



## Additive effects of Jacobson's Progressive Muscle Relaxation Technique with Aerobic Exercise on Cardiopulmonary Parameters and Quality of Life in Stage 1 Hypertensive Individuals

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#### Key Words

Stage 1 hypertension, jacobson's progressive muscle relaxation (JPMR), aerobic exercise, cardiopulmonary parameters, quality of life, blood pressure management, randomized controlled trial

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#### ABSTRACT

Hypertension is commonly referred to as elevated blood pressure. AHA/ACC guidelines published in the year 2017 documented normal BP as systolic <120 and diastolic <80 mm Hg (3). Stage 1 hypertension is characterized by systolic 130–139 or diastolic 80–89 mm Hg. Aerobic exercise may help with BP regulation and cardiac function and improve overall physical health. Jacobson's Progressive Muscle Relaxation (JPMR) technique is a well-known method for relieving muscle tension. Considering the association between elevated SNS activity and hypertension, relaxation techniques like JPMR may stimulate the PNS, potentially improving cardiovascular health. Moreover, such interventions may improve QoL by promoting emotional and social well-being. This study aimed to evaluate the additive effects of JPMR combined with aerobic exercise on cardiopulmonary parameters and QoL among individuals with stage 1 hypertension. A non-blinded RCT was conducted recruiting forty participants aged 18-45 years with stage 1 hypertension and mild to moderate physical activity levels who received referrals from medical specialists and cardiologists. Participants were randomly assigned to either a control group receiving aerobic exercise or an intervention group receiving JPMR along with aerobic exercise. The duration of the intervention was four weeks with five sessions per week. Outcome measures included BP, heart rate (HR), respiratory rate, rate-pressure product, and QoL (assessed via the SF-36 questionnaire) and were recorded at baseline and post-intervention. Within-group analyses demonstrated statistically significant improvements in all measured cardiopulmonary parameters and quality of life scores after four weeks in both groups. Between-group comparisons indicated significant differences only in the 'role limitation due to physical health' component and the 'health change' domain of the SF-36 questionnaire. The findings suggest that both JPMR and aerobic exercise independently produce significant improvements in cardiopulmonary parameters and QoL among stage 1 hypertensive individuals. However, combining JPMR with aerobic exercise did not yield additional statistically significant benefits beyond those achieved by either intervention alone.

## INTRODUCTION

Hypertension, commonly referred to as elevated blood pressure, is a major global health concern<sup>[1]</sup>. Due to the absence of symptoms and its association with increased mortality rates worldwide, it is also labelled as “a silent killer”<sup>[1]</sup>. The risk of common CVDs, including heart failure (HF), stroke, coronary artery disease (CAD), and chronic kidney disease (CKD), is associated with hypertension<sup>[2]</sup>. Timely management of hypertension may help prevent further associated complications while controlling mortality and morbidity rates<sup>[3]</sup>.

Several regulatory systems undergoing complex interactions constitute the pathophysiology of hypertension. Increased sympathetic nervous system (SNS) activity, dysregulation of the renin-angiotensin-aldosterone system (RAAS), and increased sodium retention leading to volume expansion are some of the key mechanisms leading to increased vascular resistance and cardiac afterload, which are central to causing and maintaining increased BP<sup>[4]</sup>. American College of Cardiology (ACC) and American Heart Association (AHA) guidelines published in the year 2017 documented normal BP as systolic <120 and diastolic <80 mm Hg (3). Systolic 120–129 and diastolic <80 mm Hg is considered increased BP, while stage 1 hypertension is characterized by systolic 130–139 or diastolic 80–89 mm Hg<sup>[3]</sup>. Stage 2 hypertension is defined as systolic blood pressure = 140 mmHg or diastolic blood pressure = 90 mmHg<sup>[3]</sup>.

