

**Effect of concentric and eccentric resisted exercise on blood pressure and heart rate in mild to moderate hypertensive individuals**Divya Khare<sup>\*</sup>, Manali Shah and Abhinav Sathe*Department of Physiotherapy, Ayushman College, 817, Sunkhedi via Danish Kunj, Kolar Road, Bhopal, M.P. India***\*Correspondence Info:**

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E-mail: [adivyakhare@gmail.com](mailto:adivyakhare@gmail.com)**Abstract****Aim:** To study and compare the effect of concentric and eccentric Resisted Exercise on resting blood pressure and heart rate in hypertensive individuals.**Methodology:** 30 hypertensive individuals were selected and randomized into two groups; Group A and B. Group A (n=15) performed concentric arm curls for 6 days and group B (n=15) performed eccentric arm curls for 6 days.**Result:** Significant changes were seen in eccentrically trained individuals.**Conclusion:** The short term Eccentric Resisted Exercise produces comparatively more reduction in resting blood pressure and heart rate than concentric type of resisted exercise in mild to moderate hypertensive subjects.**Keywords:** Concentric, Eccentric, Resisted Exercise, Hypertension**1. Introduction**

Blood pressure is the lateral pressure exerted on the wall of the vessels by the column of blood present in it. The maximum pressure, which occurs during systole, is called systolic pressure and the minimal pressure produced during diastole is called diastolic pressure. The difference between two pressures is called pulse pressure. The average of pressure produced during a cardiac cycle is known as mean pressure. It is calculated by taking the diastolic pressure and adding one third of pulse pressure.[1] Systolic pressure ranges from 100 to 130 mm of Hg with the average pressure being 120 mm of Hg. Diastolic pressure ranges from 60 to 80 mm of Hg and the average is 70 mm of Hg. Pulse pressure is the difference between systolic and diastolic pressures and is 50 mm of Hg. The mean arterial blood pressure ranges from 95 to 100 mm of Hg.[1] Hypertension, or more correctly blood pressure that is too high, is defined as a systolic pressure of  $\geq 140$  mm Hg and/or a diastolic pressure of  $\geq 90$  mm Hg, on repeated measurements under standardised conditions.[2, 3].

Hypertension is a significant independent risk factor for cardiovascular disease and the most important modifiable cause of mortality. More than 7 million deaths per year across the world are due to hypertension.[2] Hypertension is called "the silent killer" because it often causes no symptoms for many years, even decades, until it finally damages certain critical organs.[4] It induces a major cause of death and disability the world over. In middle-aged individuals, a

decrease of only 2mmHg in systolic blood pressure reduces cardiovascular mortality by 4%.[5] The risks associated with hypertension include stroke, heart failure, heart disease, myocardial infarction, renal failure, and kidney disease.[6]

Life-style modification is the first step in the treatment of hypertension; it includes moderate sodium restriction, weight reduction in the obese, decreased alcohol intake, and an increase in exercise.[7-9] Drug therapy is necessary when the above measures have not been successful or when hypertension is already at a dangerous stage (Grade 3) when first recognized.[7]

One of the common forms of non-pharmacologic prescription for hypertension is exercise. Adopting a healthy lifestyle is critical for the prevention of high blood pressure and is an indispensable part of the treatment of those with hypertension. Higher levels of physical activity and greater fitness are associated with a reduced incidence of hypertension. Engaging in regular aerobic physical activity, such as brisk walking, for at least 30 min/day, most days of the week, as a means to lower blood pressure.[10,11]

Resistance exercise has been shown to reduce both systolic and diastolic blood pressure by 3-5mmHg by increasing parasympathetic tone and thereby reducing peripheral vascular resistance.[5] Other possible physiological explanations could be that resistance training changes the muscular composition, increases diameter of already existing

arteries and veins, promotes angiogenesis (i.e., new vessel growth) and/or improves the vasodilatory capacity.<sup>12</sup> As a consequence it could reduce the peripheral resistance and blood pressure at rest.[3,13,14]

## 2. Subjects And Methods

The Study design was a comparative experimental study. Physicians diagnosed mild to moderate hypertensive individuals, were included in the study. Out of 52 hypertensive individuals 30 were selected and randomised into two groups; Group A and B. After fulfilling the inclusion and exclusion criteria; detailed assessment was taken for each patient. Prior to the participation in study the patients were explained about the procedure and their consent was taken for voluntary participation.

### 2.1 Protocol

**Procedure:** 30 hypertensive individuals were selected and randomised into two groups; Group A and B. Group A (n=15) performed concentric arm curls for 6 days and group B (n=15) performed eccentric arm curls for the next 6 days.

