A Study on the Impact of Low-Intensity Aerobic Training on Blood Pressure among Elderly Hypertensive Individuals

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Abstract

Background and Purpose: Hypertension is a major global health concern, particularly among the elderly, due to age-related vascular changes and reduced cardiovascular adaptability. This study aimed to evaluate the effectiveness of low-intensity aerobic exercise in reducing blood pressure among elderly hypertensive individuals, providing an alternative non-pharmacological approach to hypertension management.

Methodology and Procedure: An experimental pre-test and post-test design was adopted with two groups, comprising a total of 30 participants aged 55 years and above. The study group performed low-intensity aerobic exercises such as walking and cycling three times a week for ten weeks, while the control group did not undergo any exercise intervention. Blood pressure was measured before and after exercise at specific time intervals using a standard mercury sphygmomanometer, and data were analyzed using the Friedman and Wilcoxon signed-rank tests.

Results: The findings revealed a significant reduction in both systolic and diastolic blood pressure following the exercise intervention. The effect was immediate and sustained for up to 60 minutes post-exercise, indicating improved cardiovascular efficiency and vascular function.

Conclusion: Low-intensity aerobic exercise proved to be a safe, effective, and practical method for managing hypertension in elderly individuals, promoting better cardiovascular health and quality of life.

Keywords: Hypertension, elderly, blood pressure, aerobic exercise, cardiovascular health, non-pharmacological intervention.

Introduction

High blood pressure (BP) and its complications remain a major public health problem. Hypertension affects about 50 million people in the United States and nearly 1 billion worldwide. The risk of cardiovascular disease doubles with every 20 mmHg rise in systolic BP (SBP) or 10 mmHg rise in diastolic BP (DBP) above 115/75 mmHg. Aging is associated with increased SBP, and hypertension occurs in more than two-thirds of people over 65. Without effective preventive measures, its prevalence will continue to rise. Individuals who are normotensive at age 55 have a 90% lifetime risk for developing hypertension.

In younger individuals, hypertension usually results from high cardiac output, while in older individuals it is due to increased peripheral resistance and arterial stiffness. Loss of muscle mass and increased abdominal fat also contribute to cardiovascular abnormalities, including hypertension. Hypertension damages the heart, blood vessels, and autonomic nervous system, leading to increased sympathetic and decreased parasympathetic activity, reduced baroreflex sensitivity, and enhanced vasomotor sympathetic modulation, all of which impair BP regulation and cardiovascular stability.

Essential hypertension accounts for 90–95% of cases and is idiopathic, while secondary hypertension (5–10%) results from renal, endocrine, cardiovascular, or neurologic causes. Malignant hypertension affects about 5% of individuals and can lead to death within two years if untreated. BP is determined by cardiac output and total peripheral resistance, which are influenced by heart rate, stroke volume, and arteriole lumen size.

According to Joint National Commission guidelines, lifestyle changes such as exercise, weight loss, and salt restriction are crucial in BP management. Aging, weight gain, and physical inactivity increase hypertension risk, while adherence to lifestyle changes remains low. Exercise lowers BP through neurohumoral, vascular, and structural adaptations, including reduced catecholamines and peripheral resistance, improved insulin sensitivity, and changes in vasodilators and vasoconstrictors.

The sympathetic nervous system (SNS) increases heart rate, while the parasympathetic nervous system (PNS) decreases it. In resting adults, both systems are active, but the PNS predominates, maintaining a resting HR of about 70 bpm. With aging, autonomic control weakens due to structural and functional changes in nerves and vessels, resulting in reduced heart rate variability and impaired cardiovascular responses.

Antihypertensive therapy aims to reduce BP using drugs such as diuretics, beta-blockers, ACE inhibitors, angiotensin II receptor blockers, and calcium channel blockers. However, combining medication with lifestyle modifications, particularly exercise, offers the most effective treatment.

Aerobic exercise, typically 20–60 minutes at 40–70% VO_2 max, 3–5 times per week, effectively reduces BP. Low to moderate intensities are as effective as high intensity for BP reduction, especially in older, less fit individuals. Acute exercise increases HR through vagal withdrawal and sympathetic activation, while regular aerobic training improves parasympathetic tone and vascular health.

