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ORIGINAL ARTICLE

COMPARATIVE EFFECT OF FORWARD STAIRCASE CLIMBING VERSUS BACKWARD STAIRCASE CLIMBING TRAINING ON CARDIO RESPIRATORY PARAMETERS FOR SUBJECTS WITH HYPERTENSION

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Abstract

Background and Objective: *Forward staircase climbing and backward staircase climbing training, individually have found to be effective in cardiorespiratory parameters such as blood pressure, heart rate in subjects with hypertension. The purpose of this study was to find the comparative effect of forward staircase climbing versus backward staircase climbing training on cardio respiratory parameters for subjects with hypertension.* ***Methods:*** *An experimental study design, 40 subjects with hypertension were randomized into 20 subjects each group; forward staircase climbing group and backward staircase climbing group. Forward staircase climbing group received forward staircase training while backward staircase climbing group received backward staircase training for 4 weeks. Outcome measures such as heart rate, blood pressure were measured before and after four weeks of training.* ***Results:*** *Analysis of means within the groups found that there is statistically significant improvement in means of blood pressure and heart rate in forward stair climbing and in backward stair climbing groups. When post-intervention means were compared between the groups there was no statistically significant difference in means of heart rate and blood pressure.* ***Conclusion:*** *The present study concluded that the forward staircase climbing and backward staircase climbing training found significantly effective in improvement of cardiorespiratory parameters such as blood pressure and heart rate for subjects with hypertension. However, forward stair climbing shown to have greater percentage of improvement on cardiorespiratory parameters than backward stair climbing technique.*

Key words: *Hypertension, Heart rate, Blood pressure, Harvard 3 minute step test, forward staircase climbing, backward staircase climbing.*

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INTRODUCTION

Hypertension (HTN) is a progressive cardiovascular (CV) syndrome arising from complex and interrelated etiologies. Hypertension is usually defined by the presence of a chronic elevation of systemic arterial pressure above a certain threshold value. However, increasing evidence indicates that CV risk associated with elevation of blood pressure (BP) above approximately 115⁄75 mm Hg increases in a log-linear fashion up to 140/90 mmHg or above most of the time.[1,2,3,4,5] HTN is a modern epidemic. India's population is large and the absolute number of people with HTN is quite high. With over 139 million patients, India accounts for 15 per cent of world's uncontrolled hypertension patients. Prevalence rates are high among men than among women, nearly one in fifth young adults between ages of 24 and 32 has high blood pressure.[6,7] Hypertension is also a major risk factor for heart disease, stroke, aneurysms of the arteries (e.g. aortic aneurysm), peripheral arterial disease and chronic kidney disease. The risks increase as the age and the figure rises to 60 percent of all adults over age 65.[8]

The combination of regular physical activity and weight control can reduce the risk of HTN in both sexes regardless the level of obesity.[9] Emily D. Parker studied the relation between the physical activity and an incident hypertension in younger adults in the development of coronary artery risk and concluded that physical activity merits attention in the prevention of incident hypertension among young adults, particularly as they move into middle age.[10]

Exercise program may lead to additional benefits when combined with the lifestyle interventions.[10] Thus, patients are advised to take up a modest level of aerobic exercise on a regular basis, such as walking, jogging, and swimming at least for 30-45minutes, three to four times a week.[10]

Staircase climbing is a simple, inexpensive, a common training procedure and it is patient directed treatment that has been reported to be highly associated with cardiovascular and fitness benefits.[11] Stair climbing has some advantages over running. It's more challenging because the body weight is being lifted against the gravity. Stair climbing serves as a feasible opportunity to remain physically active within everyday-life. Sharon Klopfenstein in their study concluded that stepping exercise has been shown to increase cardio-respiratory fitness in healthy adults and increase physical function in patients with peripheral vascular disease. Stair case climbing promotes autonomic nervous system function and lower heart rates, which each decreases the risk of developing diabetes, independent of body mass.[12]

Forward staircase climbing (FSC) shown improved resting and exercise heart rate, perceived exertion and dynamic balance performance in healthy individuals and also contribute to better overall fitness, reduced fall risk, and less perceived strain during daily life activities.[12] Wise et al., examined the effects of health promotion Intervention by use of stairs, and concluded that the benefits of regular physical activity like stair case climbing helps to control and prevent the cardiovascular risk and premature mortality. They stated that 10 minutes of stair climbing a day promotes in achieving and maintaining healthy weight, decreasing in the blood pressure and insulin resistance.[13]