First-line or conservative management of hypertension includes nonpharmacological interventions, and hence lifestyle modifications, including regular physical activity, are an effective measure for managing hypertension, according to the WHO<sup>[5]</sup>. Aerobic exercise (involving sustained rhythmic muscle activity) is a critical addition to exercise prescriptions for hypertensive patients, as it improves oxygen consumption<sup>[6]</sup>. The American Heart Association and the American College of Sports Medicine guidelines recommend aerobic exercise of moderate intensity for at least half an hour on most days of the week or high-intensity exercise for at least 20 minutes on 3 days per week<sup>[6]</sup>. A significant decrease in BP measures was recorded with aerobic training of a minimum of 4 weeks, particularly among hypertensive individuals and those with related metabolic conditions<sup>[7]</sup>, according to research. Autonomic adaptations, including increased parasympathetic tone, improved baroreflex sensitivity, and decreased SNS activity and peripheral vascular resistance, collectively mediate these effects<sup>[8]</sup>.

In addition to aerobic exercise, relaxation techniques such as Jacobson’s Progressive Muscle Relaxation (JPMR) may result in reduced muscle tension and modulated ANS activity<sup>[9]</sup>. JPMR helps with both physical and mental relaxation while initiating systematic tensing and subsequent relaxation of major muscle groups, progressing from distal to proximal regions<sup>[10]</sup>. While JPMR helps with stress-related issues and anxiety relief, it can also be very helpful if practised more often than not in a routine. Since vasodilation reduces peripheral resistance, which in turn lowers BP, muscular relaxation therapy modifies the balance between vasoconstriction and vasodilation. Moreover, decreased cortical arousal and sympathetic output lead to decreased vascular smooth muscle tone, thus lowering BP<sup>[11]</sup>. Moreover, improved venous return and reduced peripheral resistance are added benefits of JPMR<sup>[12]</sup>.

A study was conducted in India to investigate the effects of aerobic exercise versus the JPMR technique on patients with hypertension, recruiting 20 hypertensive adults aged 25-55. They were randomly assigned to two groups: one performed aerobic exercise (30-45 minutes long, 5 sessions per week for 4 weeks), and the other practised JPMR (30 minutes long, 5 sessions per week for 4 weeks). Both interventions resulted in significant reductions in SBP, DBP, and HR, but the group engaged in aerobic exercise showed greater improvements: SBP decreased by 6 mmHg, DBP by 2.3 mmHg, and HR by 4.3 bpm, while the JPMR group saw reductions of 3 mmHg (SBP), 2 mmHg (DBP), and 2.2 bpm (HR). It was concluded that aerobic exercise is more effective than JPMR for lowering BP in hypertensive patients<sup>[13]</sup>.

While both aerobic exercise and JPMR have been independently shown to improve cardiopulmonary function and QoL in hypertensive populations, there is limited research addressing the combined effects of these interventions. Exploring the additive impact of JPMR alongside aerobic exercise is of clinical importance, as it may offer effective strategies for blood pressure control and holistic patient well-being. This study aims to address this gap by investigating whether a combined approach yields better improvements in cardiopulmonary parameters and QoL compared to either intervention alone in individuals with stage 1 hypertension.

## MATERIALS AND METHODS

This study used a non-blinded RCT design conducted over one year from May 2024 to May 2025 at Foundation University College of Physical

Therapy and Fauji Foundation Hospital, Rawalpindi. Ethical approval was obtained from the Ethical Review Committee of Foundation University Medical College (ERC No. FF/FUMC/215-503 Phy/24), and the trial was registered with ClinicalTrials.gov (NCT06997445). Written informed consent was obtained from all participants prior to enrollment, who were fully briefed on the purpose and procedures of the study. Confidentiality of the participants and their data was maintained throughout the research process.

The sample size was calculated using G\*Power software, resulting in a target of 40 participants to achieve adequate statistical power. Participants were recruited via referral from medical specialists and cardiologists using a non-probability purposive sampling strategy. Eligible subjects included males and females aged 18 to 45 years, diagnosed with stage 1 hypertension based on ACC/AHA criteria, and classified as having mild to moderate physical activity levels according to the International Physical Activity Questionnaire (IPAQ). Individuals with unstable angina, recent myocardial infarction, severe neurological, musculoskeletal, or gynecological conditions, as well as morbid obesity, were excluded to minimize confounding factors.

Following enrollment, random allocation of the participants into two groups was done. The control group underwent aerobic exercise interventions consisting of treadmill walking, stepping, and stationary cycling. The experimental group received the same aerobic exercise program combined with Jacobson's Progressive Muscle Relaxation (JPMR) technique. Both interventions were administered five days per week for a duration of four weeks.

