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Research Article

Effect of Isometric Handgrip Training on Heart Rate and Arterial Pressure in Normotensive Individuals

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Abstract: The most common and prevalent amongst sedentary lifestyle diseases is high blood pressure. The present study was planned to observe the effects of isometric handgrip training on heart rate and arterial pressure in normotensive individuals. It was carried out on 50 healthy volunteers of either sex aged between 19 – 35 years. They were divided into two groups, Group I and II. Each group consisted of twenty five subjects. Group I was taken as controls and no training was given to them. Group II was taken as study group and isometric hand grip training was imparted to them every 2 weeks for a total of 8 weeks. The results of the study show that isometric handgrip training does reduce resting heart rate and arterial pressure in normotensive individuals. Hence this form of exercise training can be used as a non pharmacological intervention in lowering arterial pressure and heart rate.
Keywords: Lifestyle Diseases, Physical Exercise, Hypertension, Isometric Handgrip Training, ECG, Heart Rate.

INTRODUCTION

Physical exercise is any bodily activity that enhances or maintains physical fitness and overall health without which a person is likely to suffer from lifestyle diseases. The most common lifestyle disease is hypertension.

It is estimated to affect nearly one quarter of the adult population and resulting in 7.1 million deaths each year [1, 2] and it is expected to increase 60% by 2025 [3]. Hypertension is a primary risk factor for the development of coronary artery disease (CAD) and stroke, which are the leading causes of death in major developed and developing countries [4]. Recent research from the Framingham Heart Study has shown that the residual lifetime risk for developing hypertension in healthy middle aged and elderly individuals is 90% [5]. Antihypertensive therapy alone has failed to control blood pressure due to poor effectiveness and adherence to these prescriptions. Elevated blood pressure levels can be controlled and managed to a great extent with exercises. It is not the duration of a single exercise session that counts, for protection of the heart, but the total daily amount of energy expended. Therefore, the best way to exercise may be in short bouts of intense exercise, which can be particularly helpful for older people [6, 7].

Exercise can be either static or dynamic. An exercise is supposed to be dynamic when the movement is at both the muscles and joints. Examples are swimming, walking, cross country skiing, bicycling, weight training, aerobics, etc. Static exercises involves the contraction of skeletal muscle without a change in muscle length hence the alternative term, isometric (iso=same, meter=length) exercise. In this type of exercise there is no movement at the joint [8]. Examples include climbing, mountain biking and motocross (grip and upper body strength), judo, wrestling, alpine skiing (static strength required to stabilize the upper and lower body), shooting, gymnastics, horseback riding, weight lifting, shotput, hammerthrow and everyday activities such as lifting heavy boxes or carrying a heavy briefcase [46].

The resistance exercises produce cardiovascular response that is different from that of dynamic exercises. The central cardiovascular effects of static exercise training primarily reflect the heart's response to increased afterload or blood pressure, whereas training responses to dynamic exercise are the result of volume load on the heart [9].

Aerobic exercise training has been documented to produce a reduction of resting Blood Pressure (BP) among sedentary, normotensive and hypertensive adults [1, 10-13]. The reduction in BP may be due to an acute and long term blood vessel relaxation caused by biochemical, neural and hormonal changes in the walls of the blood vessel [14].

The blood pressure and heart rate (HR) responses to isometric exercise are influenced by the force of the contraction [15], the size of the contracting muscle [16] and the length of time contracted [17]. There are (at least) two neural systems at work when muscles are exercised. The first, the Central Command, is located in the higher centers in the brain. It monitors the nerve signals sent out to the muscles and responds by stimulating areas in the brainstem responsible for heart rate and strength of contraction. The second is a feedback system that detects work in the muscle by monitoring contraction and the buildup of cellular wastes. The signals are then sent to the brainstem to increase cardiac output to compensate for increased muscular activity [18].

The resistance exercises are known to elicit an increase in the mean arterial pressure which is necessary to maintain blood flow to exercising muscles whose arterial supply is being compressed. This rise in BP occurs because of an increase in cardiac output which is secondary to an increase in heart rate without causing significant change in stroke volume and systemic vascular resistance [19]. However, reductions in arterial pressures have been reported following isometric or resistive exercise training such as Isometric handgrip (IHG) exercise or weightlifting [20-24]. Furthermore, epidemiological data indicate that the incidence of hypertension was lower in occupations classified as moderate to high in isometric activity. After allowing for the confounding factors such as obesity, alcohol and smoking they concluded that the daily performance of high levels of isometric activity prevented the occurrence of hypertension. It may also offer a complementary benefit to Cardiovascular system (CVS) by reducing circulating levels of Low density lipoproteins (LDL) and increasing High density lipoproteins (HDL) [25].

