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Original Research Article

Effectiveness of Interval Training Versus Circuit Training Exercises on Blood Pressure, Heart Rate and Rate of Perceived Exertion in Individuals with Prehypertension

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ABSTRACT

Introduction: Hypertension is ranked third as a cause of disability and is a predictor of cardiovascular diseases, cerebrovascular accidents and death. Management of hypertension in earlier stages can prevent subsequent risk. Researchers have proven that regular aerobic and resisted exercises have their effect on lowering BP levels in hypertensives as well as prehypertensives. The objective of this study was to find out the effectiveness of interval training and circuit training on blood pressure, heart rate and rate of perceived exertion after 6 weeks in individuals with prehypertension.
Methods: 30 individuals with prehypertension were included into the study based on inclusion and exclusion criteria. There were 2 groups consisting of 15 patients in each group. Group A received interval training and group B received circuit training 5 days in a week for 6 weeks. Outcome measures included in this study were blood pressure, heart rate and rate of perceived exertion.
Result: Statistically there was a significant difference found between pre and post levels of systolic blood pressure, diastolic blood pressure, heart rate and rate of perceived exertion in both the groups ($p > 0.05$). But when both the groups were compared using unpaired t test, there was no significant difference found between both the groups ($p < 0.05$).
Conclusions: Both the methods are equally effective in reducing blood pressure levels after 6 weeks of training in individuals with prehypertension.

Key Words: Prehypertension, Interval training, circuit training etc.

INTRODUCTION

Hypertension has been identified as one of the leading risk factor for mortality and has earned reputation as 'the silent killer'. [1] A study done in 1939 observed that there was a sharp increase in mortality in individuals with blood pressure (BP) measurements greater than 140/90 mmHg, giving rise to the usual clinical definition of hypertension. The investigators also observed that systolic BP in the range 120-140 mmHg, especially in younger

individuals, was associated with progression to definitive hypertension and cardiovascular disease later in life, systolic BP in this range was first referred to as having 'prehypertension'. This concept of prehypertension, defined as systolic BP of 120-139 mmHg and/ or a diastolic BP of 80-89 mmHg, was incorporated into guidelines for the management of BP by the Seventh Report of the Joint National Committee (JNC 7). Hence according to 7th report of Joint National Committee on prevention, detection, evaluation and treatment of high blood pressure, prehypertension is defined as rise in systolic blood pressure between 120-139 mm Hg and diastolic blood pressure between 80-89 mm Hg. [2,3]

Recently, in a meta-analysis, it was found that prehypertension is also associated with elevated the risks of CVD, CHD and stroke. [4] A study of urban residents living in Chennai (age > 18 years) found prevalence of prehypertension as 47% while a survey in an industrial population reported prehypertension 44%. A study of urban population in north India shows that prevalence of prehypertension is 36% in age group of 30-39 years. [5,6]

Pharmacological treatment of hypertension includes antihypertensives like beta blockers, calcium channel blockers etc. and that of with prehypertensive individuals remains a matter of debate. [7,9] Non-pharmacological measures include lifestyle modifications like dietary changes, stress management, cessation of smoking and regular physical activity. [9,10] Physical activity in the form of regular aerobic exercise has been recommended for the prevention of high blood pressure as well as the lowering of blood pressure among all levels of hypertension. Studies have tried to compare the effectiveness of continuous and interval training protocols and found that both forms of exercise are beneficial for lowering of blood pressure levels. [11]

Aerobic Interval training involves alternating moderate to high intensity exercise (e.g., running briskly) with a recovery period (e.g., walking). The idea is to work harder during work intervals. Interval training adheres to the principle of adaptation. It leads to many physiological changes including an increase in cardiovascular efficiency (the ability to deliver oxygen to the working muscles) as well as increased tolerance to the build-up of lactic acid. These changes result in improved performance, greater speed, and endurance. [11,12] It was found in earlier research that moderate intensity interval training program is an effective as an adjunct to non-pharmacological management of essential hypertension. [12,13]

The term circuit refers to a number of selected exercises arranged consecutively. Each participant moves from one station to the next performing 8 to 20 repetitions at each station with little rest period (15-30 seconds). By adding a 30-second to 3-minute (or longer) aerobics station between each station, referred to as aerobic circuit training, the method attempts to improve cardiorespiratory endurance as well (although this has not been conclusively supported in experimental research). The program may be performed with exercise machines, hand-held weights etc. However circuit training does not appear to elevate blood pressure and may beneficially lower blood pressure in borderline hypertensives. [14]

