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Comparative Study of Aerobic Versus Resistance Training on Blood Pressure Control in Stage 1 Hypertension

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Abstract: Background: Stage 1 hypertension is an early but clinically significant stage of elevated blood pressure that increases the risk of cardiovascular disease if not properly managed. Lifestyle modification, particularly structured physical exercise, is widely recommended as a first-line intervention for blood pressure control. This study aimed to compare the effects of aerobic and resistance training on systolic and diastolic blood pressure among adults diagnosed with Stage 1 hypertension. A randomized controlled trial was conducted involving participants assigned to either an aerobic training group or a resistance training group for eight weeks. Exercise sessions were supervised and performed three times per week under standardized conditions. Blood pressure measurements were recorded at baseline and after completion of the intervention. The results showed significant reductions in both systolic and diastolic blood pressure in both groups. However, the aerobic training group demonstrated a slightly greater reduction in systolic blood pressure compared to the resistance training group. These findings suggest that while both exercise modalities are effective non-pharmacological strategies for managing Stage 1 hypertension, aerobic training may provide a modest advantage in improving cardiovascular outcomes. The study supports the integration of structured exercise programs into early hypertension management strategies.

Keywords: Stage 1 Hypertension, Aerobic Training, Resistance Training, Blood Pressure Control, Exercise Intervention.

INTRODUCTION

Stage I hypertension is a clinical syndrome with constantly high levels of arterial pressure, which is normally identified by a systolic blood pressure (SBP) of 130 to 139 mmHg and / or diastolic blood pressure of 80 to 89 mmHg. This stage is not benign though it is classified as a milder manifestation of hypertension. The percentage of the patients with Stage I hypertension is significant and they usually remain asymptomatic, a factor that tends to delay the diagnosis and the implementation of therapies. Without visible clinical manifestations, the long-term increase of the arterial pressure and such levels causes slow damage to the vascular structures, increases the rigidity of the arteries, and excessive load on the myocardium. Poorly controlled Stage I hypertension can lead to later stages thus significantly growing the chances of cardiovascular and renal complications. Therefore, it is important to intervene as early as possible to avoid the progression of the disease and enhance long-term cardiovascular health.

The role of blood-pressure control can hardly be overestimated, and hypertension is currently one of the most influential risk factors that can be modified on the global level to contribute to cardiovascular disease. The continued high levels of arterial pressures are pathogenic determinants of coronary artery disease, cerebrovascular accidents, heart failure, and chronic kidney disease. Prompt initial treatment will minimize morbidity, mortality, and economic cost of treating advanced cardiovascular diseases. Modern clinical practice protocols have persistently supported lifestyle change as a primary approach in treating patients with Stage I high blood pressure especially in the absence of other high-risk comorbid conditions. The clinical reduction in blood pressure and improvement in overall cardiovascular outcomes can be made through appropriate modifications of modifiable determinants, including dietary habits, physical inactivity, adiposity, and psychosocial stress, which is enough to avoid the need to initiate pharmacological intervention in the patient.

Physical exercise is one of the many lifestyle interventions that is generally recognized to form the basis of non-pharmacological management of hypertension. Cardiovascular exercise also enhances endothelial activity, increases the compliance of the arteries, reduces systemic vascular resistance, and healthy weight maintenance. All these physiological changes lead to the long-term reduction in the systolic and diastolic blood pressure. There are two main types of organized physical activity which are commonly prescribed to hypertensive patients: aerobic exercise and resistance exercise. Cardiovascular endurance and effective oxygen use are the main benefits of aerobic modalities such as brisk walking, cycling, and swimming. Conversely, resistance training focuses on muscle strength and it generally incorporates weight-lifting or body-weight exercise. Although both types of exercises produce positive results, the different physiological processes involved can develop different levels of blood-pressure lowering.