Backward staircase climbing (BSC) found significant greater metabolic responses. Backward walking at low intensity elicits similar oxygen consumption as forwardwalking. Due to the seeming awkwardness of the act of climbing the stairs backward, the subject's cardio vascular system will task more, thus results in better improvement in their cardiovascular system.[11,12]

Tsun-Yu Woo et al., studied the difference in energy consumption and muscular strength due to forward and backward exercise, mainly the walking, jogging and climbing stairs and they concluded that leg muscles are trained more efficiently by backward climbing stairs than forward climbing stairs, due to the

backward movement can generate higher heart rate by slower speed than the forward movement, thus the backward walking and jogging can maintain cardio-respiratory fitness and consume body energy more effectively than forward movements.[14]

Research examining both the forward and backwards stair climbing exercise independently is widely available, yet no research has directly examined the comparative effect between these two training for assessing cardiorespiratory parameters in subjects with HTN. Therefore, the present study with research question, whether there is a difference in forward versus backward stair climbing training on cardio respiratory parameters in subjects with hypertension? Therefore, the purpose of the study is to find the short term comparative effect of FSC and BSC on Cardiorespiratory parameters such as Blood pressure and Heart rate on performance of 3min Harvard step test for subjects with HTN. It was null hypothesized that there will be no significant difference between forward versus backward staircase climbing on cardio respiratory parameters such as heart rate, blood pressure on performance of 3 minute Harvard step test in subjects with hypertension.

METHODOLOGY

This is an experimental study with two groups: Group-A and Group-B. As this study involved human subjects the Ethical Clearance was obtained from the Ethical Committee of KTG College of Physiotherapy and K.T.G. Hospital, Bangalore as per the ethical guidelines of Bio-medical research on human subjects. This study was registered under Rajiv Gandhi University of Health Sciences. The subjects were registered for dissertation with registration number 09_T031_47186. Subjects included in the study were with history of hypertension with minimum 3 years of duration, American college of HTN criteria for classification and reporting of HTN, both male and female subjects with age group between 25 to 55 years, optimal Body mass Index (18.5-24.9 kg/m2), subjects who involved in mild to moderate physical activities, willingness to participate in the study. Subjects were excluded with structural abnormality e.g. kypho-scoliosis, recent cardiac surgery and abdominal surgery, any medical condition likely to interfere with active training e.g. uncontrolled angina, evidence of paralysis and weakness of lower limb muscles. Subjects were recruited and study was conducted at KTG Hospital, Bangalore. Subjects who meet inclusion criteria were recruited by Simple random sampling method using closed envelops, randomly allocated subjects into two groups. Subjects who meet inclusion criteria were informed about the study and a written informed consent was taken. Total 40 Subject (n=40), 20 in each group completed the studied. Total duration of training was for four weeks, 5 sessions per week.

Procedure for Forward staircase climbing (FSC) Group: Subjects received verbal instruction and visual demonstration of the stair climbing from the examiner. A wooden step ladder with four steps about 15cm high on the ascent side, and three steps 20cm high on the descent side, was used for the stair climbing training program. Its total height was 60cm and its gradient on the ascent and descent sides were 0.67 and 0.91 respectively. All steps were 50cm wide. Participants in the FSC group ascended and descended the stepladder in the forward direction without holding the rails. Each ascent and descent lasted a total of eight seconds, with the participant's alternate foot stepping on a stair every second as the researcher made a count of 1 to 8. The subjects had three repeated ascents and descents per session during week 1 of the training. Progression: The training program was progressed as follows: Weeks 2: 6 ascents and descents/session; Weeks 3: 9 ascents and descents/session; Weeks 4: 12 ascents and descents/session.

Procedure for intervention for backward staircase climbing (BSC) Group: Participants in the BSC group ascended and descended the stepladder as explained in FSC group but in the backward direction. Pace and progression

were the same as for the forward stair climbing group.

Subject in both the groups were advised to continue their regular physical activities but not aerobic and resistance exercises.

Outcome Measurements:

The subject's left arm brachial artery blood pressure in sitting and heart rate was measured before and after Harvard 3 minute step test in both the groups before and after four weeks of training. Before 3 minutes pre-exercise Harvard 3 minute step and after Harvard 3 minute step, post-exercise 3 minutes rest, brachial artery blood pressure in sitting and heart rate was measured in both the groups.