MATERIALS AND METHODS

The staff and students of Pravara institute of medical sciences were screened for prehypertension in this experimental study. 50 individuals were found to be prehypertensive. Out of these 50 individuals, 30 individuals were selected by simple random sampling and are requested to participate in the study. Inclusion criteria

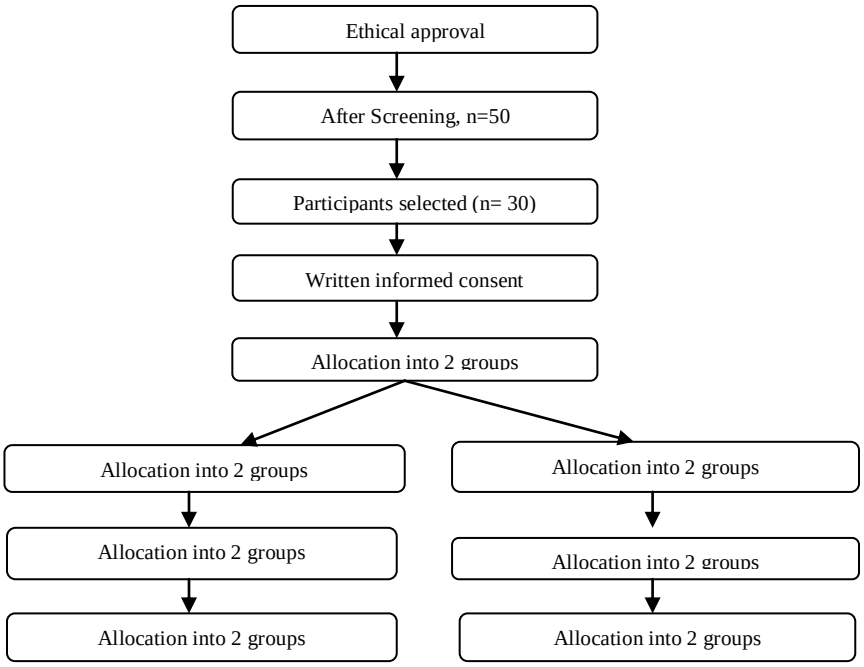
used was individuals who were having Systolic blood pressure between 120-140 mm of Hg and/or Diastolic blood pressure between 80-89 mm of Hg, with the age group between 20-40 years. Individuals with known cardiovascular diseases, pulmonary diseases, metabolic diseases, neuropathies, neurological or musculoskeletal deformities, cardiac arrhythmias were excluded from the study. After being approved by the Institution's Ethical and Scientific Review Committee (Ref.no. PIMS /CPT / IEC/ 2014/1481), an informed written consent was obtained from all the patients who were willing to participate in the study after explaining the purpose and procedure of the study.

Procedure: Selected participants were briefed about the study and about the intervention and informed written consent was obtained. All 30 participants were allocated into 2 groups. Each group will contain 15 participants,

Group A: Interval training.

Group B: Circuit training.

Intervention for group A and group B is as follow:



GROUP A: Aerobic interval training was given on treadmill for 30 minutes after 5 minutes of warm up with 1:2 ratio of work and relief period. Exercise was 30 min on a treadmill with intensity alternating between 50% (2 min) and 80% (1 min) (1×10 + 2×10 = 30 min.) of reserve heart rate. [15] Subjects were trained for 5 days in a week for 6 weeks. Maximum heart rate was calculated by using 220-age formula. Target heart rate was calculated with the help of Karvonen formula. After 30 minutes training session, each participant performed cool down session for 5 minutes.

GROUP B: Circuit comprises of resistance as well as aerobic activity. After each station of resistance training, participant underwent aerobic activity for 1 min. Resistance training was given for 30. Circuit training was given for 30 minutes after 5 minutes of warm up. Subjects were trained for 5 days in a week at an intensity of 60% to 80% of 1 RM. 1 RM was calculated by trial and error method for each individual. Then 60% of 1

RM is calculated and resistance training was given. Each individual completed at least 3 rounds of circuit. After 30 minutes of training, each participant performed cool down session for 5 minutes. Circuit comprised of seated chest press, stepping, bench press, brisk walking, rowing pulley, spot jogging, lateral pull down, stepping, leg press, brisk walking, arm curls and spot jogging.

