Original Article

DOI: 10.7860/JCDR/2025/74283.20858

Comparing the Effectiveness of Aerobic Training, Isometric Handgrip Exercise and Yoga Therapy to Manage Primary Hypertension: A Randomised Controlled Trial

Physiotherapy Section

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ABSTRACT

Introduction: Hypertension is the most avoidable cause of Cardiovascular Diseases (CVDs), with a prevalence of 22.4% among young adults. Lifestyle modifications, dietary changes and various non pharmacological therapies-including aerobic training, resistance training, handgrip exercises and yoga therapy-are effective in managing primary hypertension. However, non pharmacological treatments have shown contradicting results in earlier studies. Therefore, there is a need to identify better interventions for managing primary hypertension to lessen the considerable burden of hypertension on the public health system.

Aim: To compare the effectiveness of aerobic training, isometric handgrip exercise and yoga therapy in managing blood pressure among individuals with primary hypertension.

Materials and Methods: A randomised controlled trial was conducted at MM Super-Speciality Hospital, Mullana, Ambala, Haryana, India from February 2023 to May 2023. Forty hypertensive patients over 18 years of age were recruited based on the inclusion and exclusion criteria. Participants were divided into four groups: aerobic training, isometric handgrip exercise, yoga therapy and a control group, with 10 subjects in each group. Six weeks of intervention were provided four times a week and Systolic Blood Pressure (SBP) and Diastolic Blood Pressure (DBP) were measured at baseline and postintervention. For statistical analysis, Statistical Package for the Social Sciences (SPSS) version 20.0 was used. The Wilcoxon Signed Rank test and Kruskal-Wallis test were applied for intra- and intergroup comparisons. A p-value of <0.05 was considered statistically significant.

Results: Aerobic training showed significant improvement (p-value <0.001) in SBP, with a median (IQR) reduction of 9.75 and in DBP, with a median (IQR) reduction of 9.50, along with regular pharmacotherapy.

Conclusion: A supervised aerobic exercise training program, along with pharmacotherapy, was superior to other interventions in effectively managing primary hypertension.

Keywords: Blood pressure, Cardiovascular diseases, Resistance training

INTRODUCTION

Hypertension, often known as high blood pressure, is a chronic medical condition in which a person's arterial blood pressure is consistently elevated [1]. High-income countries have seen a slight decrease in the rate of hypertension prevalence over the last 20 years, whereas significant increases have been reported in low- and middle-income countries [2]. The prevalence of hypertension increases with age, with rates of 22.4% among the young and middle-aged group, 54.5% among those aged 40-59 years and 74.5% among individuals aged 60 or older [3]. There are several pharmacological treatments available for hypertensive patients, with or without existing co-morbidities, based on assessment and evaluation, particularly for those who have already been counselled on lifestyle modifications. According to the World Health Organisation (WHO), the initiation of pharmacological treatment should occur when a person has a SBP of ≥140 mmHg and a DBP of ≥90 mmHg with a confirmed diagnosis [4].

Lifestyle modifications and dietary changes are recommended as the first line of therapy in both European and North American treatment guidelines for primary and secondary prevention of hypertension [5]. One of the most effective non pharmacological antihypertensive methods is exercise [6]. Various forms of exercise, such as yoga therapy [7], handgrip exercises [8] and aerobic training [9], as well as meditation, can be beneficial. Physical activity serves as an alternative tool for systematically managing hypertensive individuals over the age of 18 years. Isometric handgrip exercises can reduce resting blood pressure by influencing two factors that determine mean arterial pressure: total peripheral resistance and cardiac output [8].