Outcome measures were collected at baseline and after the four-week intervention period. Systolic and diastolic BP were measured using a validated cardiac monitor, while HR was recorded via pulse oximetry. Respiratory rate was determined by counting breaths per minute. The rate-pressure product (RPP) was calculated as the product of HR and SBP to assess myocardial workload. QoL was evaluated using the 36-Item Short Form Health Survey (SF-36) questionnaire, which included multiple domains reflecting physical and mental health status.

SPSS version 21.0 was used to conduct the statistical analysis. Both quantitative and qualitative variables were analyzed. The normality of data distribution was assessed, and due to violations of normality assumptions, non-parametric tests (the Mann-Whitney U test for between-group comparisons and the Wilcoxon Signed-Rank test for within-group changes over time) were used. A

p-value of less than 0.05 was considered statistically significant.

## RESULTS AND DISCUSSIONS

A total of 40 participants were involved in the study, with a mean age of  $40.13 \pm 5.14$  years. The average weight and height were  $70.55 \pm 9.09$  kg and  $166.1 \pm 9.88$  cm, respectively, with a mean body mass index (BMI) of  $25.57 \pm 3.03$  kg/m<sup>2</sup>. Baseline demographic comparisons revealed statistically significant differences between groups in age ( $p = 0.017$ ) and BMI ( $p = 0.032$ ), while height ( $p = 0.499$ ) and weight ( $p = 0.190$ ) showed no significant difference (see Table 1).

Both the experimental and control groups showed statistically significant lowered systolic and diastolic blood pressure after four weeks of intervention ( $p < 0.001$  within each group). The median SBP decreased from 135 mmHg to 130 mmHg in both groups, with no statistically significant difference between groups at baseline ( $p = 0.633$ ) or post-intervention ( $p = 0.113$ ) (Table 2). Similarly, diastolic blood pressure decreased significantly within groups, but between-group differences were not statistically significant at baseline ( $p = 0.057$ ) or after intervention ( $p = 0.966$ ) (Table 3).

Heart rate decreased significantly within both groups ( $p < 0.001$ ); however, no significant between-group differences were observed at either time point. Respiratory rate also showed a significant decline within groups ( $p < 0.01$ ) without significant between-group differences. See figure 1

QoL was assessed using the SF-36 questionnaire, covering multiple dimensions. Both groups demonstrated significant within-group improvements in all domains from baseline to post-intervention ( $p < 0.05$ ). Between-group analysis revealed statistically significant differences at baseline and post-intervention in the "Role Limitation due to Physical Health" domain ( $p = 0.035$  and  $p = 0.023$ , respectively) and the "Health Change" domain ( $p = 0.040$  and  $p = 0.037$ , respectively). Other QoL domains, including physical function, role limitation, emotional and social functioning, pain, general health, energy, and emotional well-being, showed improvements within groups but no significant differences between groups (Figure 2).

Overall, both the combined intervention (Jacobson's Progressive Muscle Relaxation plus aerobic exercise) and aerobic exercise alone produced significant improvements in cardiopulmonary parameters and QoL measures among individuals with stage 1 hypertension.



Fig. 1: Downward trends in heart rate and respiratory rate after intervention in both groups, with very similar trajectories



Fig. 2: SF-36 Domains

Though there existed no statistically significant differences between the groups, indicating that JPMR combined with aerobic exercise did not provide additive benefits over aerobic exercise alone within the four-week intervention period.

Despite the well-documented benefits of independent aerobic exercise and Jacobson's Progressive Muscle Relaxation (JPMR) technique, limited literature has explored their combined or additive effects on cardiopulmonary parameters and QoL in individuals with stage 1 hypertension. This study aimed to address this gap by evaluating the additive effects of JPMR with aerobic exercise on SBP, DBP, HR, RR, RPP, and QoL in patients with stage 1 hypertension. The interventions targeted both psychological (muscle relaxation) and physical (aerobic activity) aspects of health.

The significant within-group improvements observed across all measured domains in both the intervention and control groups highlighted the clinical relevance of both approaches. These findings suggest that JPMR and aerobic exercise, whether applied individually or together, represent viable, low-cost, and non-pharmacological treatment options for managing stage 1 hypertension and improving overall patient health. Significantly, the absence of additive effects does not diminish the effectiveness of each intervention, supporting their use as standalone therapies within clinical practice.