DATA ANALYSIS AND RESULTS

Statistical analysis was carried out utilizing the trial version of SPSS 17.0 and Graph Pad Prism 5.0 and $p<0.05$ is considered as level of significance. Student's Paired' test and Unpaired' test was applied to analyze the data.

Systolic BP: In interval training group the difference between the pre and post values of systolic BP was (4.53±1.76) and that of circuit training group was (3.86±1.40). After 6 weeks comparison of differences was done. The Student's Unpaired't' test was used to analyse the data which revealed that there was statistically no significant difference between two groups.

Diastolic BP: In group A the difference between the pre and post values of diastolic BP was (1.86±1.18) and that of circuit training group was (1.73±1.48). After 6 weeks comparison of differences was done. The Student's Unpaired't' test was used to analyse the data which revealed that there was statistically no significant difference between two groups.

Heart Rate: In interval training group the mean difference between the pre and post values of diastolic BP was (3.73±1.48) and that of circuit training group was (3.60±0.82). After 6 weeks comparison of differences was done. The Student's Unpaired 't' test was used to analyse the data which revealed that there was statistically no significant difference between two groups.

Rate of Perceived Exertion: In interval training group the difference between the pre and post values of RPE was (0.8±1.01) and that of circuit training was (0.93±1.033). After 6 weeks comparison of differences was done. The Student's Unpaired 't' test was used to analyse the data which revealed that there was statistically no significant difference between two groups.

Table 1: Systolic Blood Pressure

Systolic BP	Pre-Intervention (Mean±SD)	Post-Intervention (Mean±SD)	Mean difference	P value	t value
Group A	129.46±2.87	124.6±1.95	4.86±0.91	(p<0.05) significant	9.934
Group B	128.26±2.91	124.53±3.06	3.73±0.15	(p<0.05) significant	9.727

Table 2: Diastolic BP

Diastolic BP	Pre-Intervention (Mean±SD)	Post-Intervention (Mean±SD)	Mean difference	P value	t value
Group A	81.37±2.37	79.86±2.56	1.87±0.19	(p<0.05) significant	6.089
Group B	81.73±2.12	80±2.61	1.73±0.49	(p<0.05) significant	4.516

Table 3: Heart Rate

Heart Rate	Pre-Intervention (Mean±SD)	Post-Intervention (Mean±SD)	Mean difference	P value	t value
Group A	88±4.78	84.26±4.71	3.73±1.48	(p<0.05) significant	9.0727
Group B	86.13±2.77	82.53±2.97	3.60±0.82	(p<0.05) significant	16.837

Table 4: Rate of perceived exertion

Rate of perceived exertion	Pre-Intervention (Mean±SD)	Post-Intervention (Mean±SD)	Mean difference	P value	t value
Group A	12.33±0.97	11.53±0.91	0.8±1.01	(p<0.05) significant	3.055
Group B	12.60±0.82	11.66±0.97	0.93±1.033	(p<0.05) significant	3.500

DISCUSSION

The results obtained in this study indicated that statistically there was no significant difference in the effects of interval training and circuit training on prehypertension. Both the groups showed reduction in systolic as well as diastolic blood pressure levels after 6 weeks.

Systolic and Diastolic BP: Because arterial blood pressure is a function of the product of cardiac output and total peripheral resistance, reductions in arterial blood pressure observed after exercise must result from decreases in cardiac output, total peripheral resistance, or both. Rise in blood pressure has a multifactorial etiology and, therefore, several mechanisms may be involved in the hypotensive effects of exercise training. The underlying mechanisms responsible for the reduction in BP elicited by exercise training remain elusive and controversial. The prevailing current opinion is that exercise training must act upon a number of mechanisms, resulting in the reduction of total peripheral resistance, cardiac output, or both. Reductions in cardiac output, sympathetic nerve activity, plasma norepinephrine levels, and total peripheral resistance have been reported. [11-13,15-17]