**Mode of exercise:** The subjects were tested in the sitting position .Concentric muscle actions were performed by raising the dumbbell from the fully extended to the fully flexed position of the forearm (i.e. concentric curls). Eccentric muscle actions were performed by lowering the

dumbbell from the fully flexed position to the fully extended position of the forearm (i.e. Eccentric curls). The duration of each arm curl lasted for 3-sec and followed by a 2 sec period in which the arm and the dumbbell were passively returned to the starting position by physiotherapist that is approximately 12 curls per minute.

**Experiment protocol:** All the individuals were screened and assessed for 1-RM for unilateral concentric curls on day one. The results of 1-RM test were used to determine the resistance to be used during the experiment. Additionally, each subject was familiarized with the testing protocol as subjects were trained to perform concentric (for group A) or eccentric (group B) biceps curls. After 2 days the exercise session was started. The subjects were given warm up exercises for 5 minutes before the exercise session. Exercise training consists of 3 sets of 12 repetitions of unilateral concentric or eccentric curls by using a workload representing 50% of their 1-RM for the curls. 2 minutes rest between the sets was given to avoid overtraining. Progression was made according to Delorme’s principle. Outcome measures were evaluated before and after the exercise. First measurement included resting heart rate, resting blood pressure and 1- RM. Second measurement was taken 24 hours after the last exercise session.

SUMMARY OF PROCEDURE		
	Group A (n=15)	Group B (n=15)
Warm up period (before exercise session)	5 minutes	5 minutes
Experimental protocol	3 sets of 12 repetition of unilateral concentric arm curls	3 sets of 12 repetition of unilateral eccentric arm curls
Work load	50% of 1 RM	50% of 1 RM
Rest period	2 minutes rest between each set	2 minutes rest between each set
Progression of workload	As per Delorme’s principle	As per Delorme’s principle
Duration of training	6 days	6 days

## 3. Results

Table 1: Comparison of pre and post training values of systolic blood pressure (SBP) within Group A and Group B.

Variable	Group	Pre (Mean ± SD)	Post (Mean ± SD)	Mean Difference	t- Value	Statistical Significance
SBP	A	151.2000 ± 6.83687	149.2000 ± 7.24273	2.000	2.646	P= 0.019, S
	B	151.0667 ± 7.51633	148.0000 ± 6.67618	3.067	5.996	P= 0.000, S

\*S- significant (p <0.05) NS- not significant (p >0.05)

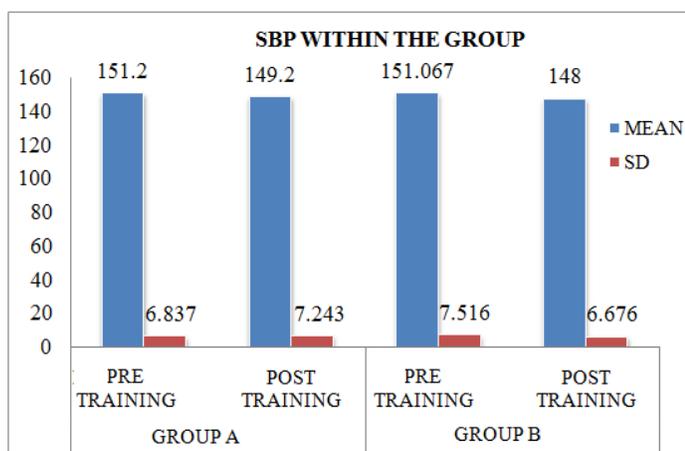


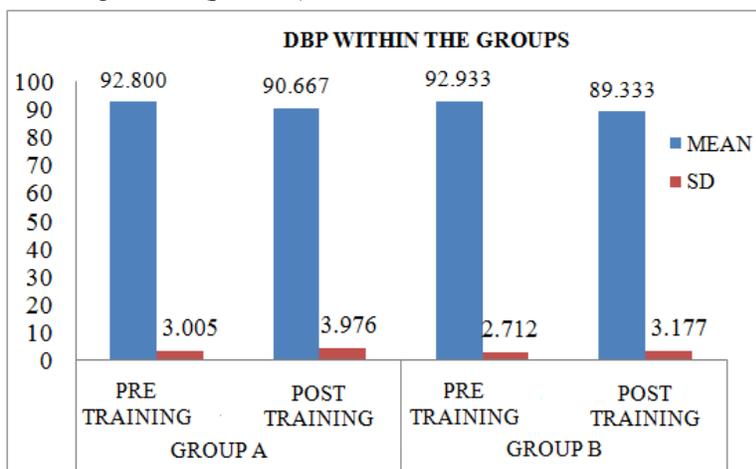
Figure 1: Comparison of mean and SD of Systolic Blood Pressure (SBP) within the groups.