Harvard 3 minute step test: Step benches (male = 40cm high, 28cm wide; female = 30cm high, 28cm wide), were used for this test. The subjects were dressed in light apparel. A cadence of 96 beats per minute was set with the metronome to achieve a pace of 24 steps per minute. A complete step consists of four counts thus: 1.One foot placed on the bench – one foot; 2. The second foot placed on the bench; 3. The first foot withdrawn to the floor; 4. The second foot withdrawn to the floor. Stepping up and down was done as long as the participant maintained pace with the metronome or showed no evidence of fatigue for a period of 3 minutes. Immediately after the test, the subject was asked to sit on a comfortable.[11]

Blood pressure: Sphygmomanometer and stethoscope was used to determine the arterial blood pressure using the conventional method. Measurement was taken with the subject in sitting position, with the arms horizontally supported at the heart level. The brachial artery was occluded by a cuff placed around the upper arm and inflated to above systolic pressure. As it is gradually deflated, pulsatile blood flow is re-established and accompanied by sounds that can be detected by a stethoscope held over the artery just below the cuff. The sounds are originated from a combination of turbulent blood flow and oscillations of the arterial wall. The onset of sounds corresponds to the systolic pressure and disappearance of sounds corresponds to diastolic pressure. Diastolic and systolic blood pressures were recorded in mmHg. Validity for sphygmomanometer measurement was found from the different study and inter tester reliability was tested, studies have found that the excellent reliability in measurement and thus is recommended that sphygmomanometers are maintain and calibrated regularly to ensure the pressure scale remains accurate to within +/-3mmHg. It has been stated that the mercury sphygmomanometer always has been regarded as the gold standard for clinical measurement of blood pressure.[15, 16]

Heart Rate (Pulse rate): The subject's radial pulse was taken in beats per minute, with the forearm slightly pronated and the wrist slightly flexed. The subject was instructed to sit comfortably and the therapist placed his/her index and middle fingers together on the subjects wrist, about 1/2 inches on the inside of the joint, in line with the index finger. Once a pulse is found, the number of beats is counted within a one minute period. Timing was done with a stopwatch. Studies have shown good reliability and validity for the measurement of heart rate.17

Statistical Methods:

Descriptive statistical analysis was carried out in the present study. Out Come measurements analyzed are presented as mean ± SD. Significance is assessed at 5 % level of significance with p value was set at 0.05 less than this is considered as statistically significant difference. Paired 't' test as a parametric and Wilcoxon signed rank test as a non-parametric test have been used to analysis the variables pre-training to post-training with calculation of percentage of change. Independent 't' test as a parametric and Mann Whitney U test as a non-parametric test have been used to compare the means of variables between groups with calculation of percentage of difference between the means. The Statistical software namely SPSS 16.0, Stata 8.0, MedCalc 9.0.1 and Systat 11.0 were used for the analysis of the data and

Microsoft word and Excel have been used to generate graphs, tables etc.

RESULTS

The study carried on total 40 subjects (Table-1) in Forward staircase climbing group there were 20 subjects with mean age 35.70 years and there were 14 males and 6 females were included in the study. In Backward staircase climbing Group there were 20 subjects with mean age 36.75 years and there were 14 males and 6 females were included in the study. There is no statistically significant difference in mean ages between the groups.

When means were analyzed within the FSC Group and BSC group (Table-2,3, 4 and 5) shows that there is a statistically significant change in means of Diastolic and systolic blood pressure and Heart Rate when means were analyzed from pre intervention to post intervention measurements within the group with negative percentage of change showing that there is decrease in the post means and with positive percentage of change showing there is increase in post means. There is a no clinical significance effect with small to medium effect size.

When pre and post intervention means were compared (Table-6) between groups shows that there is no statistically significant change in means of systolic and Diastolic blood pressure, and Heart Rate when means were analyzed compared between the groups with negative percentage of change showing that there is decrease in the post means and with positive percentage of change showing there is increase in post means. There is a no clinical significance difference effect with small effect size.