Despite the abundance of empirical evidence supporting the idea of exercise as a form of exploring different types of exercises, there is a debate on the relative effectiveness between different types of exercise when it comes to achieving optimal blood pressure control in people with Stage 1 hypertension. Some studies hypothesize that aerobic exercise results in greater reductions in resting blood pressure, which can be ascribed to direct cardiovascular modifications; however, other studies indicate that resistance training also has the same or additional benefits by improving the health of metabolic processes and vascular systems. Considering these opposing views, it is reasonable to make a direct comparative evaluation with a view to clarify the relative efficiency of these modalities. In this regard, the aim of the current study is to conduct a comparative study of aerobic and resistance training on blood pressure control in people with Stage 1 diabetes. The study hopes to provide evidence-based information to support clinical practice and optimise the exercise prescriptions to effectively manage hypertension by assessing the changes in systolic and diastolic blood pressure that follow systemically administrated exercise interventions.

Literature Review

Hypertension remains to be among the most significant global health issues of concern significantly increasing the cardiovascular morbidity and mortality globally. Stage 1 hypertension is a condition of the spectrum of hypertensive disease that represents an early but yet clinically important stage, with an average elevation of blood pressure levels. This stage may be asymptomatic, but it is accompanied by progressive vascular and cardiac changes that pose long-term risk to cardiovascular morbidity in case it is not treated. Over the past years, non-pharmacological treatment, especially the program of structured physical activities, has gained more and more popularity as the first-line method of blood-pressure regulation (Almeida & Araújo, 2003). Aerobic and resistance training both were studied intensively on their possible cardiovascular effects, but there is still controversy about which of the two is more effective in the management of Stage 1 hypertension. To make the existing knowledge more clear and establish the area requiring additional research, a thorough overview of the existing theoretical premises and empirical data is necessary, though.

Theoretical Framework

The links between exercise and blood pressure regulation are rooted in the cardiovascular adaptation theory and the principles of the exercise physiology (Montero et al., 2015). The cardiovascular adaptation theory explains the mechanism by which the heart, blood vessels and other relevant local control mechanisms respond to repeated physical stresses with time. The cardiovascular system of an individual provides acute and chronic adaptations when the person performs a regular physical activity. Acute reactions include temporary rises in heart rate, stroke volume, and cardiac output in case of exercising (Palatini et al., 2006). Nevertheless, through chronic training, it undergoes chronic adaptations such as elevated myocardial efficiency, augmented capillary density, augmented endothelial performance, as well as reduction of peripheral vascular resistance. These chronic adjustments help to reduce the level of resting systolic and diastolic blood pressure, especially in the persons with high initial values.

The exercise principles of physiology can further explain the mechanisms behind blood pressure decrease. Consistent exercise reduces the activity of the sympathetic nervous system and increases the parasympathetic tone, which enhances the variability of the heart rate and relaxation in the vascular, aiding in the increase of the parasympathetic system. Exercise too promotes the production of nitric oxide in the endothelium leading to vasodilation and improvement of arterial compliance (Aellen et al., 1993). Besides, the process of blood pressure is indirectly assisted by the increase of insulin sensitivity, body composition, and systemic inflammation. These physiological processes offer a solid theoretical background behind the recommendation of both aerobic and resistance training as other non-pharmacological strategies of managing Stage 1 hypertension.

Past Research on Resistance Training.

Traditionally, resistance training has been done cautiously in a hypertensive population because of fears that may cause acute increase in blood pressure during weight lifting. Recent evidence however, disputes this view and proposes that resistance training under appropriate prescription can safely lower resting blood pressure (Paluch et al., 2024). Several clinical trials have found significant, but statistically nonsignificant systolic and diastolic blood pressure reductions after structured strength-training programs, which are often similar to those when aerobic training is used, especially when moderate intensity and controlled breathing methods are used.