There is significant difference of pre and post training values of SBP in patients performed concentric resisted exercise.  
 There is significant difference of pre and post training values of SBP in patients performed eccentric resisted exercise.

**Table 2: Comparison of pre and post training values of diastolic blood pressure (DBP) within Group A and Group B.**

Variable	Group	Pre (Mean ± SD)	Post (Mean ± SD)	Mean Difference	t- Value	Statistical Significance
DBP	A	92.8000 ± 3.00476	90.6667 ± 3.97612	2.133	4.000	P= 0.001, S
	B	92.9333 ± 2.71153	89.3333 ± 3.17730	3.600	7.407	P= 0.000, S

\*S- significant (p <0.05) NS- not significant (p > 0.05)



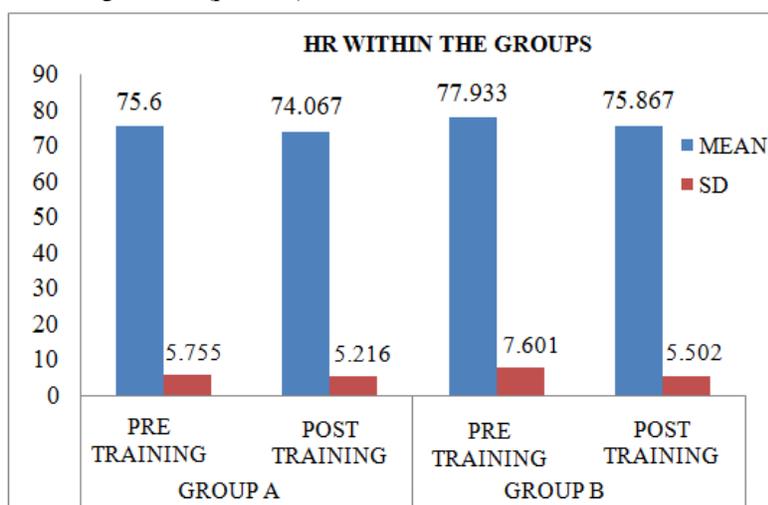
**Figure 2: Comparison of mean and SD of Diastolic Blood Pressure (DBP) within the groups.**

There is significant difference of pre and post training values of DBP in patients performed concentric resisted exercise.  
 There is significant difference of pre and post training values of DBP in patients performed eccentric resisted exercise.

**Table 3: Comparison of pre and post training values of heart rate (HR) within Group A and Group B**

Variable	Group	Pre (Mean ± SD)	Post (Mean ± SD)	Mean Difference	t- Value	Statistical Significance
HR	A	75.6000 ± 5.75450	74.0667 ± 5.21627	1.533	1.907	P= 0.77, NS
	B	77.9333 ± 7.60138	75.8667 ± 5.50151	2.067	2.277	P= 0.039, S

\*S- significant (p <0.05) NS- not significant (p >0.05)



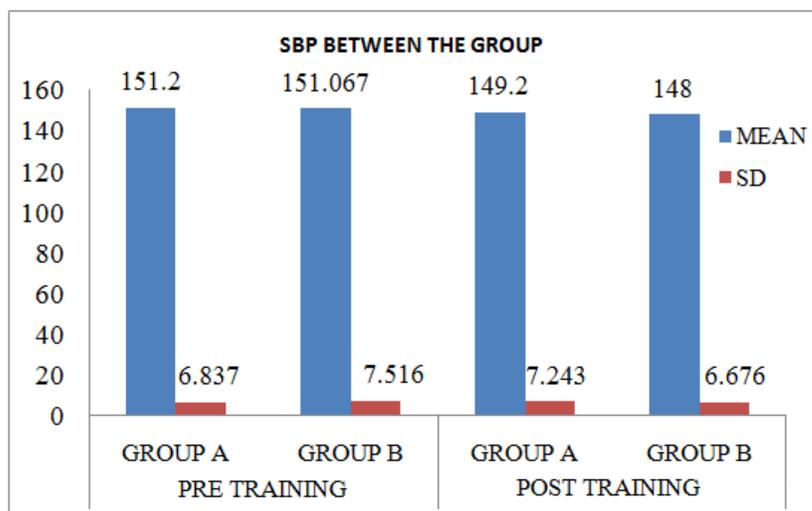
**Figure 3: Comparison of mean and SD of Heart Rate (HR) within the groups.**

There is no significant difference of pre and post training values of HR in patients performed concentric resisted exercise.  
 There is significant difference of pre and post training values of HR in patients performed eccentric resisted exercise.