Basic Characteristics of the subjects studied		**Forward staircase climbing group**	**Backward staircase climbing Group**	**Between the groups Significance[a]**
Number of subjects studied (n)		20	20	--
Age in years (Mean± SD)		35.70± 6.07 (26-47)	36.75± 4.37 (29-45)	p= -0.827 (NS)
Gender	Males	14	14	----
	Females	6	6	

Table 1: Basic Characteristics of the subjects studied

Forward staircase climbing Group	**Pre training - before Havard step test Mean±SD (min-max)**	**Pre training - after Havard step test Mean±SD (min-max)**	**Post training before Havard step test Mean±SD (min-max)**	**Post training after Havard step test Mean±SD (min-max)**
Systolic blood pressure	136.30± 7.58 (125- 148)	137.85±6.99 (127-148)	132.25± 7.18 (120-145)	129.75± 5.25 (120-140)
Diastolic Blood pressure	91.05± 4.55 (85- 105)	92.20±5.11 (87-110)	87.40± 4.46 (81-97)	87.05± 4.14 (82-97)
Heart Rate	78.20± 7.14 (65- 90)	80.35± 6.08 (70-92)	75.15± 3.96 (68-82)	75.05± 3.67 (70-82)

Table 2: Analysis of Blood pressure and Heart rate within Forward staircase climbing Group

Forward staircase climbing Group	Blood Pressure	Percentage of change and difference	t value[a]& Parametric Significance P value	Z value[b]& Non parametric significance P value	95% Confidence Interval for Difference		Effect size r
					Lower	Upper	
Pre training before and after Harvard step test	Systolic blood pressure	1.13%	-3.134 P= 0.005**	-2.465 P= 0.014**	-2.463	6.763	+0.106 (Small)
	Diastolic Blood pressure	1.26%	-2.562 P= 0.019**	-2.477 P= 0.013**	-1.400	3.700	+0.118 (Small)
	Heart Rate	2.74%	-2.760 P= 0.012**	-2.828 P= 0.005**	-2.582	5.782	+0.16 (Small)
Post training before and after Harvard step test	Systolic blood pressure	-1.89%	3.126 P= 0.006**	-2.691 P= 0.007**	-3.708	4.808	+0.19 (Small)
	Diastolic Blood pressure	-0.40%	0.907 P=0.376 (NS)	-0.431 P= 0.666(NS)	-2.607	3.407	+0.04 (Small)
	Heart Rate	-0.13%	0.129 P= 0.899 (NS)	-.313P= 0.754 (NS)	-3.182	4.282	+0.01 (Small)
pre and post training before Harvard step test	Systolic blood pressure	-3.01%	6.426 P< 0.000**	-3.591 P< 0.000**	-4.151	4.151	+0.26 (Small)
	Diastolic Blood pressure	-4.09%	8.996 P< 0.000**	-3.849 P< 0.000**	-2.348	2.448	+0.37 Medium
	Heart Rate	-3.97%	2.292 P= 0.034**	-1.921 P= 0.055*	-2.772	1.972	+0.25 (Small)
pre and post training After Harvard step test	Systolic blood pressure	-4.92%	7.762 P< 0.000**	-3.743 P= 0.000**	-4.143	2.043	+0.44 Medium
	Diastolic Bloodpressure	-4.49%	10.435 P< 0.000**	-3.967 P= 0.005**	-1.655	3.255	+0.54 (Large)
	Heart Rate	-4.11%	3.916 P= 0.001**	-3.415 P= 0.005**	-3.566	1.066	+0.46 Medium

** Statistically Significant difference p<0.05; NS- Not significant; a. Pared t test. b. Wilcoxon Signed Ranks Test

Table 3: Analysis of Blood pressure and Heart rate within Forward staircase climbing Group

Backward staircase climbing Group	Pre training - before Havard step test Mean±SD (min-max)	Pre training - after Havard step test Mean±SD (min-max)	Post training before Havard step test Mean±SD (min-max)	Post training after Havard step test (Mean±SD) min-max
Systolic blood pressure	134.15± 6.80 (125- 145)	137.30±6.29 (67-88)	132.25± 5.69 (125-140)	130.80± 4.37 (125-140)
Diastolic Blood pressure	89.90± 3.30 (85- 95)	91.80±4.23 (85-98)	87.35± 2.85 (83-94)	86.25± 3.49 (80-90)
Heart Rate	76.60± 5.86 (67- 88)	79.80± 5.55 (74-92)	75.55± 3.42 (70-82)	76.30± 3.55 (68-80)

Table 4: Analysis of Blood pressure and Heart rate within backward staircase climbing Group