Blood pressure changes are primarily attributed to a reduction in peripheral vascular resistance, significantly influenced by the Sympathetic Nervous System (SNS) and the structure and function of blood vessels [9]. The benefits of aerobic exercise or training are well-established in the prevention of CVD [10]. Aerobic exercises rely on the cardiopulmonary system for the exchange, transportation and removal of O_2 and CO_2; thus, this same system benefits from the stress and overload caused by aerobic exercises in the heart, blood vessels, lungs, muscles and all systems involved in blood pressure regulation [11]. Yoga therapy typically combines isometric exercise, breathing exercises, stretching, deep relaxation therapy and meditation. Although yoga therapy can be an interesting alternative approach in managing primary hypertension, its effects on hypertension remain inconclusive [12].

All of the above non pharmacological treatments have shown mixed results in earlier studies. Therefore, there was a need to compare established non pharmacological interventions in managing primary hypertension to lessen the considerable burden of hypertension on the public health system. This study thus aimed to compare the effectiveness of aerobic exercise training, isometric handgrip exercise and yoga therapy in managing primary hypertension.

MATERIALS AND METHODS

A randomised controlled trial was conducted at MM Super-Speciality Hospital, Mullana, Ambala, Haryana, India from February

2023 to May 2023. The study was approved by the Institutional Ethical Committee (IEC) with reference number IEC-2229 and was registered in the Clinical Trial Registry with identifier number CTRI/2022/11/047530. Informed consent was obtained from all participants before the study commenced.

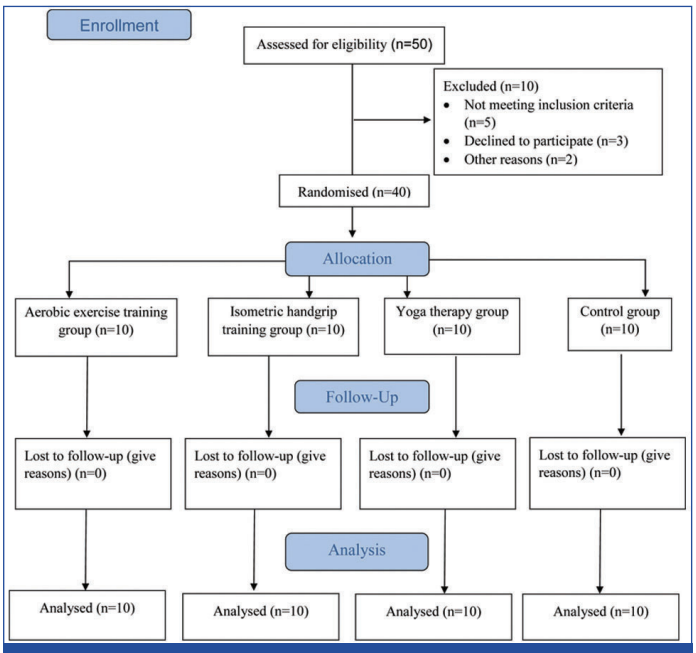
Inclusion criteria: Individuals with primary hypertension aged over 18 years and Body Mass Index (BMI) range of 18.5 to 24.9 kg/m^2 [13] were included in the study.

Exclusion criteria: Individuals with secondary hypertension, any health issues that may affect the study outcomes, including Coronary Heart Disease (CHD), Heart Failure (HF) patients, Myocardial Infarction (MI), pulmonary embolism or a stroke in the last three months, subjects with neuromuscular diseases and musculoskeletal conditions, pregnant women or women anticipating pregnancy, patients with renal failure or peripheral arterial occlusive disease were excluded from the study.

Sample size calculation: The sample size was calculated using G*Power (3.1.9.4) based on a previously published study [14], in which the effect size was determined using pre- and post-values of the SBP variable in the aerobic exercise group, using the formula: effect size=(mean Post-mean Pre)/SD pooled (standard deviation), with the power of the study set at 95%. The minimal sample size required was 28, or 7 in each group. The final sample size obtained was 40 subjects (10 in each group), with three subjects added to each group based on an assumed 30% dropout rate. All participants were equally divided into four groups: aerobic training group, isometric handgrip exercise group, yoga therapy group and control group, as shown in [Table/Fig-1]. All participants were asked to fill out the informed consent form and anthropometric measurements and demographic details (age, gender, height, weight, BMI) were recorded. All participants were instructed to continue their antihypertensive medications during the study period and it was confirmed before their recruitment that they were all prescribed the same category of antihypertensive drugs to avoid bias between the groups. The study was conducted in accordance with the National Ethical Guidelines for Biomedical and Health Research Involving Human Participants (ICMR 2017) and the Helsinki Declaration (Revised, 2013). Baseline and postintervention assessments of blood pressure (SBP and DBP) were performed in all groups.