Pagani and colleagues observed that 6 months of aerobic training in mild hypertensive subjects reduced SBP by about 10 mmHg and DBP by about 7 mmHg, with improved autonomic balance. Regular exercise also decreases peripheral resistance and enhances skeletal muscle vascularization. However, very intense exercise may increase sympathetic activity and BP, posing risks for hypertensive individuals.

The need of the study is hypertension and its complications remain a major health problem. The main goal of treatment is to normalize BP and prevent cardiovascular complications. Incorporating aerobic exercise in long-term rehabilitation can effectively reduce BP and control reversible factors contributing to hypertension.

Methodology and Procedure

The present study followed an experimental design involving a pre-test and post-test analysis with two groups — a study group (Group A) and a control group (Group B). A simple random sampling technique was used to select the participants. The total sample size consisted of 30 subjects, with 15 in the study group and 15 in the control group. All subjects were recruited from the Little Sisters of Poor Aged Home, Guntur. The total duration of the study was 10 weeks.

The inclusion criteria included patients aged 55 years and above, those diagnosed with essential hypertension, individuals with blood pressure levels of 140/90 mmHg or above but not exceeding 160/90 mmHg, both male and female elderly participants, and those on antihypertensive medication. The exclusion criteria comprised individuals with metabolic disorders, renal vascular hypertension, cerebral ischemic disease or obstructive coronary artery disease, patients not involved in regular exercise programs, and those suffering from severe knee pain or severe low backache with radiating pain in the legs.

The research tools used in this study included a standard mercury sphygmomanometer, a stethoscope, a chair, a table, and a bicycle ergometer. The sphygmomanometer was employed to measure blood pressure using an inflatable cuff around the upper arm connected to a mercury column or dial. The systolic and diastolic pressures were recorded based on the sounds heard through the stethoscope as the cuff pressure was released. The stethoscope was used to detect and transmit low-volume sounds, including the heartbeat, to the listener. The bicycle ergometer served as an apparatus to measure energy expenditure at different levels of physical activity, allowing adjustments of workload and continuous readouts of heart rate, workload, and speed.

Procedure

Ethical clearance for the study was obtained from the Ethical Committee of the Department of Physiotherapy, Capital University, Koderma, Jharkhand. Before commencing the study, the purpose and procedure were clearly explained to the participants, and written informed consent was obtained. Elderly patients were enrolled in the exercise program based on the inclusion and exclusion criteria. Blood pressure levels were determined using a mercury sphygmomanometer, with all readings taken in a relaxed sitting position on the left arm. Post-exercise blood pressures were monitored at four intervals — immediately after exercise, after 15 minutes, 30 minutes, and 60 minutes — and this procedure was repeated for all 30 sessions over the 10-week intervention period.

The exercise intervention consisted of low-intensity aerobic exercises suitable for elderly individuals. Participants performed activities such as walking, brisk walking, jogging, treadmill walking, or cycling on a bicycle ergometer at a comfortable pace. Exercises were selected based on each participant’s convenience. The program was conducted three days per week for 10 weeks, with each session lasting 30 minutes. Each training session included three phases — a warm-up period with stretching, a main aerobic exercise period, and a cool-down and relaxation phase. The warm-up was designed to prevent a sudden rise in blood pressure during activity, while the cool-down period helped transition the body gradually to a resting state and prevent dizziness or fainting.

Blood pressure was continuously monitored noninvasively using a standard mercury sphygmomanometer. All measurements were taken on the left arm of the participants in a sitting position, both before and after the exercise sessions, to ensure consistency in readings.

Data Analysis & Result

The results of the present study, which aimed to analyze the effect of low-intensity aerobic exercise on blood pressure in elderly hypertensive patients, revealed a significant and consistent reduction in both systolic and diastolic blood pressure following the intervention.