Backward staircase climbing Group		Percentage of change and difference	t value[a] (Parametric) Parametric Significance P value	Z value[b] (Non parametric significance) P value	95% Confidence Interval for Difference		Effect size r
					Lower	Upper	
Pre training - before and after Havard step test	Systolic blood pressure	2.34%	-3.804 P= 0.001**	-3.083 P= 0.002**	-4.883	-1.417	+0.23 (Small)
	Diastolic Blood pressure	2.11%	-4.566 P= 0.000**	-3.197 P= 0.001**	-2.771	-1.029	+0.24 (Small)
	Heart Rate	4.17%	-2.937 P= 0.008**	-2.563 P= 0.010**	-5.481	-.919	+0.27 (Small)
Post training – before and after Havard step test	Systolic blood pressure	-1.09%	1.955 P= 0.65	-2.111 P= 0.035**	-.102	3.002	+0.14 (Small)
	Diastolic Blood pressure	-1.25%	1.897 P= 0.073	-1.786 P= 0.074**	-.114	2.314	+0.17 (Small)
	Heart Rate	0.99 %	-1.637 P= 0.118	-1.670 P= 0.095**	-1.709	0.209	+0.10 (Small)
pre and post training before Havard step test	Systolic blood pressure	-1.43%	2.633 P= 0.016**	-2.119 P= 0.034**	.390	3.410	+0.15 (Small)
	Diastolic Blood pressure	-2.87%	7.105 P= 0.000**	-3.648 P= 0.00**	1.799	3.301	+0.38 (Medium)
	Heart Rate	-71.28%	1.020 P= 0.321 (NS)	-.960 P= 0.337(NS)	-1.105	3.205	+0.09 (Small)
pre and post training after Havard step test	Systolic blood pressure	-4.84%	6.190 P= 0.000**	-3.630 P= 0.000**	4.302	8.698	+0.51 (Large)
	Diastolic Blood pressure	-6.23%	6.672 P= 0.000**	-3.734 P= 0.000**	3.809	7.291	+0.17 (Small)
	Heart Rate	-4.48%	3.325 P= 0.004**	-2.753 P= 0.00**	1.297	5.703	+0.10 (Small)

** Statistically Significant difference p<0.05; NS- Not significant; a. Pared t test. b. Wilcoxon Signed Ranks Test

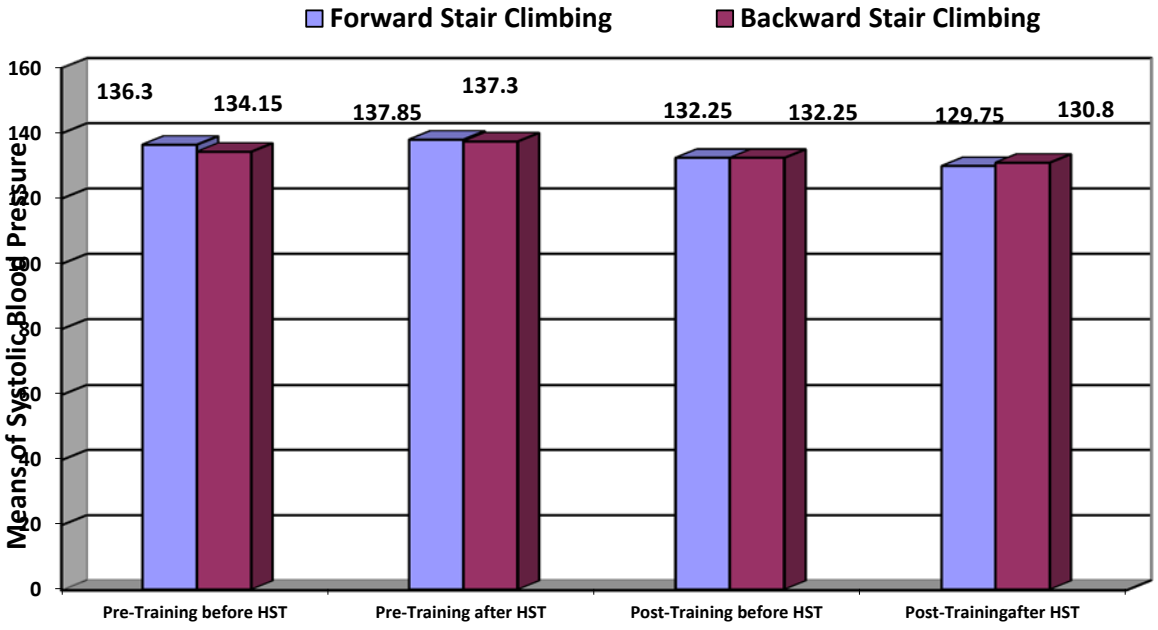
Table 5: Analysis of Blood pressure and Heart rate within backward staircase climbing Group