Intervention

For the aerobic training group, participants underwent aerobic exercise training following the American College of Sports Medicine (ACSM) guidelines [15] and Joint National Committee 8 (JNC) guidelines [16] using a treadmill for four sessions per week, with an average duration of 30 minutes at a moderate intensity of 60-80% of HRmax during the six-week intervention period. All sessions were supervised by the primary researcher and the intensity of aerobic training progressed weekly according to the participants' abilities.



[Table/Fig-1]: Consort flowchart of the study.

For the isometric handgrip exercise training group, participants were instructed to perform four sets of two-minute contractions of the flexor muscles of the hand (grip) at 30% of Maximum Voluntary Contraction (MVC) with three minutes of rest [17] between contractions, using a hydraulic hand-held dynamometer for four sessions per week over six weeks. Feedback and encouragement were provided to help subjects maintain the 30% MVC. To assess Maximum Voluntary Contraction, a single maximum score for the hand grip contraction was recorded using the dominant hand while sitting upright in a chair, with the foot resting on the floor, employing a hand dynamometer device.

For the yoga therapy group, participants were asked to perform 30 minutes of yoga, which included a series of yoga postures beginning with Padmasana while chanting "Om" (holding the position for 1 minute with 5 repetitions), followed by Gomukhasana (30 seconds hold with 5 repetitions), Pawanmuktasana (30 seconds hold with 5 repetitions), Ujjayi Pranayama (10 repetitions increased up to 20), Shavasana (holding the pose for 5 minutes), Sheetali Pranayama (5 repetitions increased up to 10) and Ida Nadi (5 repetitions increased up to 10), in combination with breathing exercises and meditation.

For the control group, there was no intervention; participants continued their regular lifestyle and medication. Pre- and post-assessments were conducted after the 6-week intervention period to compare the outcomes with the experimental groups. The post-outcome measures were re-assessed after the 6-week intervention period for data analysis.

STATISTICAL ANALYSIS

The SPSS version 20.0 was used for statistical analysis. Data were expressed in the form of median (interquartile range, IQR) and normality was assessed using the Shapiro-Wilk test, as the sample size was less than 50. This assessment revealed that only height and weight were normally distributed. Since age and BMI were not normally distributed, non parametric tests were employed. The Wilcoxon Signed Rank test and the Kruskal-Wallis test were applied for intra- and intergroup comparisons. A p-value <0.05 was considered statistically significant.

RESULTS

The median (interquartile range) was found to be 27 (4) years for age, 167.5 (12) cm for height, 66.5 (10.7) kg for weight and 24 (1.5) kg/m^2 for BMI, respectively. The results were significant for aerobic training concerning both SBP (p-value <0.001) and DBP (p-value <0.001). For the isometric handgrip exercise group, the significance was p-value=0.073 for SBP and p-value=0.11 for DBP. In the yoga therapy group, the values were significant with SBP (p-value=0.01) and DBP (p-value <0.001). The control group showed no significant results with SBP (p-value=0.87) and DBP (p-value=0.721) [Table/Fig-2]. In the intra group analysis, the aerobic training and yoga therapy groups showed statistically significant results.