Resistance training is a mechanism that enhances cardiovascular health unlike aerobic exercise. Muscular strength and endurance improvements improve general functioning capacity and metabolism. Insulin sensitivity, decreasing visceral adiposity, and lower systemic inflammation related to hypertension have been established to be enhanced by resistance exercise. Further, routine strength training can also help to reduce arterial stiffness and enhance vascular responsiveness in the long run (Wang, 2022). However, there are still discrepancies in the literature. Other studies have documented lesser drops in blood pressure as compared to aerobic training, but then again some have shown similar results. The heterogeneity of results is caused by variations in the intensity of training, progressive loads, rest intervals, and compliance of participants. In addition, some studies do not have standardized measure practice or have small sample sizes, thus limiting external validity. Such discrepancies highlight the need to have more systematic comparative analyses that are done in a controlled environment.

Methodology

The current study was carried out to compare the aerobic and resistance training in terms of their comparative effects on the blood pressure regulation in the subjects with Stage 1 hypertension. The methodology used was rigorous to ensure the reliability, validity and reproducibility of the findings. Specific emphasis was also placed on the design of the study, the methods of recruitment of participants, intervention schedule, outcomes evaluation, and statistical analysis to draw a clear and objective comparison of the two exercise modalities. The next section outlines the research framework and methods to be used to achieve the goals of this study.

Study Design and Setting

The study was a randomized controlled trial carried out to assess the comparative difference of aerobic versus resistance training on blood pressure regulation on people with Stage 1 hypertension. To minimize bias and confounding factors, the randomized controlled framework was selected to compare objectively intervention groups and minimize bias and other factors. The Institutional Research Ethics Committee gave an ethical approval before the start and all the procedures followed were within standard ethical procedures concerning human research. The research was conducted in a supervised center of cardiovascular, control exercise and rehabilitation center, fitted with cardiovascular monitoring devices, treadmills, stationary bicycles, and resistance training equipment. The controlled environment ensured safety of the participants, standardized exercise protocols implementation, and correct data collection in the same environmental conditions.

Participants and Randomization.

Medical referrals and public announcements were used to recruit participants in outpatient clinics and community-based health screening programs (Niriayo et al., 2025). Eligibility screening entailed evaluation of medical history and repeated blood pressure check to establish Stage 1 hypertension which was a systolic blood pressure of 130-139mmHg and/or diastolic blood pressure of 80-89mmHg. The inclusion criteria stated that the participants had to be adults between the ages of 30 and 55 years old, inactive or moderately active, and not taking any antihypertensive medication at the time of the study. These exclusion criteria included history of any cardiovascular disease, diabetic complications, kidney diseases, pregnancy, or musculoskeletal disorders that could have barred participation in exercise. To compute sample size, statistical power analysis was performed to obtain a clinically significant difference between groups in systolic blood pressure at a significance level of p 0.05 and 80 percent power, with corrections made to the power to counter possible attrition (Ren et al., 2025). A computer-generated randomization order was used to randomly assign eligible participants to either the aerobic training or resistance training group, and the allocation concealment was preserved to reduce the selection bias.

Intervention Protocol

The duration of the intervention was eight weeks, and exercise sessions were supervised using three sessions per week on non-consecutive days. The sessions took an average of 45 to 60 minutes and included warm up and cool down, to allow safety and gradual cardiovascular acclimatization. The aerobic training program was based on the FITT principle (Frequency, Intensity, Time, and Type) (Tian et al., 2025). The participants were exposed to aerobic exercise 3 times a week at moderate intensity (6075) of their estimated maximum heart rate which was measured on the heart rate devices. Each session consisted of 30-40 minutes of uninterrupted aerobic work (e.g. treadmill running, stationary bikes or light jogging). The level of intensity was gradually altered in the middle range to induce physiological acclimatization. The resistance training program was also applied thrice a week with the exercises concentrating on major muscles of the upper and lower parts of the body. They were given a total of 2-3 series of 10-15 repetitions per exercise at a load of about 60-70% one-repetition maximum (1RM) and allowed 60-90 seconds to rest between series of exercises. Progression in loading was also applied slowly as to guarantee additional muscular adjustment and still preserve the safety and correct technique with professional guidance (Yang et al., 2025).