Contrary to assumptions, the current study didn't find statistically significant between-group differences in lowering SBP, DBP, or HR when comparing the combined JPMR and aerobic exercise intervention to aerobic exercise alone.

Table 1: Demographic Characteristics (Baseline)

Variable	Interventional Group (n=20) Mean ± SD	Control Group (n=20) Mean ± SD	p-value
Age (years)	38.20 ± 5.96	42.05 ± 3.31	0.017*
Height (cm)	165.05 ± 9.68	167.20 ± 10.20	0.499
Weight (kg)	72.45 ± 8.85	68.65 ± 9.16	0.190
BMI (kg/m <sup>2</sup> )	26.59 ± 3.18	24.55 ± 2.56	0.032*

\*Significant at p < 0.05

Table 2: Between-Group Analysis of Systolic Blood Pressure (mmHg)

Assessment Time	Interventional Group Median (IQR)	Control Group Median (IQR)	p-value
Baseline	135 (9)	135 (10)	0.633
After 4 weeks	130 (5)	130 (10)	0.113

Table 3: Between-Group Analysis of Diastolic Blood Pressure (mmHg)

Assessment Time	Interventional Group Median (IQR)	Control Group Median (IQR)	p-value
Baseline	92.5 (10)	90 (12.5)	0.057
After 4 weeks	85 (10)	85 (10)	0.966

Table 4: Between-Group Analysis of RPP

Assessment time	Interventional Group Mean ± SD	Control Group Mean ± SD	P-value
At Baseline	10826.7 ± 1027.49	10720.0 ± 1325.53	0.914
After 4 weeks	9570.7 ± 669.3	9853.6 ± 1134.9	0.645

Table 5: Within-Group Analysis of Cardiopulmonary Parameters

Parameter	Group	Baseline Mean ± SD	4 Weeks Mean ± SD	p-value
Systolic BP	Experimental	134.75 ± 4.7	127.5 ± 4.4	0.000
	Control	133.7 ± 5.9	129.8 ± 5.6	0.000
Diastolic BP	Experimental	93.5 ± 6.3	85.5 ± 5.8	0.000
	Control	89.5 ± 7.0	85.1 ± 5.04	0.000
Heart Rate	Experimental	80.35 ± 7.19	75.10 ± 5.08	0.000
	Control	80.15 ± 8.8	75.85 ± 7.4	0.000
Respiratory Rate	Experimental	17.80 ± 2.09	15.65 ± 2.6	0.000
	Control	17.95 ± 19.5	16.30 ± 2.8	0.008
RPP	Experimental	10826.7 ± 1027.49	9570.7 ± 669.3	0.000
	Control	10720.0 ± 1325.53	9853.6 ± 1134.9	0.000

Table 6: Within-Group Analysis of SF-36 Domains

Domain	Group	Baseline Mean ± SD	4 Weeks Mean ± SD	p-value
Physical Function	Experimental	79.5 ± 11.7	93.0 ± 4.9	0.000
	Control	86.25 ± 13.3	94.5 ± 5.3	0.002
Role Limitation Physical	Experimental	46.25 ± 35.6	75.0 ± 19.8	0.000
	Control	70.0 ± 35.9	88.75 ± 18.9	0.024
Role Limitation Emotional	Experimental	68.34 ± 43.8	100.0 ± 0.0	0.010
	Control	75.0 ± 44.4	100.0 ± 0.0	0.025
Social Functioning	Experimental	86.25 ± 16.6	97.5 ± 6.5	0.011
	Control	88.75 ± 15.6	95.63 ± 8.3	0.020
Pain	Experimental	72.13 ± 19.6	95.5 ± 9.2	0.001
	Control	74.5 ± 20.3	87.25 ± 15.3	0.006
General Health	Experimental	49.5 ± 11.4	54.75 ± 14.7	0.017
	Control	56.5 ± 10.2	59.25 ± 11.03	0.009
Health Change	Experimental	47.25 ± 16.0	46.25 ± 16.7	0.655
	Control	58.75 ± 18.6	58.75 ± 18.6	1.000
Energy	Experimental	50.75 ± 6.34	66.5 ± 8.59	0.000
	Control	53.0 ± 7.32	62.0 ± 9.51	0.000
Emotional Well-being	Experimental	64.4 ± 8.69	78.2 ± 6.55	0.000
	Control	69.4 ± 11.18	74.4 ± 10.08	0.000

This contrasts with the findings of Shinde *et al.*<sup>[14]</sup>, who reported distinct advantages for each intervention: significant reductions in SBP with aerobic exercise and in DBP with JPMR in stage 1 hypertensive patients. The present study's lack of between-group differences may be attributed to differences in sample size, intervention duration, or population characteristics.

