

Cardiovascular Response to Exercise: Static v/s Dynamic.

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ABSTRACT

Background: Limited research has been carried out to compare acute cardiovascular responses to static and dynamic exercise in older adult. So in our study we compared the responses to static and dynamic exercise in older adults to find out and support the inclusion of resistance exercise as a part of fitness program designed for healthy subjects of older age group. **Aims & Objective:** The purpose of this study was to compare the acute cardiovascular responses of healthy older adults to static and dynamic exercise. **Methods:** In the present study 8 healthy normotensive volunteers, recruited in age group of 40-60 years, performed IHG exercise. Their HR and BP were recorded prior to and after one minute of 40% maximum voluntary contraction of the forearm. Then after a gap of two weeks subjects, performed dynamic exercise using ergo metric cycle. Their HR and BP were recorded prior to and after one minute of completion of exercise. All the recordings were compared before and after both types of exercise. **Results:** Both types of exercise led to significant rise in SBP, & HR. The rise in DBP was significant in subjects who performed static exercise only. From BP and HR responses, it is clear that acute responses to both exercises are almost similar, supporting the inclusion of static exercise in exercise programs for older adults. **Conclusion:** This study indicates that the press or response is well regulated in both exercise groups. This supports the inclusion of resistance exercise as part of an overall fitness program designed for healthy older adults.

Keywords: Blood Pressure (BP); Systolic Blood Pressure (SBP); Diastolic Blood Pressure (DBP); Electrocardiograph (ECG); Isometric Handgrip (IHG); Handgrip Dynamometer (HGD); Heart Rate (HR).

INTRODUCTION

Use of Advance / Modern technology in today's life has led us to live a sedentary life. This sedentary life in association with unhealthy food habits has led us to many health problems like obesity, hypertension, diabetes, cancer etc. In order to avoid such complications of sedentary lifestyle, some form of physical exercise is must in our routine. Exercise can be categorized as either dynamic or static exercise. Many positive physiological adaptations occur in older persons as a result of resistance exercise. Physical changes, such as muscle hypertrophy, decreased adiposity, and enhanced muscular strength, have been reported in several studies. These adaptations have the cumulative effect of increasing quality of life while slowing some age related processes.

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There are (at least) two neural systems at work when muscles are exercised. The first is central command located in higher centers in the brain. It monitors the nerve signals sent to the muscles and responds by stimulating areas in the brainstem responsible for

HR and strength of contraction. The second is feedback systems that detect work in the muscle by monitoring contraction and build-up of cellular metabolites. It then signals the brainstem to increase CO to compensate for increased muscular activity.^[1,2]

Static exercise produces a cardiovascular response that differs significantly from that observed during dynamic exercise. The physiological response to dynamic exercise is an increase in oxygen consumption and heart rate that parallels the intensity of imposed activity and a curvilinear increase in stroke volume. There is a progressive increase in systolic blood pressure with the maintenance of or slight decrease in diastolic blood pressure and concomitant widening of pulse pressure. Thus, aerobic exercise imposes primarily a volume load on myocardium. Whereas with isometric exercise the heart rate and blood pressure responses are largely proportionate to tension exerted relative to greatest possible tension in muscle group (%MVC) rather than absolute tension developed. Stroke volume remains largely unchanged with static exercise. Result is modest increase in cardiac output with little or no increase in metabolism. Despite increase in cardiac output, blood flow to the non contracting muscle does not significantly increase probably because of reflex vasoconstriction. The combination of increased

cardiac output and vasoconstriction causes a disproportionate rise in systolic, diastolic and mean blood pressure. Thus a significant pressure load is imposed on the heart, presumably to increase perfusion to active muscles.^[2]

Until recently, resistance exercise in the older population had been considered risky, in part because of exaggerated responses secondary to the placement of large demands on the cardiovascular system. However, limited research has been completed that compares the acute cardiovascular responses to resistance exercise and dynamic exercise in older adults.

In our study we set to confirm & compare the acute cardiovascular responses to static & dynamic exercise in older subjects and whether physical activity in form of resistance exercise is positively associated with responses in all older adults of both the sexes.

MATERIALS AND METHODS

The present Study was conducted on 80 healthy volunteers (40-60 years). BP and HR were measured in all the subjects before and within one minute of completion of exercise. Blood pressure was recorded with standard mercury sphygmomanometer^[3, 4]; measurement of HR was done using lead II of Cardiofax Electrocardiograph (ECG) machine (Medicaid systems).

Selection of Subjects

The subjects were recruited for study purely on voluntary basis from Dayanand Medical College and Hospital, Ludhiana. Each of the subjects was briefed about the study and was 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 inclusion criteria were enrolled for the study.

Inclusion Criteria: (i) Age group between 40-60 years; (ii) Heart rate (60—100 beats/min); (iii) Blood pressure (\leq 120/80 mm of Hg)

Exclusion Criteria: (i) Hypertensive; (ii) Diabetic; (iii) Smokers; (iv) Alcoholic; (v) Subjects who had participated in any exercise training within one month from the onset of study

The subjects were screened for inclusion into the study. Two measurements of HR and BP were taken per week for two weeks. The average of 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.