Comparative Analysis		Percentage of difference	t value[a] Parametric Significance P value	Z value[b] (Non parametric significance) P value	95% Confidence Interval for Difference		Effect size r
					Lower Bound	Upper Bound	
Pre training - before Havard step test	Systolic blood pressure	-1.58%	0.944 P= 0.351(NS)	-0.866 P= 0.387 (NS)	-2.463	6.763	+0.14 (Small)
	Diastolic Blood pressure	-1.27%	0.913 P= 0.367 (NS)	-0.687 P= 0.492 (NS)	-1.400	3.700	+0.14 (Small)
	Heart Rate	-2.06%	0.774 P= 0.443 (NS)	-0.828 P= 0.408 (NS)	-2.582	5.782	+0.12 (Small)
Pre training - after Havard	Systolic blood	-0.369%	0.262 P= 0.795	-0.327 P= 0.744 (NS)	-3.708	4.808	+0.04 (Small)

step test	pressure		(NS)				
	Diastolic Blood pressure	-0.43%	0.269 P= 0.789 (NS)	-0.082 P= 0.935 (NS)	-2.607	3.407	+0.04 (Small)
	Heart Rate	-0.68%	0.298 P= 0.767 (NS)	-0.422 P= 0.673 (NS)	-3.182	4.282	+0.04 (Small)
Post training – before Havard step test	Systolic blood pressure	0.00%	0.000 P= 1.000 (NS)	-0.041 P= 0.967 (NS)	-4.151	4.151	+0.00 (Small)
	Diastolic Blood pressure	-0.05%	0.042 P= 0.967 (NS)	-0.565 P= 0.572 (NS)	-2.348	2.448	+0.007 (Small)
	Heart Rate	0.56%	-0.341 P= 0.735 (NS)	-0.314 P= 0.754 (NS)	-2.772	1.972	+0.05 (Small)
Post training –after Havard step test	Systolic blood pressure	1.57%	-0.687 P= 0.496 (NS)	-0.636 P= 0.525 (NS)	-4.143	2.043	+0.99 (Small)
	Diastolic Blood pressure	0.92%	0.660 P= 0.513 (NS)	-0.196 P= 0.845 (NS)	-1.655	3.255	+0.10 (Small)
	Heart Rate	-1.65%	-1.093 P=0.281 (NS)	-1.188 P= 0.235 (NS)	-3.566	1.066	+0.17(Small)

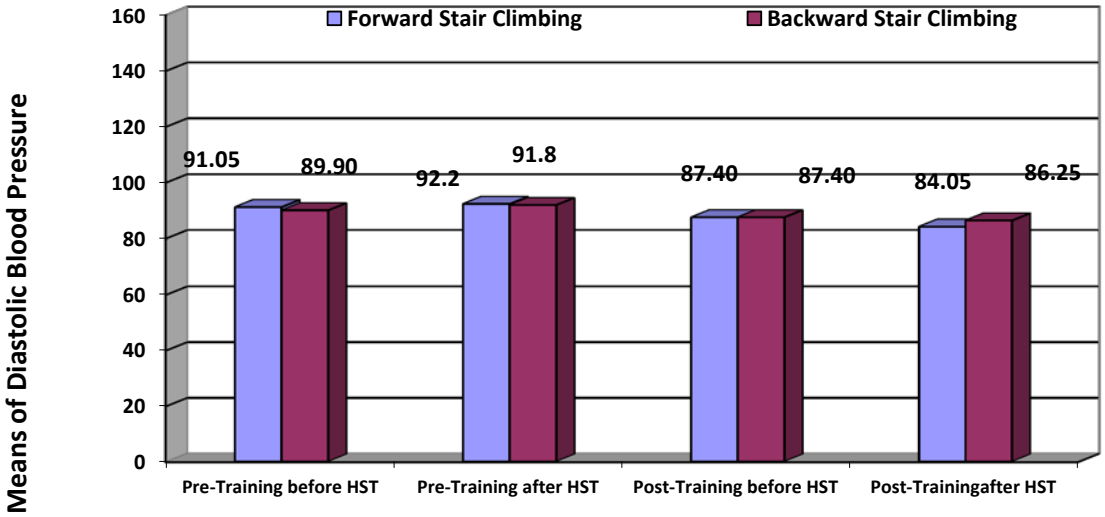
** Statistically Significant difference p<0.05; NS- Not significant a. Independent t test b. Mann-Whitney Test