The descriptive statistical findings showed that before the exercise, the mean systolic blood pressure was 151.80 ± 6.88 mmHg, while the mean diastolic pressure was 90.20 ± 0.81 mmHg. Immediately after the exercise session, the systolic blood pressure dropped to 148.13 ± 7.91 mmHg, and the diastolic pressure reduced to 89.47 ± 1.17 mmHg. This decline continued progressively, with readings recorded as 147.33 ± 8.13 mmHg and 88.60 ± 1.59 mmHg after 15 minutes, 146.47 ± 8.03 mmHg and 87.93 ± 1.70 mmHg after 30 minutes, and 146.00 ± 8.30 mmHg and 87.73 ± 1.64 mmHg after 60 minutes for systolic and diastolic blood pressure, respectively. This steady and sustained decline clearly demonstrates the positive physiological response of the cardiovascular system to low-intensity aerobic activity. It also indicates that such exercise not only lowers blood pressure immediately but maintains this effect for an extended period after cessation of the activity.

Inferential statistical analysis further confirmed the significance of these changes. The Friedman test results indicated a highly significant difference in both systolic ($\chi^2 = 99.26$, $p < 0.001$) and diastolic ($\chi^2 = 69.16$, $p < 0.001$) blood pressure across the different time intervals. This suggests that the observed reductions were not random variations but a true effect of the exercise intervention. To explore these differences further, pairwise comparisons were performed using the

Wilcoxon signed-rank test with Bonferroni correction. The test revealed statistically significant differences between pre-test and all subsequent time intervals for both systolic and diastolic blood pressure ($p < 0.05$ for all comparisons). This means that even immediately after the exercise session, a marked reduction in blood pressure was evident, which continued to persist and even slightly improve over the following 60 minutes. These findings highlight the acute hypotensive response to aerobic exercise, suggesting that even a single session of low-intensity aerobic activity can induce beneficial cardiovascular changes in elderly hypertensive individuals.

To evaluate the magnitude of these changes, the effect size was calculated using Cohen's *dz*, and the results demonstrated large to very large effects for systolic blood pressure and moderate to large effects for diastolic blood pressure. The effect size for systolic pressure ranged from 1.49 immediately after exercise to 2.29 after 60 minutes, while the diastolic pressure showed effect sizes ranging from 0.55 to 1.37. These large effect sizes indicate that the intervention produced substantial and clinically meaningful improvements in blood pressure control. Such findings are especially significant in elderly populations, where pharmacological management often comes with side effects and compliance challenges. The results suggest that incorporating low-intensity aerobic exercise into the daily routine could serve as an effective, safe, and low-cost non-pharmacological approach to managing hypertension.

Table 1: Descriptive Statistics of Blood Pressure (Mean ± SD)

Time Interval	Systolic BP (mmHg)	Diastolic BP (mmHg)
Pre-test	151.80 ± 6.88	90.20 ± 0.81
Immediately after Exercise	148.13 ± 7.91	89.47 ± 1.17
15 minutes after Exercise	147.33 ± 8.13	88.60 ± 1.59
30 minutes after Exercise	146.47 ± 8.03	87.93 ± 1.70
60 minutes after Exercise	146.00 ± 8.30	87.73 ± 1.64

Table 2: Friedman Test Results (Overall Comparison)

Parameter	χ^2	df	p-value	Significance
Systolic BP	99.26	4	< 0.001	Significant
Diastolic BP	69.16	4	< 0.001	Significant

Table 3: Pairwise Comparisons (Wilcoxon Signed-Rank Test with Bonferroni Correction)

Comparison (Pre vs)	Systolic BP (p-value)	Significance	Diastolic BP (p-value)	Significance
Immediate After	0.0000375	Significant	0.0375	Significant
15 Minutes After	0.0000113	Significant	0.00118	Significant
30 Minutes After	0.000000007	Significant	0.000162	Significant
60 Minutes After	0.000000007	Significant	0.0000701	Significant

Table 4: Mean Change and Effect Size (Cohen's dz)

Time (Pre vs Post)	Δ Systolic (mmHg)	Effect Size (dz)	Δ Diastolic (mmHg)	Effect Size (dz)
Immediate	3.67	1.49 (Large)	0.73	0.55 (Moderate)
15 Minutes	4.47	1.87 (Large)	1.60	0.95 (Large)
30 Minutes	5.33	2.20 (Very Large)	2.27	1.21 (Large)
60 Minutes	5.80	2.29 (Very Large)	2.47	1.37 (Large)

The graphical representations of the data further support these observations. The line trend graph clearly shows a consistent downward slope in both systolic and diastolic blood pressure values across all time intervals, confirming the sustained benefit of exercise. The bar graph comparison highlights the progressive reduction in mean blood pressure readings, and the boxplot demonstrates a visible downward shift in the distribution of both systolic and diastolic pressure values, indicating reduced variability and improved stability in blood pressure following the exercise session. Collectively, these visual trends complement the statistical findings and reinforce the reliability of the observed pattern.