After all the requirements were fulfilled, eighty subjects were shortlisted. BP was measured in non-dominant arm in seated position after at least ten minutes of rest, before the start of exercise and within one minute of exercise completion. Subjects were labeled as normotensive, if their resting SBP

was \leq 120 mm Hg and resting DBP was \leq 80 mm Hg.^[4] SBP was taken as korotkoff phase I (appearance of sound) and DBP was taken as korotkoff phase V (disappearance of sound).^[5] HR was calculated from RR interval by continuous recording of lead II on ECG machine (Cardiofax Medicaid Ambala). Speed of ECG paper was 25 mm/sec. Heart rate was calculated as follows: Heart rate = $(60 \times 25)/RR = 1500/RR$. Subjects were explained about the use of the handgrip dynamometer (HGD) prior to beginning of isometric exercise. They were also trained to maintain an effort that would enable them to hold a steady tracking on the pointer of the dynamometer at 40% of their maximum voluntary contraction (MVC). MVC was calculated for each subject. To determine the maximum force (MVC) that the subject can exert with their dominant hand, the subject was asked to exert a maximal effort for less than 2 seconds on HGD. After three minutes rest, another effort was made. After three maximal effort recordings, the greater of three was taken as MVC.^[6]

After measuring resting HR and BP the subjects were asked to exert force on the HGD approximately 40% of their MVC (maximum voluntary contraction) with dominant hand and sustain it for a minimum period of 2 minutes till fatigue (not more than 4 minutes if fatigue does not sets in). BP and HR were measured after completion of IHG exercise. The results were compared within and between groups for changes in HR and BP in response to IHG exercise. Subjects were called again after a period of two weeks.

Blood pressure and Heart rate was recorded at rest. Subject was instructed to sit on cycle ergometer and start doing cycling at the rate of 60 revolutions per minute and record was taken from odometer on cycle and slowly intensity of cycling was increased. Subject was informed to continue the exercise upto 3 minutes. Heart rate was recorded after exercise. Systolic pressure was taken as korotkoff phase 1 (appearance of sounds) and diastolic blood pressure was taken as korotkoff phase V (disappearance of sound).

Statistical Analysis

Data collected on various variables was analyzed statistically. Mean and standard deviation (SD) was computed. Unpaired 't' test was applied to compare the means in different groups and paired 't' test to compare the differences between the means within groups before and after exercise. Data was analyzed using Stata 10 (general purpose statistical software package) software.

RESULTS

Table 1: shows that there was statistically significant increase in mean values of SBP ($p=0.000$), DBP ($p=0.000$) & HR ($p=0.000$) after handgrip exercise.

Table 2: shows that there was statistically significant increase in mean values of SBP (p=0.000) & HR

(p=0.000) after dynamic exercise, with insignificant rise in DBP.

Table 1: Comparison of parameters in subjects before and after static exercise.

Changes in parameters after static exercise by the subjects						
Parameters	Before Exercise		After Exercise		Paired t-value	p-value
	Mean	SD	Mean	SD		
SBP	108.60	7.38	115.60	9.75	5.03	0.0000
DBP	77.45	8.55	80.80	9.58	3.89	0.0004
HR	80.20	11.51	88.92	10.86	6.78	0.000

Table 2: Comparison of parameters in subjects of before and after Dynamic exercise.

Changes in parameters after dynamic exercise by the subjects						
Parameters	Before Exercise		After Exercise		Paired t-value	p-value
	Mean	SD	Mean	SD		
SBP	108.60	7.38	124.40	13.18	7.06	0.0000
DBP	77.45	8.55	77.10	8.93	0.187	0.8526
HR	80.20	11.51	113.96	17.91	10.94	0.000

Table 3: Comparison of parameters in subjects after static & dynamic exercise.

Parameters	After Exercise				Unpaired t-value	p-value
	Group I (Static)		Group II (Dynamic)			
	Mean	SD	Mean	SD		
SBP	115.60	9.75	124.40	13.18	3.39	0.001
DBP	80.80	9.58	77.10	8.93	1.78	0.070
HR	88.92	10.86	113.96	17.91	7.55	0.000

Table 3 shows that there was statistically significant greater rise in mean values of SBP (p=0.001) & HR (p=0.000) after dynamic exercise, with insignificant higher rise in DBP after static exercise.

DISCUSSION

With changing lifestyle and awareness, exercise in any form has become an important part of life. Earlier exercise programs emphasized on dynamic exercise, but research increasingly suggests that static exercise when appropriately prescribed has a lot of favorable effects. In present study we set to confirm & compare the acute cardiovascular responses to static & dynamic exercise in older subjects and whether physical activity in form of resistance exercise is positively associated with responses in all older adults of both the sexes. Eighty healthy normotensive volunteers in age group of 40-60 years were recruited for the study. Two measurements of HR and BP were taken per week for two weeks. The average of four readings was taken as the resting parameters. All the subjects performed isometric handgrip exercise and their heart rate and blood pressure were recorded prior to exercise and within one minute of cessation of exercise.