Research has shown only modest increase in mean arterial pressure and heart rate with a 2-minute contraction performed at 30% of Maximal Voluntary Contraction (MVC) [24]. Thus in patients recommended for traditional exercise therapies, low intensity isometric exercise (~ 30% MVC) is well tolerated and acceptable.

There is a general agreement in the literature that aerobic (dynamic) training elicits small reductions of arterial blood pressure [20]. Health organizations such as American Heart Association (AHA) and the American college of Sports Medicine have promoted aerobic exercise as a lifestyle modification for lowering blood pressure, especially in hypertensives [1]. Individuals with high blood pressure have been counseled not to engage in resistance exercise programs because of fear of an unusually high blood pressure response.

Resistance training has long been accepted as a means for developing and maintaining muscular strength, endurance, power, and muscle mass (hypertrophy) [26, 27]. But the evidence is not as clear regarding its effects on arterial pressure, although some suggest that isometric exercise training is an effective modality to reduce arterial pressure at rest but not during exercise. Earlier some landmark studies had been performed keeping in mind isometric hand grip training and normal blood pressure. The first study demonstrated that total body isometric contractions decreased resting systolic blood pressure (SBP) and diastolic blood pressure (DBP) in hypertensive individuals [28]. The second study was associated with varying degree of isometric exercise having a reduced incidence on hypertension [29]. A significant reduction in SBP and DBP had been reported in only 7 % and 13 % of the studies respectively. Although previous narrative reviews have suggested that progressive resistance exercise does not increase resting systolic and diastolic blood pressure, and thus may have potential benefits [1, 30-33]. But chronic resistance exercises have not been recommended so far as a non pharmacological intervention for controlling resting blood pressure and heart rate in adults. This may be due to the lack of statistically significant and positive findings, hence the present study was planned to observe the effects of isometric handgrip training on heart rate and arterial pressure in normotensive individuals.

MATERIAL AND METHODS

The present study was carried out on 50 healthy, normotensive, untrained subjects (25 males, 25 females) with ages varying from 19 – 35 years. Blood pressure and heart rate were measured in all the subjects. Blood pressure was recorded by using standard mercury sphygmomanometer [34-36] and heart rate was calculated from lead II of the Cardiofax Electrocardiograph (ECG) machine (Medicaid Systems).

The subjects were recruited for the study purely on volunteer basis. Each of the subjects were briefed on the full study and were asked whether they would participate. Those who agreed signed a written informed consent and their detailed medical and related history along with general examination was undertaken.

Those subjects who fulfilled the required criteria following inclusion were enrolled for the study.

Inclusion Criteria

- Subjects in the age group of 19—35 years
- Subjects of either sex
- Subjects heart rate in the range of 60—100 beats/min
- Normotensive subjects (BP ≤ 120/80 mm of Hg)

To screen the subjects for inclusion into the study, two measurements of heart rate and blood pressure were taken per week for two weeks. The average of the four readings was taken as the resting parameters. The subjects who did not meet the above requirements or had any history of the following were excluded

Exclusion criteria

- Subjects who either had a history of or were hypertensive
- Diabetic
- Smokers
- Alcoholics
- Had renal disease
- Had participated in any isometric training within one month of the onset of study.
- After all the requirements were fulfilled, fifty subjects were shortlisted and these were randomly divided into two groups of twenty five each.

The subjects in both groups were informed that the study was designed to examine the fluctuations in heart rate and blood pressure over a period of eight weeks of isometric handgrip training. Both the groups were informed that the follow up of blood pressure and heart rate would be taken every two weeks. Subjects were asked to maintain the same exercise protocol, nutritional and general activities during the period of their participation in the study. They were also instructed not to change diet, to start smoking or consuming alcohol or initiate any other major lifestyle changes. Blood pressure was measured in the non-dominant arm after at least 10 minutes of seated rest, before the start of the first training, thereafter their resting blood pressure and heart rate was measured every two weeks, for a total of eight weeks.