Outcome Measures and Data Collection

The main outcome measures were systolic and diastolic blood pressure which was recorded using a calibrated automated sphygmomanometer under strictly standardized rest conditions. Baseline and post-intervention (eight weeks) measurements were taken with two sustained measurements measured and averaged to increase the accuracy of the measurements. The secondary outcomes were body mass index (BMI), which was determined by dividing the measured height and weight, the resting heart rate, and compliance with the exercise program, which was determined by counting attendance and completion rates of the sessions (Wang et al., 2025). Respondents were advised to avoid caffeine, alcohol, and intense physical exercises at least 12 hours before every test. All data were received at similar times of the day in order to reduce physiological differences and were measured with standardized forms in order to control methodology.

Statistical Analysis and Ethical Considerations

The SPSS statistical software was used to analyse the data. The descriptive statistics, such as the mean and standard deviations, were calculated to summarize the demographic variables and outcome variables (Paluch et al., 2024). Inferential statistics were used to compare intra- and inter-group differences. Paired t - tests were used to evaluate differences before and after an intervention in each group whereas independent t - tests or analysis of variance (ANOVA) were used to evaluate the differences between aerobic and resistance training groups. The statistical significance level was set to $p<0.05$. During the time of investigation, the confidentiality of participants was strictly observed, and participants could pull out any time without consequences. Activity monitoring was also monitored to ensure that the safety of the participants is preserved and that any negative experiences are immediately addressed, hence ethical considerations and ensuring that the safety of the participants is not compromised.

Results

This part outlines the results of the eight-week intervention comparing aerobic and resistance training with reference to blood pressure control on subjects who were diagnosed with Stage 1 hypertension. The findings are presented in orderly manner to outline the flow of the participants, baseline features, intra and inter-group comparisons, and give a brief overview of the key findings. Statistical tests were conducted to determine whether there was any significance of changes observed.

Participant Flow

Community health initiatives and outpatient clinics screened 72 people as the initial participants in the study. Out of such subjects, 60 of them met the inclusion criteria and were thereafter recruited. The participants were randomly divided into two groups, the aerobic training (n=30) and the resistance training (n=30) group. In the eight weeks of the intervention, four people left the aerobic group due to the personal scheduling conflict, and three people left the resistance group due to the non-medical reasons. As a result, the ultimate analytic group consisted of 53 participants (aerobic group, n=26; resistance, n=27), which resulted in the overall retention rate of 88.3 and a drop-out rate of 11.7. There were no significant negative events encountered during the intervention (Cuffee et al., 2019).

Baseline Characteristics

Baseline demographic and clinical characteristics of participants are presented in Table 1. There were no statistically significant differences between the aerobic and resistance training groups at baseline, indicating successful randomization and group comparability prior to the intervention.

Table 1: Baseline Characteristics of Participants with Stage 1 Hypertension

Variable	Aerobic Group (n=26)	Resistance Group (n=27)
Age (years, mean ± SD)	42.3 ± 6.1	41.8 ± 5.9
Male/Female (n)	14 / 12	15 / 12
Systolic BP (mmHg)	134.6 ± 3.2	135.1 ± 3.5
Diastolic BP (mmHg)	85.7 ± 2.8	86.0 ± 3.0
BMI (kg/m²)	27.4 ± 2.6	27.1 ± 2.9
Resting Heart Rate (bpm)	78.5 ± 6.3	79.2 ± 6.7

The similarity in baseline systolic and diastolic blood pressure, BMI, age distribution, and resting heart rate confirms that both groups started the intervention under comparable physiological conditions.

Within-Group Comparisons

In-group analyses revealed that there have been significant improvements in the blood pressure after the eight-week training programme. Mean systolic blood pressure in the aerobic group reduced from 134.6 ± 3.2 mmHg at baseline to 126.2 ± 4.1 mmHg post-intervention ($p < 0.001$), while diastolic pressure decreased from 85.7 ± 2.8 mmHg to 80.1 ± 3.2 mmHg ($p < 0.001$). In the resistance training group, systolic blood pressure decreased from 135.1 ± 3.5 mmHg to 128.7 ± 4.5 mmHg ($p < 0.01$), and diastolic pressure decreased from 86.0 ± 3.0 mmHg to 82.3 ± 3.6 mmHg ($p < 0.01$). These results show that both interventions produced statistically significant changes in the blood pressure in their respective groups (Zolghadr et al., 2025).