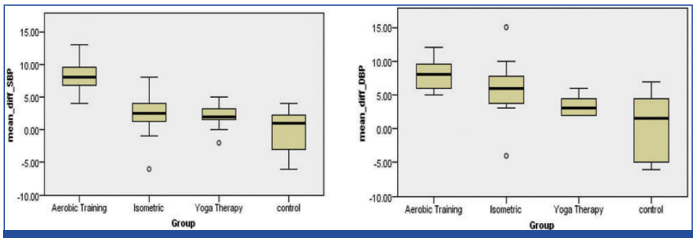
For the intergroup comparison of SBP and DBP, the Kruskal-Wallis test was applied, with data expressed in the form of mean rank. In the intergroup analysis, the aerobic training group had a higher mean rank, followed by the isometric handgrip exercise group, as shown in [Table/Fig-3]. The box plot diagram illustrates the change scores in SBP and DBP among the various groups, as depicted in [Table/Fig-4].

Group	Median (IQR)		p-value
Aerobic training (N=10)	Pre-SBP-141.5 (8.25)	Post-SBP-134.5 (9.75)	<0.001*
	Pre-DBP-90 (12.25)	Post-DBP-82.5 (9.50)	<0.001*
Isometric handgrip exercise (N=10)	Pre-SBP-141 (6.00)	Post-SBP-138.5 (4.25)	0.073
	Pre-DBP-89.5 (7.75)	Post-DBP-84 (10)	0.11
Yoga therapy (N=10)	Pre-SBP-140 (13)	Post-SBP-138.5 (14.2)	0.019*
	Pre DBP-90 (11.75)	Post-DBP-85.5 (11.2)	<0.001*
Control group (N=10)	Pre-SBP-140.5 (9)	Post-SBP-139.5 (8.25)	0.87
	Pre-DBP-84.0 (9)	Post-DBP-85 (9.25)	0.721

[Table/Fig-2]: Intragroup comparison of pre and postintervention Systolic Blood Pressure (SBP) and Diastolic Blood Pressure (DBP) in all four groups.
Wilcoxon-signed test, *significant p-value <0.05

Group	N	Mean rank	p-value
Aerobic training	10	SBP- 34.65	<0.001*
		DBP- 31.35	
Isometric handgrip exercise	10	SBP- 18.70	
		DBP- 24.15	
Yoga therapy	10	SBP- 17.35	
		DBP- 15.15	
Control group	10	SBP- 11.30	
		DBP- 11.35	

[Table/Fig-3]: Postintervention intergroup group change in mean rank of SBP and DBP.
SBP: Systolic blood pressure; DBP: Diastolic blood pressure



[Table/Fig-4]: Box plot graph shows the change in score difference in SBP and DBP among various groups in Median (IQR).

Pairwise comparisons between groups were conducted postintervention for both SBP and DBP. The results show that aerobic training exhibited a more statistically significant difference (p-value <0.001), as illustrated in [Table/Fig-5].

Groups	Aerobic training	Isometric handgrip exercise	Yoga therapy	Control group
Aerobic training group	—	SBP- 0.013*	SBP- 0.005*	SBP- ≤0.001*
		DBP- 0.991	DBP- 0.011*	DBP- 0.001*
Isometric handgrip exercise	SBP- 0.013*	—	SBP- 1.000	SBP- 0.921
	DBP- 0.991		DBP- 0.496	DBP- 0.082
Yoga therapy	SBP- 0.005*	SBP- 1.000	—	SBP- 1.000
	DBP- 0.011*	DBP- 0.496		DBP- 1.00
Control group	SBP- ≤0.001*	SBP- 0.921	SBP- 1.000	—
	DBP- 0.001*	DBP-0.082	DBP- 1.000	

[Table/Fig-5]: Comparison of Systolic Blood Pressure (SBP) and Diastolic Blood Pressure (DBP) between groups after the intervention.
*Statistically significant p-value <0.05, Kruskal Wallis test

DISCUSSION

In the present study, aerobic training showed significant improvements in the management of primary hypertension and was beneficial for cardiovascular health in conjunction with pharmacotherapy, as compared to the other groups. Similar findings were also reported in a semi-experimental study by Baghaiee B et al., which indicated significant effects for SBP (p-value=0.031) and DBP (p-value=0.023) resulting from aerobic training for the management of hypertension in adults [18]. A randomised controlled trial conducted by Dureja G and Bardhan S, concluded that there were no significant changes in SBP, but significant changes in DBP were observed with treadmill exercise training in young adults [19].