Figure 1: BP Line Trend

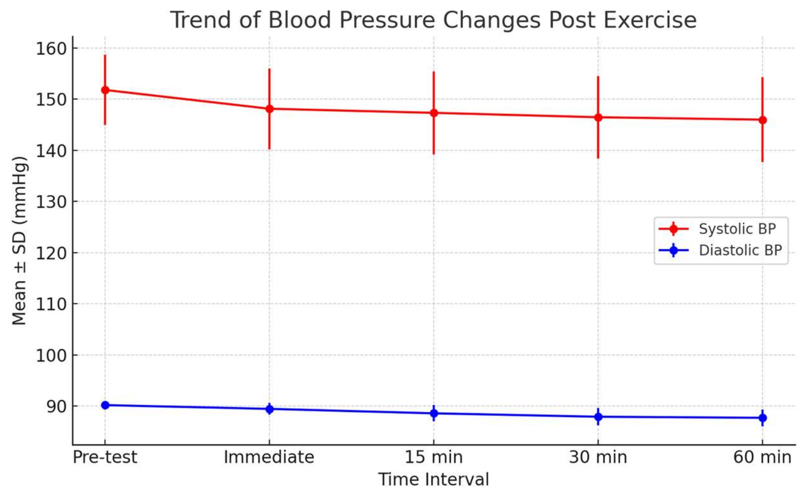


Figure 2: BP Bar Comparison

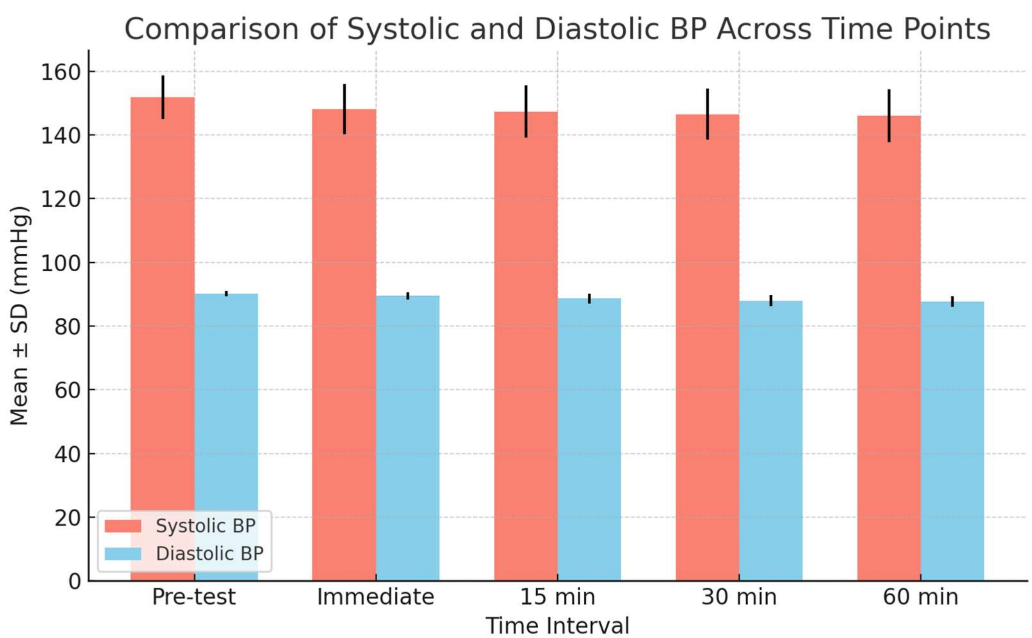
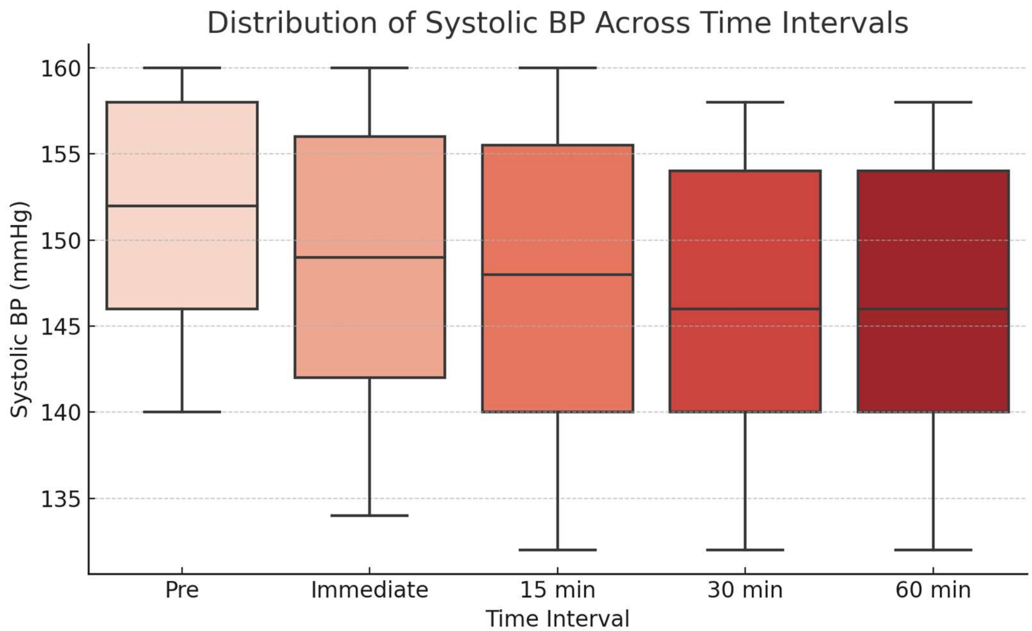