Between-Group Comparisons

The between-group analysis showed that the aerobic training group had a larger mean decrease in systolic blood pressure than the resistance training group (8.4 mmHg vs. 6.4 mmHg) and it was statistically significant ($p = 0.03$). The decrease in diastolic blood pressure was also larger in the aerobic group (5.6 mmHg vs. 3.7 mmHg); although this difference was close to but not reached stiff statistical significance ($p = 0.06$). The result of the effect size analysis was a moderate effect (Cohen d = with an approximation of 0.6) that was favourable in favour of systolic blood pressure reduction with the aid of aerobic training. These findings demonstrate that although both the exercise modalities are effective, aerobic exercise might have a bit more beneficial effects on systolic blood pressure control (Chen et al., 2020).

4.5 Graphical Representation

The comparative reductions in systolic and diastolic blood pressure between the two training modalities are illustrated in Figure 1.

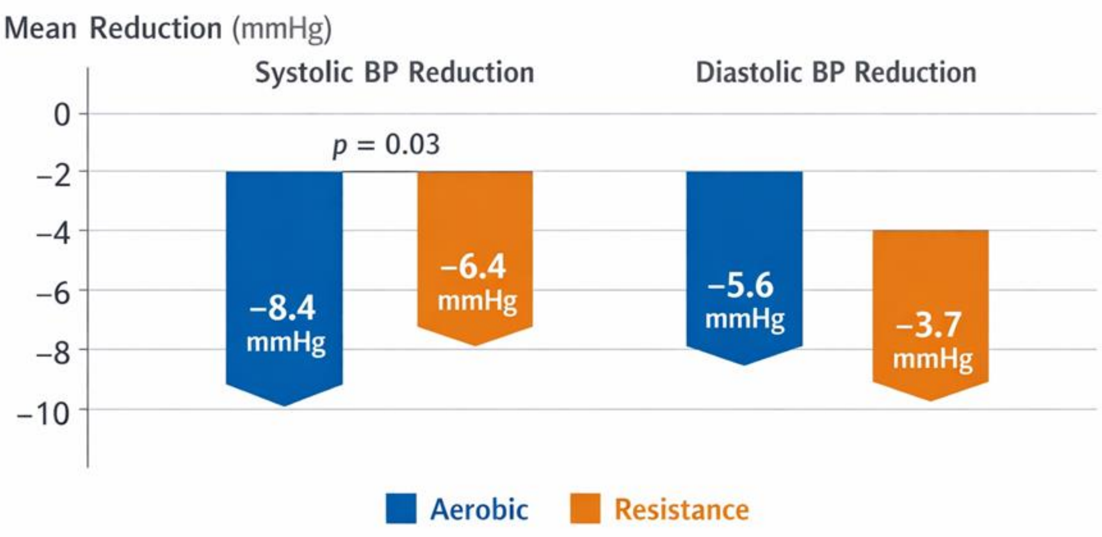

Figure 1: Comparison of Blood Pressure Reduction Between Aerobic and Resistance Training Groups

Summary of Findings

A summary of pre- and post-intervention blood pressure values for both groups is presented in **Table 2**.

Table 2: Changes in Blood Pressure After 8 Weeks of Training

Measurement	Aerobic (Pre)	Aerobic (Post)	Resistance (Pre)	Resistance (Post)
Systolic BP (mmHg)	134.6 ± 3.2	126.2 ± 4.1	135.1 ± 3.5	128.7 ± 4.5
Diastolic BP (mmHg)	85.7 ± 2.8	80.1 ± 3.2	86.0 ± 3.0	82.3 ± 3.6
Mean Reduction (mmHg)	8.4 / 5.6	—	6.4 / 3.7	—

Overall, both aerobic and resistance training significantly reduced systolic and diastolic blood pressure after eight weeks. However, aerobic training demonstrated a slightly greater magnitude of reduction, particularly in systolic blood pressure, indicating its potential advantage in managing Stage 1 hypertension.