Table 6: Comparative analysis of Blood pressure and Heart rate between Forward and Backward staircase climbing Groups



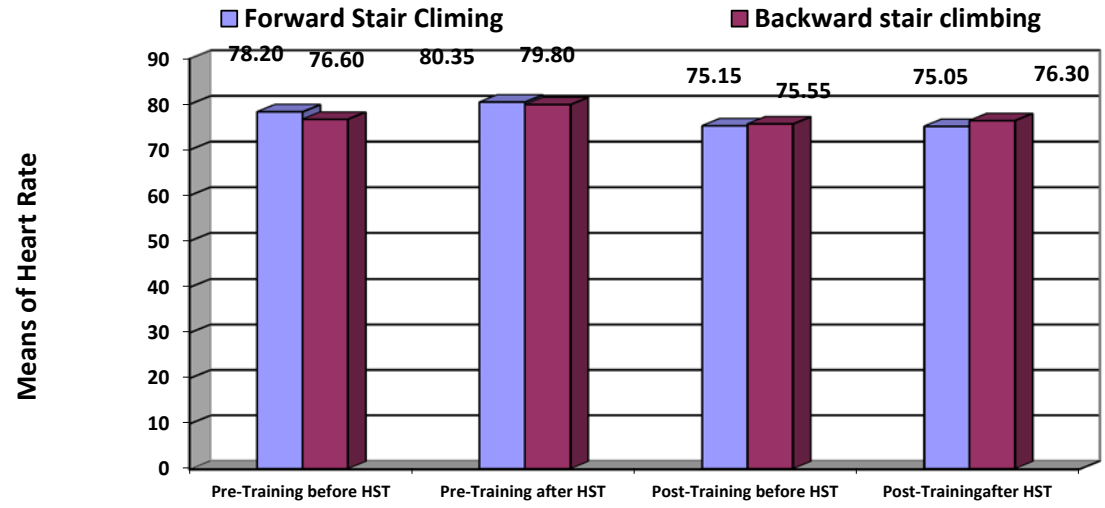
The above graph shows that there is no statistically significant change in means of systolic blood pressure when means were compared between the groups

Graph 1: Comparative analysis of Systolic blood pressure between Forward and Backward staircase climbing Groups



The above graph shows that there is no statistically significant change in means of Diastolic blood pressure when means were compared between the groups

Graph 2: Comparative analysis of Diastolic Blood pressure between Forward and Backward staircase climbing Groups



The above graph shows that there is no statistically significant change in means of Heart Rate when means were compared between the groups.

Graph 3: Comparative analysis of Heart rate between Forward and Backward staircase climbing Groups

DISCUSSION

In present study, it is found that in study group following four weeks of forward stair climbing training on performance of Harvard step test shown statistically significant greater percentage of change in improvement in cardiopulmonary parameters such as blood pressure and Heart rate than the backward stair climbing in subjects with hypertension.

In FSC group there is significant improvement in blood pressure and heart rate with small to medium effect size. The FSC may be effective that may leads to improvement in myocardial contraction and electrical stability, with increase in stroke volume during FSC, this

leading to a higher maximal cardiac output. In addition, the diameter and dilatory capacity of coronary arteries may be increased, due to collateral formation caused by training. FSC also has shown to effect on the tendency of blood to clot. Changes include reduced platelet aggregation and increased fibrinolytic activity, possibly resulting from lower levels of plasminogen activator inhibitor-1. In addition, regular physical activity lowers inflammatory factors such as plasma fibrinogen concentrations, C-reactive protein and white cell count. Due FSC there are metabolic adaptations that may occurs which includes stimulation of lipid oxidation during activity.[4] There are alterations in the transportation of blood lipids, with a higher ratio of high-density lipoprotein (HDL) to low-density lipoprotein (LDL) and increased lipoprotein lipase activity, which increases the use of circulating triglycerides as fuel and increases their clearance even at rest. Activation of this enzyme also speeds up the conversion of the VLDL to HDL. Thus improves the sensitivity of liver, skeletal muscle and adipose tissue to the actions of insulin.[5,6]