After a gap of two weeks, resting heart rate and blood pressure were recorded in all the subjects. Two measurements of HR and BP were taken per

week for two weeks. The average of four readings was taken as the resting parameters. All the subjects performed dynamic exercise.

Subject was instructed to sit on cycle ergometer and start doing cycling at the rate of 60 revolutions per minute and record was taken from odometer on cycle and slowly intensity of cycling was increased. Subject was informed to continue the exercise upto 3 minutes. Heart rate was recorded after exercise. Systolic pressure was taken as korotkoff phase 1 (appearance of sounds) and diastolic blood pressure was taken as korotkoff phase V (disappearance of sound) (6). Comparisons were done within group before and after both forms of exercise. Results were also compared between two types of exercise performed by the subjects.

While with exercise cardiovascular responses represent a characteristic pattern, it is clear that there is quite a large variation in the absolute magnitude of responses from person to person. It is an inevitable consequence of static exercise that there is large increase in both systolic and diastolic blood pressure with increase occurring in roughly parallel fashion. The cardiovascular and hemodynamic adjustments to exercise are primarily mediated by alterations in parasympathetic and sympathetic neural activity (Mitchell, 1990).^[7] These exercise-induced changes in autonomic neural outflow, which are designed to meet the metabolic demands of the exercising muscle, are mediated via multiple neural mechanisms working in concert. It is well accepted

that central command, the exercise press or reflex and the arterial baroreflex are all involved in mediating the characteristic cardiovascular and haemodynamic adjustments to exercise.^[8] The characteristic rise in blood pressure seen with isometric exercise was earlier explained as a mechanical consequence of contracting muscles blocking their own blood supply. The current view is that cardiovascular response to static exercise is the outcome of an interaction between several influencing factors. With central command, afferent inputs from skeletal muscle receptors, arterial and cardiopulmonary receptors playing major role.^[9,10]

The heart rate response to isometric exercise encompasses an integration of cardiovascular, muscular and nervous system. With contraction of skeletal muscle there is activation of afferent fibers by stretch and increase in metabolites produced from cellular activity along with rise in plasma catecholamines and decreased parasympathetic drive contributing to changes in heart rate.^[9,10]

With Dynamic exercise there is an increase in oxygen consumption and heart rate. Aerobic exercise imposes primarily a volume load on myocardium. The increase in stroke volume results from an increase in venous return, which, in turn, increases the left ventricular end-diastolic volume (LVEDV) (preload). The increased preload stretches the myocardium and causes it to contract more forcibly in accordance with the Frank-Starling law of the heart. Contractility of the myocardium is also enhanced by the sympathetic nervous system, which is activated during physical activity. Thus, an increase in the left ventricular end-diastolic volume and a decrease in the left ventricular end-systolic volume (LVESV) account for the increase in stroke volume during light to moderate dynamic exercise.^[11] Heart rate increases immediately at the onset of activity as a result of parasympathetic withdrawal. As exercise continues, further increases in heart rate are due to the action of the sympathetic nervous system.^[12] Systolic blood pressure (SBP) will rise in a pattern very similar to that of cardiac output: There is an initial increase and a plateau once steady state is achieved. The increase in systolic blood pressure is brought about by the increase in cardiac output. Diastolic blood pressure remains relatively constant because of peripheral vasodilation, which facilitates blood flow to the working muscles. The small rise in systolic blood pressure and the lack of a significant change in diastolic blood pressure cause the mean arterial pressure (MAP) to rise only slightly, following the pattern of systolic blood pressure. Total peripheral resistance (TPR) decreases owing to vasodilation in the active muscles. The vasodilation of vessels in the active muscles is brought about primarily by the influence of local chemical factors (lactate, K, and so on), which reflect increased metabolism.

In the present study, we compared responses to static & dynamic type of exercise. We found that with dynamic exercise there was a greater rise in SBP & HR as compared to static exercise, whereas the DBP showed an insignificant but higher response with static exercise. Hence, in the present study we found that resistance exercise elicits similar responses in older populations. There was no exaggerated response seen in older population otherwise which could have placed large demands on cardiovascular system. Along with favourable effects on cardiovascular system resistance exercise prevents loss of bone mineral density enhancing musculoskeletal fitness. Since the fastest growing segment of the population consists of those over 65 years of age^[12], it can be prescribed to older adults, promoting independence and helping in prevention of falls. Resistance exercise is an effective method to improve muscle strength and endurance, modify coronary risk factors, and enhance psychosocial well-being in people of all ages.

CONCLUSION

In the present study, we compared the acute cardiovascular responses of older adults to static as well as dynamic exercise and not much difference was found in the responses. Since cardiovascular response to exercise is major criterion in exercise prescription, resistance exercise can be added as a part of regular physical activity program in older adults. This can help to decrease the risk of chronic diseases and improve the quality of life of people of all age groups, especially helping older adults to improve and maintain their health and independent lifestyle.

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