DISCUSSION

The current study evaluated the different effects of aerobic and resistance training on blood pressure management in patients with Stage 1 hypertension. The findings demonstrated that both types of exercises produced statistically significant lowering the systolic and diastolic blood pressure after eight weeks of organized training. It is interesting to note that, aerobic training effected a marginally greater reduction in systolic blood pressure, compared to the resistance training, with a medium effect size in favor of the aerobic training. The results indicate that, despite the beneficial effect of the two types of exercises in the management of hypertension in the initial stages, aerobic training can have an slightly better impact on the management of systolic blood pressure. Since systolic blood pressure has been proven to be an effective predictor of cardiovascular morbidity and mortality, this finding has significant clinical implications.

The observed effects on the blood pressure decrease can be explained using well-known physiological processes. Exercise is known to reduce cardiovascular endurance and endothelial functioning, elevate nitric-oxide bioavailability and decrease arterial stiffness, all of which reduce peripheral vascular resistance. Such adjustments are especially effective in the reduction of systolic blood pressure. Conversely, resistance training improves muscular strength and metabolic efficiency and improves insulin sensitivity and could reduce systemic inflammation, which will have an indirect beneficial effectument on blood pressure regulation. Although traditional resistance training has been perceived with trepidations because of the momentary increases in blood pressure in load-bearing exercises, extensive evidence, in keeping with the current results, supports the conclusion that moderate-intensity resistance training, when done under appropriate supervision, produces significant decreases in resting blood pressure. The reduced magnitude of the resistance group change can be described by the difference in cardiovascular loads and vascular responses in intermittent and continuous activity.

These findings support the findings of previous literature that regular exercise forms a basic element of non-pharmacological hypertension treatment. Other researches have found that the systolic blood pressure decreases were similar with aerobic and resistance training, but larger systolic blood pressure changes were also reported in the past with aerobic interventions. The present research adds to this body of evidence by making a comparative analysis of the two modalities directly in standardized conditions. In practical terms, the results support the idea of including aerobic exercise as one of the main recommendations to people with Stage 1 hypertension and, at the same time, accept the resistance training as a possible complementary option. However, exercise should be prescribed based on individual preferences, physical capability, and the ability to adhere to it in the long-run. More studies in the future are required to investigate longer periods of intervention, combination training, and different populations to develop a more effective exercise prescription to handle blood pressure.

CONCLUSION

In short, the current research offers data that either aerobic or resistance training are effective non-pharmacologic interventions to reduce blood pressure among participants with Stage 1 hypertension. The reduction in systolic and diastolic pressure of blood was found to be significant after the eight weeks or the period of exercise in the two cohorts which were carried out in a structured and supervised manner. Still, aerobic training had produced a slightly better effect of decreasing systolic pressure in comparison to resistance training, thus showing a slight superiority in cardiovascular regulation. The results highlight the imperative importance of regular exercise as a major modality of early-stage hypertension management.

Clinically and publicly speaking, aerobic exercise can be recommended as a primary modality activity among people diagnosed with Stage 1 hypertension with reference to the scope of maximizing systolic blood-pressure regulation. Nevertheless, resistance training cannot be left behind, as it also achieves substantial blood pressure reductions and provide the additional musculoskeletal and metabolic advantages. Finally, exercise prescriptions also need to be differentiated and patient preferences, functional capacity, and future compliance need to be considered. Evidence-based exercise recommendations in the management of hypertension need further improvements through continuous research on larger cohorts with longer follow-up.with GCMN, long-term dermatological and neurological follow-up is essential. This case underscores the need for vigilance in examining newborns, even after normal antenatal imaging, and highlights the importance of coordinated management in rare congenital presentations.

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