Fig. 1: Hand grip Dynamometer (Inco, Ambala)

Fig. 2: ECG Machine (Cardiofax)

RESULTS

Table 1: Comparison of Mean SBP, DBP and HR in control group at 0 weeks and 8 weeks

Parameters	0 Week (n=25) (mean±S.D)	8 Weeks (n=25) (mean±S.D)	t-test	p value
SBP (mm/Hg)	112.48±3.430	112.24±3.527	0.244	0.404 NS
DBP (mm/Hg)	70.56±2.859	70.56±2.551	0	0.500 NS
HR (beats/min)	84.64±6.376	84.44±6.965	0.106	0.458 NS

NS = Non significant, S.D.=Standard Deviation

Table 1 shows that there was no significant change in the mean SBP (p=0.404), DBP (p=0.500) and Heart Rate (p=0.458) in controls at 0 and 8 weeks

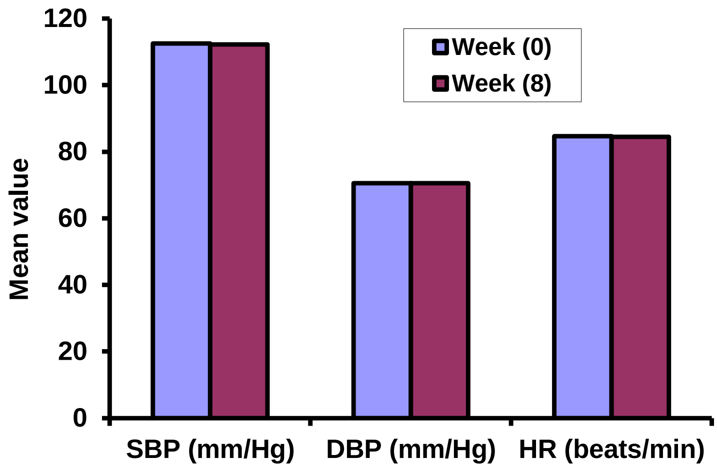

Fig. 1: Comparison within the control group of the Mean Blood Pressure and Heart Rate at 0 weeks and 8 weeks

Table 2: Comparison of Mean SBP, DBP and HR in study group at 0 weeks and 8 weeks

Parameters	0 Week (n=25) (mean± S.D.)	8 Weeks (n=25) (mean± S.D.)	t-test	p value
SBP (mm/Hg)	112.08±4.453	105.04±4.550	5.529	0.000
DBP (mm/Hg)	70.64±4.957	64.08±4.334	4.979	0.000
HR (beats/min)	84.4±8.977	76.76±8.368	3.113	0.002

Table 2 shows that there was a significant decrease in mean SBP (p=0.000), DBP (p=0.000) and HR (p=0.002) in the study group after 8 weeks of training, when compared to that at 0 weeks.

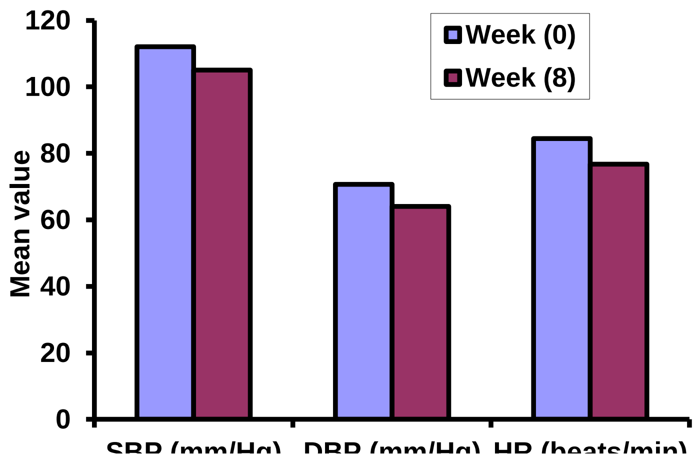

Fig. 2: Comparison within the study group of the Mean SBP, DBP and HR in study group at 0 weeks and 8 weeks

DISCUSSION

Chronic essential hypertension is a major risk factor for cardiovascular disease. Morbidity and mortality from cardiovascular causes increase curvilinearly as blood pressure rises, with no evidence of a threshold of risk. The current therapy for hypertension is the prescription of antihypertensive medications but the adverse effects and cost considerations has lead to poor compliance with medication regimes. This has failed to produce the desired reduction in the blood pressure levels [37]. The ineffectiveness of hypertension therapies has necessitated the need to investigate novel therapeutic alternatives like isometric handgrip training as an adjunct or alternative to drug therapy for lowering resting arterial pressure.