Boreham et al., in their study on older hypertensive men, observed that hypotension after exercise performed at 70% of maximal oxygen consumption (VO_2max) was greater and lasted longer than after exercise performed at 50% of VO_2max.They studied there is significant reductions in VO_2 max heart rate and blood lactate, after forward stair climbing programme.[18] Adiputra et al., in their study stated that there is a significant decrease in resting heart rate, blood pressure and percentage body fat in dance exercise program. Because blood pressure and heart rate responses during the recovery period can be influenced by exercise intensity, it is possible that different intensities of exercise may also have distinct effects on post-exercise rate pressure product.[19]

The improvement in blood pressure and heart rate after FSC could be due to the increase in the cardiovascular endurance. Meyer et al., studied 12 weeks promotional campaign for stair use, they found that that significant increase in participant activity level and declines in diastolic blood pressure. They stated that climbing staircase maintains more calories than jogging, hence reduces 25% risk mortality compared to those who are less active.[20] C. Boreham et al., Studied on the training effects of short bouts of stair climbing on cardio respiratory fitness, blood lipids, and homocysteine in sedentary young women and they concluded that accumulating short bouts of stair climbing activity throughout the day can favorably alter important cardiovascular risk factors in previously sedentary young women.[21]

In Backward stair climbing group, there is a significant improvement in cardiopulmonary parameters. Studies have found that backward walking increases the oxygen uptake, increases expiratory ventilation, and heart rate which are higher during climbing at 5% elevation than at 0%. During backwards walking, there is increased in stride frequency and decreased stride length. This alteration in stride could possibly increase the oxygen requirement during backward locomotion. Flynn et al., in their study stated that backward walking produce a similar effect as rate of oxygen consumption is same as forward walking. It could be due to the seeming awkwardness of the act of climbing the stairs backward, the subject cardiovascular system would be tasked more, thus resulting in the improvement in their cardiovascular endurance.[22]

The finding of study suggests that both FSC and BSC training procedures as used in this study might not have tasked the cardiovascular systems of participants enough to bring about a significant improvement in blood pressure and heart rate. This may be due to the number of steps and height of the stairs used in this study. the observed difference between the effects of staircase climbing on cardiorespiratory parameters in both studies could also be explained by the difference between the speed of staircase climbing in two studies though there was an overload in terms of increase in the number of ascents in both studies. In this study ascents and descent initially lasted for 8sec and gradually progressed.[20, 21, 22]

Comparison of effects of forward and backward staircase climbing training on subjects forward and backward staircase climbing training has similar effect on the participants cardiovascular parameters except for cardiovascular endurance in which FSC was significantly better. The findings in this study of backward staircase climbing compared with those in the study of backward walking. Since there is no study found on backward staircase climbing on the presumption that the metabolic and mechanical demands of staircase climbing and walking may be similar.

Bases on the findings in this study the improvement obtained by forward staircase climbing training measuring by cardiorespiratory parameters blood pressure and heart rate found there is statistically significant difference in effectiveness of forward staircase climbing training and backward staircase climbing training within the group. This signifies there is similar effect obtained in cardiorespiratory parameters between the groups. Therefore, the present study accept null hypothesis.

Limitations of the study

Measurements were limited to blood pressure and heart, Influence of confounding factors and co-morbidities on blood pressure and heart rate was not considered in the study. The study was carried for four weeks. Follow-up was not done therefore long term effects were not known.

Recommendation for future research

Further study can be carried by incorporating resistance and aerobic exercise during forward and backward stair climbing related to cardiorespiratory function. Long duration study with other cardiorespiratory parameters is needed to know the effect of forward staircase climbing versus backward staircase climbing training on people with HTN. Further study is needed to compare the effect with or without regular conventional aerobic exercises. Further study needed to find the effect by measuring other standardized outcome measurements.

CONCLUSION

The present study concludes that forward staircase climbing training and backward staircase climbing training found significant improvement in cardio respiratory parameters such as blood pressure, heart rate on performance of Harvard 3 minute step test in hypertensive subjects.

The improvement obtained in blood pressure and heart rate found no significant difference between forward staircase climbing training and backward staircase climbing training between the groups. However forward stair climbing shown to have greater percentage of improvement that backward stair climbing. Use of both method of intervention has been recommended for clinical application in rehabilitation of hypertensive patients if the treatment aiming to improve cardiorespiratory parameters in early stage of hypertension rehabilitation.

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