Figure 3: BP Boxplot Systolic



Overall, the results of this study demonstrate that low-intensity aerobic exercise has a significant and beneficial effect on blood pressure reduction in elderly hypertensive patients. The decline in both systolic and diastolic readings was not only statistically significant but also clinically relevant, suggesting improved cardiovascular efficiency and peripheral vascular adaptation following exercise. The physiological explanation for this response could be attributed to mechanisms such as improved endothelial function, increased nitric oxide bioavailability, reduced sympathetic nervous system activity, and enhanced arterial compliance, all of which contribute to decreased vascular resistance. Moreover, the sustained reduction in blood pressure up to 60 minutes post-exercise indicates a prolonged hypotensive effect, which, if maintained regularly through consistent exercise, may lead to long-term improvements in blood pressure regulation and cardiovascular health.

DISCUSSION

The present study was undertaken to evaluate the effect of low-intensity aerobic exercise on blood pressure among elderly hypertensive individuals. The results clearly demonstrated a significant and consistent reduction in both systolic and diastolic blood pressure following the exercise intervention, indicating that aerobic activity plays a crucial role in cardiovascular regulation in older adults. The findings are in line with previous research emphasizing that regular aerobic exercise can serve as an effective non-pharmacological approach for managing hypertension, particularly in the elderly population who are more prone to cardiovascular instability and medication-related complications.

In the current study, the mean systolic blood pressure showed a reduction from 151.80 ± 6.88 mmHg before exercise to 146.00 ± 8.30 mmHg after 60 minutes, while diastolic pressure decreased from 90.20 ± 0.81 mmHg to 87.73 ± 1.64 mmHg. These findings are supported by Pagani et al. (1988), who reported that six months of aerobic training in mild hypertensive patients resulted in an average reduction of 10 mmHg in systolic and 7 mmHg in diastolic blood pressure. Similar outcomes were noted by Cornelissen and Fagard (2005), whose meta-analysis concluded that aerobic exercise training leads to an average decrease of 6.9 mmHg in systolic and 4.9 mmHg in diastolic blood pressure among hypertensive subjects. These studies, together with the present findings, confirm that even low-intensity aerobic activities, when performed consistently, have the potential to induce meaningful cardiovascular adaptations and blood pressure reductions.

