations is still unknown. Yoga may be used in addition to medical treatment because it has been demonstrated to lower blood pressure. Patients who regularly practise yoga may also benefit from it, as it has been shown in numerous studies to enhance subjective well-being and quality of life. [10]

Nevertheless, it is important to remember that the yoga intervention designs in the earlier research varied from study to study and the duration of the intervention varied from 3 to 20 weeks, which prevented a comparison of the therapies' efficacy. Furthermore, a number of studies combined yoga with other therapies, like dietary changes [11].

Conclusions: The therapeutic potential of home-based yoga interventions in hypertensive patients is supported by a growing body of evidence. Yoga’s ability to lower blood pressure through stress

reduction, autonomic regulation, and improved cardiovascular function makes it a promising non-pharmacological option for hypertension management. Home-based programs, particularly those supported by digital health tools, offer flexibility and accessibility, making yoga an appealing intervention for long-term hypertension control.

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