Similarly, while both the intervention and control groups in this study showed significant reductions in BP, this contrasts with results reported by Avsar Rameshkumar *et al.*<sup>[13]</sup>, who found aerobic exercise to be more effective than JPMR alone for lowering blood pressure. In our study, the improvements in BP and HR were comparable

between groups, suggesting that aerobic exercise remains a sound element of non-pharmacological hypertension management, with JPMR providing no additional short-term benefit when combined. These findings align with the research by Liujiao Cao *et al.*<sup>[15]</sup>, who demonstrated significant improvements in HR, SBP, and DBP following aerobic exercise training in hypertensive patients, reinforcing aerobic exercise's role in cardiovascular regulation. Our results corroborate the positive impact of aerobic exercise on cardiopulmonary parameters, consistent with established evidence.

Regarding QoL outcomes, this study found statistically significant between-group differences in the "Role Limitation due to Physical Health"

domain at baseline and post-intervention. This suggests that combined therapy may offer particular advantages in improving physical role functioning, which reflects how physical health problems interfere with work or other daily activities. These findings are consistent with those of Mikel Tous *et al.*<sup>[16]</sup>, who reported meaningful enhancements in physical functioning and overall health status following aerobic exercise in physically inactive individuals with hypertension. Furthermore, Hasan Kara *et al.*<sup>[17]</sup> observed similar improvements in SF-36 subscales, including physical function, role limitation due to physical health, vitality, and mental health, after a supervised aerobic training program in hypertensive participants. Together, these findings highlight the important role of aerobic exercise not only in enhancing cardiovascular health but also in positively influencing both physical and mental dimensions of quality of life. They support the integration of aerobic exercise interventions as a critical strategy to help hypertensive individuals manage disease burden while improving their daily functioning and psychological well-being.

## CONCLUSION

While both JPMR and aerobic exercise significantly improve cardiopulmonary parameters and QoL in stage 1 hypertensive individuals, the present study did not demonstrate the additive effects of JPMR when combined with aerobic exercise over four weeks. These results suggest that aerobic exercise alone is an effective intervention and that JPMR may serve as a complementary, but not necessarily additive, adjunct. JPMR may still offer value by promoting relaxation and stress relief, even if it does not produce additive improvements in the measured outcomes within this time frame.

**Limitations:** The present research had several considerable limitations. First, the relatively small sample size (n=40) limits the generalizability of the findings and may have reduced the statistical power to detect subtle between-group differences or additive effects. Second, the intervention duration of four weeks, while sufficient to demonstrate within-group improvements, might have been too short to record longer-term or cumulative benefits of combining JPMR with aerobic exercise. Third, the non-blinded design may have introduced performance or reporting biases. Additionally, baseline differences in age and BMI between groups could have influenced outcomes despite statistical adjustments. Finally, the study population was restricted to physically active individuals aged 18 to 45 years with stage 1 hypertension, limiting

applicability to older adults, those with more severe hypertension, or individuals with comorbidities.

**Recommendations:** Researchers in the future may recruit larger and more diverse samples to improve external validity and statistical significance. Extended intervention periods and longer follow-up assessments are recommended to evaluate the sustained and potentially synergistic effects of combining JPMR with aerobic exercise on cardiopulmonary health and quality of life. Implementing blinded or assessor-blinded designs can reduce bias, and stratified randomization may help balance baseline characteristics across groups. Moreover, exploring the impact of these interventions in different hypertensive populations (including stage 2 hypertension, older adults, and individuals with comorbid conditions) would provide more comprehensive insights. Finally, including objective measures of autonomic function and patient adherence could strengthen the understanding of underlying mechanisms and facilitate modified clinical recommendations.

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