In the present study, the effects of Isometric handgrip training on heart rate and arterial pressure in normotensive individuals have been studied. Fifty healthy, normotensive, untrained subjects (25 males, 25 females) with ages varying from 19 – 35 years were recruited. Group I was taken as control and no training was given to them whereas Group II was taken as the study group and they were imparted Isometric Handgrip training. Their resting heart rate and blood pressure were taken every 2 weeks, till the completion of the study, (8 weeks) and compared with the controls.

The mean values of SBP, DBP and heart rate were almost same in control and study group at '0' weeks and was statistically non-significant.

There was decrease in the mean value of SBP, DBP and heart rate in study group after 2 weeks of training but this decrease was statistically non significant.

After 4 weeks of training there was a significant decrease in SBP ($p=0.000$) and DBP ($p=0.001$) in study group as compared to the control group, but there was no statistically significant decrease in the heart rate in study group when compared to controls. Similar results have been reported by Devereux GR and his colleagues [38].

After 6 and 8 weeks of training respectively, there was a significant decrease in SBP ($p=0.000$), DBP ($p=0.000$) and heart rate ($p=0.001$) in the study group as compared to the control group. The decrease in the present study correlates with the studies performed by other workers [22, 39].

A study done in 1992, observed reduction in SBP and DBP of 9.5 and 9 mmHg respectively and SBP remained significantly decreased for upto 14 days after completion of isometric training [23]; whereas, other studies have reported a significant decrease in SBP and heart rate after training without any changes in DBP [40].

There was no statistically significant change in the mean SBP, DBP and HR in controls from the start of the study (0 weeks) till its completion (8 weeks).

There was a significant reduction in mean SBP, DBP and heart rate in study group after 8 weeks of isometric training, when compared to that at 0 weeks.

The fall in SBP may be attributed to significant decrease in the heart rate which may be due to reduction in sympathetic nerve activity [41].

The reduction in DBP may be due to adaptations in the vascular system that leads to decrease in systemic vascular resistance. The fall in DBP may also be attributed to reduction in plasma norepinephrine levels or decrease in vascular sensitivity to norepinephrine [42], alterations in oxidative stress, improved endothelium dependant vasodilation and the modulation of autonomic nervous system in the form of reduction in basal sympathetic nerve activity [43].

The small reductions in diastolic arterial pressure in the population have significant health benefits. It has been suggested that a 2-mmHg drop in diastolic arterial pressure would lead to a 17% decrease in hypertension as well as a 6% reduction in coronary heart disease and a 15% reduction in stroke-related events A 5 to 6 mmHg reduction in diastolic arterial pressure decreased coronary heart disease and stroke incidents by 16% and 38%, respectively [44]. Thus, the 5-mmHg reduction in blood pressure in our study could have an important impact on these cardiovascular-related illnesses. Furthermore, our results support the concept that sustained isometric handgrip training is an effective modality in the prevention of hypertension.

Although isometric or combined isometric and dynamic (resistance) exercise has traditionally been discouraged in patients with coronary disease, it appears that resistance exercise (eg, weight lifting at 8 to 12 repetitions/set) is less hazardous than was once presumed, particularly in patients with good aerobic fitness and normal or near-normal left ventricular (LV) systolic function. Isometric exercise, regardless of the % MVC, failed to elicit angina pectoris, ischemic ST-segment depression, or threatening ventricular arrhythmias among selected (low-risk) cardiac patients [45]. Furthermore epidemiological data indicate that regular exposure to isometric activity at the work place lowers the 5 year hypertension incidence rate by 29% [29].

Thus, it appears that isometric exercise is a safe technique and is well tolerated by adolescents. Hence it may be prescribed as part of lifestyle modification and as an adjunct or alternative to antihypertensive therapy in maintaining a desirable blood pressure level that will help in improving quality of life and reducing the risk of cardiovascular disease.

CONCLUSION

The results of the study show that isometric handgrip training does reduce resting heart rate and arterial pressure in normotensive individuals. Hence this form of exercise training can be used as a non pharmacological intervention in lowering arterial pressure and heart rate.

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