**Table 4: Comparison of pre and post training values of systolic blood pressure (SBP) between Group A and Group B**

Variable	Training	Group A (Mean ± SD)	Group B (Mean ± SD)	t-Value	Statistical Significance
SBP	Pre	151.2000 ± 6.83687	151.0667 ± 7.51633	0.051	P= 0.960, NS
	Post	149.2000 ± 7.24273	148.0000 ± 6.67618	0.472	P= 0.641, NS

\*S- significant (p <0.05) NS- not significant (p >0.05)



**Figure 4: Comparison of mean and SD of Systolic Blood Pressure (SBP) between the groups.**

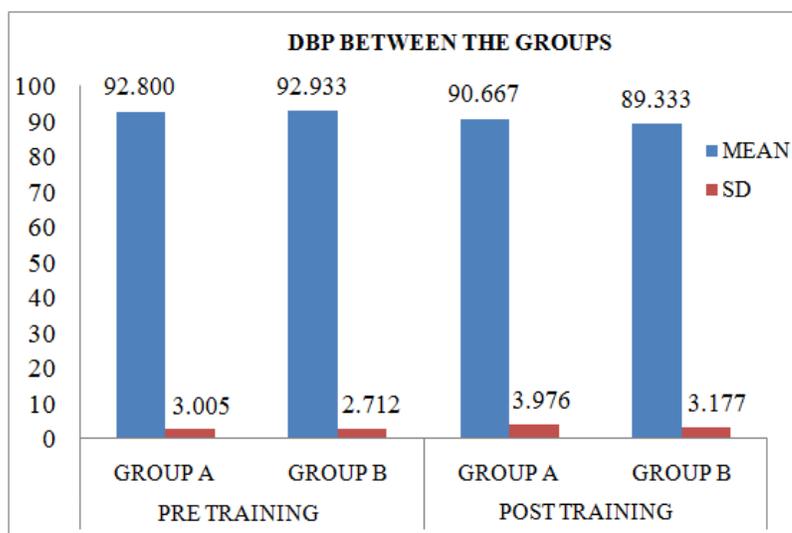
There is no significant difference of pre training values of HR in patients performed Concentric Resisted Exercise and Eccentric Resisted Exercise.

There is no significant difference of post training values of HR in patients performed Concentric Resisted Exercise and Eccentric Resisted Exercise.

**Table 5: Comparison of pre and post training values of diastolic blood pressure (DBP) between Group A and Group B**

Variable	Training	Group A (Mean ± SD)	Group B (Mean ± SD)	t-Value	Statistical Significance
DBP	PRE	92.8000 ± 3.00476	92.9333 ± 2.71153	0.128	P= 0.899, NS
	POST	90.6667 ± 3.97612	89.3333 ± 3.17730	1.015	P= 0.319, NS

\*S- significant (p <0.05) NS- not significant (p >0.05)



**Figure 5: Comparison of mean and SD of Diastolic Blood Pressure (DBP) between the groups.**

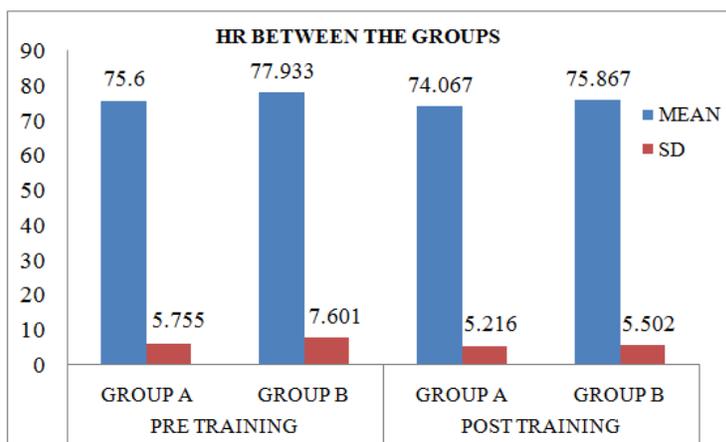
There is no significant difference of pre training values of DBP in patients performed Concentric Resisted Exercise and Eccentric Resisted Exercise.

There is no significant difference of post training values of DBP in patients performed Concentric Resisted Exercise and Eccentric Resisted Exercise.