The results found in this study are comparable with the other studies. A study done by Guilherme Veiga Guimara˜es and others found that continuous and interval exercises training both were beneficial for blood pressure control. [11] The results of this study were also supported by a Meta analysis by Veronique A. Cornelissen and Neil A. It consisted of randomized controlled trials, lasting ≥ 4 weeks investigating the effects of exercise on BP in healthy adults. Systolic BP (SBP) was reduced after endurance (-3.5 mm Hg [confidence limits -4.6 to -2.3]), dynamic resistance (-1.8 mm Hg [-3.7 to -0.011]), and isometric resistance (-10.9 mm Hg[-14.5 to -7.4]) but not after combined training. Reductions in diastolic BP (DBP) were observed after endurance (-2.5 mm Hg [-3.2 to -1.7]), dynamic resistance (-3.2 mm Hg [-4.5 to -2.0]), isometric resistance (-6.2 mm Hg [-10.3 to -2.0]), and combined (-2.2 mm Hg [-3.9 to -0.48]) training. BP reductions after endurance training were greater (P<0.0001) in 26 study groups of hypertensive subjects (-8.3 [-10.7 to -6.0]/ -5.2 [-6.8 to -3.4] mm Hg) than in 50 groups of prehypertensive subjects (-2.1 [_3.3 to -0.83]/-1.7 [-2.7 to -0.68]) and 29 groups of subjects with normal BP levels (-0.75 [-2.2 to +0.69]/-1.1 [-2.2 to -0.068]). BP reductions after dynamic resistance training were largest for prehypertensive participants (-4.0 [-7.4 to -0.5]/-3.8 [-5.7 to -1.9] mm Hg) compared with patients with hypertension or normal BP. [18]

Heart Rate: Regular aerobic exercises often results in a decrease in resting heart rate. The resting heart rate is under the influence of the autonomic nervous systems' sympathetic (accelerator) and parasympathetic (depressor) nerves. The lowered resting heart rate from exercise training is proposed to be due primarily to an increase in the parasympathetic activity with a minor decrease in sympathetic discharge. An adaptation to the lowering of the resting heart rate, from aerobic training, is the heart's ventricles (specifically the left ventricle which pumps blood throughout the body) are able to accommodate a greater volume of blood. As the resting heart rate decreases there is then more time for filling the ventricles with blood, and more time for the delivery of oxygen and nutrients to the body and the heart muscle, making the heart more efficient in meeting circulatory challenges at rest. [19]

The results observed in this study were similar to a study done by Copeland SR and others. They found that there was a decrease in resting heart rate after 6 weeks

of aerobic training (71.5±4.4 to 64.5±3.7, beats per minute, P = 0.004). [20] In another study by Cornelissen VA, Verheyden B, Aubert AE, and Fagad RH, researchers have found that there was a reduction in resting heart rate after 10 weeks of aerobic training ($p<0.05$). [21] One another study by Clausen JP also concluded reduced resting heart rate after aerobic training. [22]

Rate of Perceived Exertion: A reduction in RPE can be the consequence of enhanced cardiovascular and muscular fitness. It is a psychophysiological scale, meaning it calls on the mind and body to rate one's perception of effort. The RPE scale measures feelings of effort, strain, discomfort, and/or fatigue experienced during both aerobic and resistance training. The greater the frequencies of these signals, the more intense are the perceptions of physical exertion. Perceived exertion reflects the interaction between the mind and body. That is, this psychological parameter has been linked to many physiological events that occur during physical exercise. These physiological events can be divided into respiratory/metabolic (such as ventilation and oxygen uptake) and peripheral (such as cellular metabolism and energy substrate utilization.) Previous studies have demonstrated that an increase in ventilation, an increase in oxygen uptake, an increase metabolic acidosis or a decrease in muscle carbohydrate stores are associated with more intense perceptions of exertion. The scale is valid in that it generally evidences a linear relation with both heart rate and oxygen uptake during aerobic exercise. [23]

The results obtained in this study are comparable to other studies. A Study by Shaea A and others found that after 4 weeks of high intensity interval training, RPE was significantly decreased. [24] A study by Pierce and others found significant decrease in RPE during exercise. These findings suggest that an 8-week high volume weight training program emphasizing large muscle groups can reduce the physiological and perceived stress associated with resistance exercise. [25] Green DJ, Watts K, Maiorana AJ, and O'Driscoll GJ found that here were no significant differences in RPE during exercise, when they compared continuous cycling on a bicycle ergometer and combined aerobic and resistance exercise. [26] Hetzler RK, Seip RL, Boucher SH, Pierce E, Snead D, Weltman A found no significant differences in RPE when they compared cycle ergometer (CE) and treadmill (TM). [27]

CONCLUSION

The present study showed the significant decrease in blood pressure, heart rate and rate of perceived of exertion in both the group. This study concludes that 6 weeks of interval training and circuit training exercises are equally effective in reducing blood pressure levels in individuals with prehypertension.

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