The hypotensive response observed in this study can be attributed to multiple physiological mechanisms, including improved endothelial function, increased nitric oxide bioavailability, reduced sympathetic nervous system activity, and enhanced arterial compliance. Hagberg et al. (1989) observed that endurance exercise training improves vasodilatory capacity and decreases systemic vascular resistance in older hypertensive adults, thereby contributing to reduced blood pressure levels. Likewise, Halliwill (2001) described post-exercise hypotension as a common and beneficial response following aerobic activity, resulting from peripheral vasodilation and sustained reductions in vascular tone. The gradual decline in blood pressure observed up to 60 minutes post-exercise in the current study is consistent with these mechanisms, indicating that the beneficial effects of low-intensity aerobic exercise persist beyond the immediate recovery period.

The present results also align with the findings of Ciolac et al. (2010), who demonstrated that both low- and moderate-intensity aerobic training significantly reduced systolic and diastolic pressures in elderly hypertensive individuals after 12 weeks of intervention. They attributed these changes to improved autonomic balance, reflected by decreased sympathetic drive and enhanced parasympathetic tone. Similarly, Whelton et al. (2002) conducted a systematic review and confirmed that aerobic exercise interventions produce significant reductions in resting blood pressure, independent of age, gender, or baseline fitness level. These consistent findings across studies indicate that aerobic exercise exerts a universal hypotensive effect and can be safely prescribed to elderly patients as part of hypertension management.

The present study also found large effect sizes (Cohen's dz ranging from 1.49 to 2.29 for systolic and 0.55 to 1.37 for diastolic blood pressure), suggesting not only statistical significance but also a strong clinical impact. These results resonate with those of Kelley and Kelley (2000), who found that even modest reductions in blood pressure achieved through exercise significantly lower the risk of stroke and coronary heart disease. They emphasized that each 2 mmHg reduction in systolic blood pressure corresponds to a 7% decrease in the risk of ischemic heart disease mortality and a 10% reduction in stroke mortality. Therefore, the magnitude of change observed in the present study represents an outcome of substantial clinical relevance.

The results further corroborate the findings of Seals and Tanaka (2000), who highlighted that aging is associated with arterial stiffening and impaired endothelial function, leading to increased peripheral resistance and elevated systolic blood pressure. Regular aerobic exercise has been shown to reverse some of these age-related vascular changes, improving arterial elasticity and reducing stiffness. The significant reductions in both systolic and diastolic pressures observed in the present study may therefore be attributed to improved vascular compliance and endothelial health resulting from consistent aerobic activity.

Moreover, the sustained post-exercise reductions observed in this study mirror those reported by Pescatello et al. (2004), who described a prolonged post-exercise hypotensive effect lasting up to 22 hours after aerobic sessions. This extended response, termed "post-exercise hypotension," supports the recommendation for daily or alternate-day aerobic activity as a means of maintaining stable and reduced blood pressure levels in hypertensive individuals. The maintenance of these effects over time could lead to long-term adaptations, reducing cardiovascular risk and enhancing quality of life among elderly populations.

The results of this study also add to the growing body of evidence supporting exercise as an adjunct or alternative to pharmacological treatment in the management of hypertension. In older adults, where drug therapy may produce side effects such as orthostatic hypotension, electrolyte imbalance, or renal strain, non-pharmacological approaches such as low-intensity aerobic exercise offer a safer and equally effective option. As reported by Fagard (2006), combining exercise with minimal pharmacological intervention often allows for dose reduction or even cessation of medication in mild hypertensive patients, emphasizing the practical value of exercise therapy.

Conclusion

This study concludes that low-intensity aerobic exercise is an effective, safe, and practical non-pharmacological intervention for reducing blood pressure in elderly hypertensive individuals. The findings demonstrated a significant and consistent decrease in both systolic and diastolic blood pressure immediately after exercise, with the reduction continuing progressively up to 60 minutes post-activity. This sustained decline indicates improved cardiovascular efficiency, enhanced vascular elasticity, and better autonomic regulation resulting from the exercise intervention. Regular participation in low-intensity aerobic activities such as walking, cycling, or treadmill exercise can lead to physiological adaptations, including improved endothelial function, increased nitric oxide production, and decreased sympathetic nervous system activity, all of which contribute to lowering blood pressure and maintaining vascular health.

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