**Table 6: Comparison of pre and post training values of heart rate (HR) between Group A and Group B**

Variable	Training	Group A Mean ± SD	Group B Mean ± SD	t-Value	Statistical Significance
HR	PRE	75.6000 ± 5.75450	77.9333 ± 7.60138	0.948	P= 0.351, NS
	POST	74.0667 ± 5.21627	75.8667 ± 5.50151	0.920	P= 0.366, NS

\*S- significant (p <0.05) NS- not significant (p >0.05)



**Figure 6: Comparison of mean and SD of Heart Rate (HR) between the groups.**

There is no significant difference of pre training values of HR in patients performed Concentric Resisted Exercise and Eccentric Resisted Exercise.

There is no significant difference of post training values of HR in patients performed Concentric Resisted Exercise and Eccentric Resisted Exercise.

#### 4. Discussions

Results of present study accepts experimental hypothesis that Eccentric resisted exercise is more effective clinically than Concentric resisted exercise, on outcome of resting blood pressure and heart rate in hypertensive clients and the alternate hypothesis is cancelled.

Resistance training can affect virtually all major aspects of cardiovascular functions. Changes in Cardiac morphology, systolic and diastolic function, heart rate, blood pressure and the lipid profile indicate both cardiovascular functions and health, and cardiovascular risk. Studies done in the past have focused on the information concerning the cardiovascular responses and adaptations to resistance training.[6,15-17] and most of the studies defined the cardiovascular changes during exercise.[18-22] However, those studies were not concentrated on effect of any particular type of resistance training on resting blood pressure and resting heart rate in hypertensive subjects. So, the present study was aimed at bridging this gap. In the present study a comparative study was conducted on 30 individuals between 30 to 50 years of age group (17 males and 13 females) with mild to moderate hypertension. Individuals were divided into two groups, individuals in Group A (n=15) performed Concentric resisted exercise and individuals in Group B (n=15) performed eccentric resisted exercise for 6 days consequently. The study was conducted to find out whether Concentric or Eccentric resisted exercise is more effective in reduction of heart rate and blood pressure in hypertensive individuals. Results of the present study showed that there was a significant reduction in both systolic and diastolic blood pressure in both the groups, but no statistically significant difference existed between the groups. Here, Group B subjects showed marked reduction in blood pressure, especially in diastolic blood pressure (p= 0.000). While there is no significant reduction found in heart rate in Group A subjects (p=0.77).The reason for changes in blood pressure

might be its affect on pathophysiology of hypertension. Blood pressure is the product of cardiac output and systemic vascular resistance. It follows that patients with arterial hypertension may have an increase in cardiac output, an increase in systemic vascular resistance, or both. In middle and old aged individuals, increased systemic vascular resistance and increased stiffness of the vasculature play a dominant role.[6]

It is known that aerobic exercise training reduces arterial stiffness and blood pressure.[12,13] Collier *et al* tested the effect of aerobic and resisted training on arterial stiffness and blood pressure in pre and stage-1 hypertensive individuals. They suggested increases in arterial stiffness but reduction in both systolic and diastolic blood pressure with resisted training, it seems there was a compensatory increase in flow in the microvasculature as there was increase in reactive hyperaemia and greater increases in vasodilatory capacity with resistance training than aerobic training, which may offset the increases in arterial stiffness.[12] In the present study there was also significant reduction in resting heart rate in the eccentric resisted training than concentric training. The results suggest the possibility that the difference in muscle contraction modes causes change in resting heart rate values. Miller *et al* suggested that the maximum load one can successfully lift in the eccentric condition may be greater than that in the concentric conditions.[22] So, one may theorize that when the muscles were used to perform eccentric exercise, less work was done and less energy was expended than concentric exercise. Because of the varying exercise conditions, if muscles are under less stress, the energy, blood, and oxygen requirements are not as great as that would be if a muscle were under greater stress, and thus, the cardiac response would not be as great. This finding is in agreement with those of LaStayo *et al*[23], in which the oxygen demand of muscles during eccentric training was less than the oxygen requirements during concentric training.

We found that as little as 6 days of exercise training can decrease systolic and diastolic blood pressure in both training groups, with more reduction in eccentric training group, which is identified as the primary goal in hypertension therapy.[24] Thus, the phenomenon as a result of eccentric resisted training may produce beneficial effects on the prevention of progression of hypertension.

## 5. Conclusion

The short term Eccentric Resisted Exercise produces comparatively more reduction in resting blood pressure and heart rate than concentric type of resisted exercise in mild to moderate hypertensive subjects. Thus we can speculate that for treatment of hypertension, long term eccentric resisted exercise can be performed for more benefits on resting blood pressure. And when long term strength training exercises are to be performed in persons with hypertension, eccentric resisted exercises will prove to be more beneficial.

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