Aerobic training has been found to be effective in managing or reducing blood pressure in individuals with primary hypertension. This could be attributed to aerobic training reducing vagal tone activity, which leads to a decrease in peripheral vascular resistance, further resulting in lower blood pressure. Aerobic training improves vascular dysfunction in hypertensive subjects and reduces Sympathetic Nervous System (SNS) activation in patients with essential hypertension. In 2019, another RCT was performed to examine the effects of aerobic training combined with resistance exercise and their results also showed better improvements in the combined training group, which included aerobic training along with resistance training [20].

However, in the current study, there were non significant improvements (p-value=0.073) in SBP and DBP for the isometric handgrip exercise group. Similar findings were reported by Carlson DJ and Bafour Awuah B et al., where they noted significant effects on SBP, but no significant changes in DBP [21,22]. They also concluded that isometric handgrip exercise could be used as adjunctive therapy alongside other forms of exercise in resistant hypertensive individuals.

The current findings also showed a significant difference (p-value=0.019) from pre-SBP for the yoga therapy group and DBP, which corroborates with an earlier study demonstrating the effectiveness of integrative yoga programs in managing essential hypertension. In that study, there was a significant reduction in SBP (p-value=0.028) and DBP (p-value=0.001) [23]. The study findings revealed that yoga can be used as an adjunct to pharmacological treatment for better prognosis. This effect may be due to a simultaneous increase in parasympathetic activity and a decrease in sympathetic activity, which has been postulated as an important mechanism of action for therapeutic yoga. Cramer H, also revealed that yoga has positive effects on hypertension, concluding that yoga therapy is beneficial as an adjunct to conservative pharmacological management but should not be used as an alternative therapy [24].

The findings of the current study indicate that aerobic exercise training is most effective in managing primary hypertension when combined with pharmacological management. Aerobic exercises are also known to provide significant benefits for cardiovascular health. The results of the current study are supported by the Physical Activity Advisory Committee Report (2008) and ACSM guidelines for physical activity, which recommend atleast 30-40 minutes of moderate to vigorous intensity aerobic exercises for cardiovascular health benefits [25]. Now-a-days, non pharmacological management and lifestyle modifications are simultaneously important for controlling the burden of CVDs.

Limitation(s)

To the best of our knowledge, this was the first study to compare the effects of aerobic training, isometric handgrip exercise and yoga therapy on primary hypertension. A small sample size from a single-centred local geographical area was a limitation of this study. Additionally, only a single outcome measure, i.e., blood pressure, was considered in this study.

CONCLUSION(S)

Aerobic training, in conjunction with pharmacotherapy, is more effective in managing primary hypertension, specifically both SBP and DBP, compared to isometric handgrip exercises and yoga therapy. In primary healthcare settings, healthcare professionals should also consider non pharmacological treatments in combination with pharmacotherapy.

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PLAGIARISM CHECKING METHODS: [Jain H et al.]
- Plagiarism X-checker: Jul 24, 2024
- Manual Googling: Dec 21, 2024
- iThenticate Software: Dec 23, 2024 (10%)

ETYMOLOGY: Author Origin

EMENDATIONS: 7

AUTHOR DECLARATION:
- Financial or Other Competing Interests: None
- Was Ethics Committee Approval obtained for this study? Yes
- Was informed consent obtained from the subjects involved in the study? Yes
- For any images presented appropriate consent has been obtained from the subjects. NA

Date of Submission: **Jul 23, 2024**
Date of Peer Review: **Sep 16, 2024**
Date of Acceptance: **Dec 27, 2024**
Date of Publishing: **Apr 01, 2025**