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Evaluation of Gender Variation In Cardiovascular Response To Isometric Exercise In Normal Adolescents

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Abstract: *Isometric exercise remains an important modality in patient's rehabilitation and also employed in advanced strength and endurance training programs. The purpose of this study was to determine if the cardiovascular responses to upper limb isometric exercises differ between healthy normotensive male and female students. The study was performed on randomly selected healthy male and female subjects of age 17-19 years (30 male and 30 female). Their anthropometric variables namely height, weight and body mass index were recorded. Heart rate and blood pressure were recorded at rest and after 30 seconds of isometric exercise. Post-exercise cardiovascular parameters were significantly greater ($p<0.05$) than baseline values without gender bias. The males had a higher pre-exercise HR, SBP than the females but no significant difference in DBP and MAP. However, the post-exercise SBP and MAP were significantly greater ($p<0.05$) in males than females and no significant difference in rise in the HR and DBP between them. There was positive correlation between BMI and DBP in females and males showed positive correlation between DBP, MAP and BMI. Paired t-test and Unpaired t-test were used for statistical analysis. The study concludes that cardiovascular and hemodynamic responses to isometric handgrip exercise differ by gender.*

Key words: *Cardiovascular response; DBP; Gender; Isometric exercise; MAP; SBP*

I. Introduction

A physiological test which is done to increase the arterial pressure is the isometric hand grip exercise test. It provides pressor stimuli to the cardiovascular system through efferent sympathetic pathways, with a resultant increase in the heart rate and BP.

Exercise is a form of self-induced stress leading to circulatory and respiratory adjustments in the body to the resultant increased metabolic demand. These changes depend upon the specific types of exercises undertaken, isometric or isotonic. Isometric or static exercises are characterized by change in the muscle tension with no change in the muscle length whereas isotonic or dynamic exercises exhibit change in the muscle length with tension remaining the same. The isometric contractions are seen in various exercises like pushing against wall or holding a ball with your foot while using calf muscles to point toes, where net displacement of load is not present, but the rising tension can be felt in the contracting muscles.

Evaluation of circulatory alterations during sustained isometric muscle contraction is a useful method to assess cardiac function. The hemodynamic responses of this provocative test have been well-documented in adults. Characteristically, there is an increase in cardiac output and blood pressure, but little change in total peripheral resistance[1,2]. The raised systolic blood pressure is because of increased cardiac output and raised diastolic blood pressure is due to increased peripheral resistance during the exercise. All these circulatory changes result in an increased muscle blood flow to meet the demand of the muscles. Cardiovascular response to exercise is used as major criteria in exercise prescription for both patients and healthy people. However, it has been noted that the substantial anatomical, physiological, and morphological differences that exist between men and women may affect their exercise capacity and influence the magnitude of response to exercise[3].

Hand grip (HG) exercise is a form of isometric exercise that has been widely researched in various studies and clinical areas using the standardized protocols[4]. Grip strength testing is used as a predictor of physical functioning, for assessment of upper limb impairment, evaluation of nutritional status, injury prevention and rehabilitation, and to monitor progression of muscle strength. Hand grip exercise is also reported to enhance performance of individuals. Although, isometric exercises such as hand grip testing have been reported to cause a characteristic increase in blood pressure and other cardiovascular parameters, the cardiovascular response to isometric exercise largely depends on factors such as volume of muscle mass involved, duration, intensity, number of contractions and total workload. The purpose of our study, therefore, was to measure HR and BP response to resistive exercise like isometric handgrip exercise[5,6].

II. Aims and objectives

1. To study the effect of isometric exercise on cardiovascular system in healthy young adults.
2. To study the gender difference in cardiovascular response to isometric exercise.
3. To study the correlation between BMI and BP.

III. Material And Methods

The study was conducted on 60 young healthy medical students of first M.B.B.S. of GMC, Latur, in the age group 17-19 years (30 male and 30 female). The detailed history of the subjects was obtained and recorded to confirm the absence of any systemic affliction. The informed consent, in writing, was obtained from the subjects. The height and weight were recorded for each individual in centimeters and kilogram respectively.

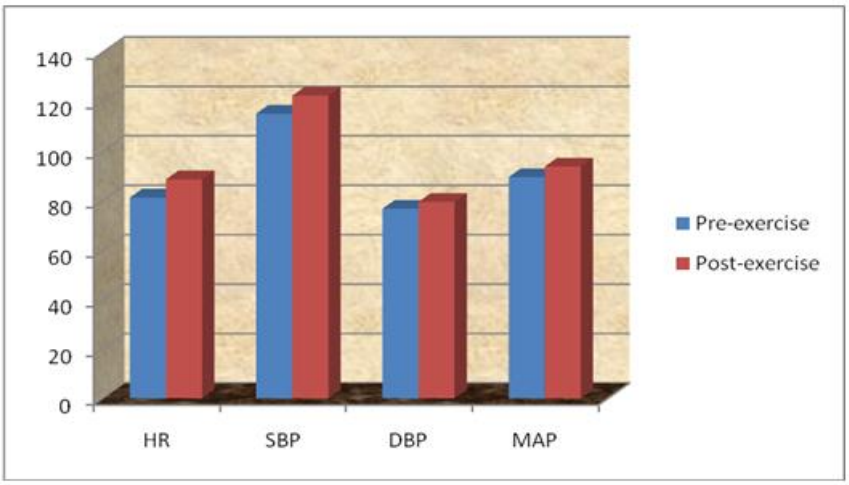
BMI was then calculated using the formula weight in kg / (height in metre)^2.The blood pressure was measured using sphygmomanometer. A Littman stethoscope was used with the Sphygmomanometer to measure the blood pressure. Heart Rate was recorded by counting the pulse rate by palpation of the radial artery. The baseline heart rate (HR), systolic and diastolic blood pressure (SBP, DBP) were recorded. The subjects with blood pressure more than 140/90 were not included in the study. Isometric Hand Grip Dynamometer (Inco, Ambala, India) was used for exercise. The dynamometer was held freely without support, not touching the subject's trunk. The position of the hand remained constant. All tests were done using the dominant hand of each participant and the subjects were asked to put maximum force thrice. The subjects performed exercise after giving proper instructions and then BP and heart rate were recorded after 30 seconds of exercise. Student's paired t-test was used to compare intra group pre and post-exercise cardiovascular parameters. Unpaired t-test was used to compare physical characteristics and pre and post exercise cardiovascular parameters between genders. Level of significance was set at $p<0.05$.

IV. Observation and results

Sixty healthy (M= 30, F=30) preclinical medical students were selected for the study. Age group of subjects was between 17 to 19 years. Mean height of the male was 171.8cms and female was 157.2cms. Mean weight of women was 47.4kgs and of men was 57.7kgs. The height and weight were significantly greater in men ($P< 0.05$). There was no significant difference between the ages of men and women. Post-exercise cardiovascular parameters were significantly greater ($p<0.05$) than baseline values without gender bias (Table I, Graph I). The male participants had a higher pre- exercise or basal HR, SBP than the females but no significant difference in DBP and MAP (Table II, Graph II). However, the post-exercise SBP and MAP were significantly greater ($p<0.05$) in males than females and no significant difference in rise in HR and DBP between them (Table V, Graph III). There was positive correlation between BMI and DBP in females (Table 3) and males showed correlation between BMI and DBP, MAP (Table 4).

Table 1 Comparison of pre- & post-exercise cardiovascular parameters amongst all subjects

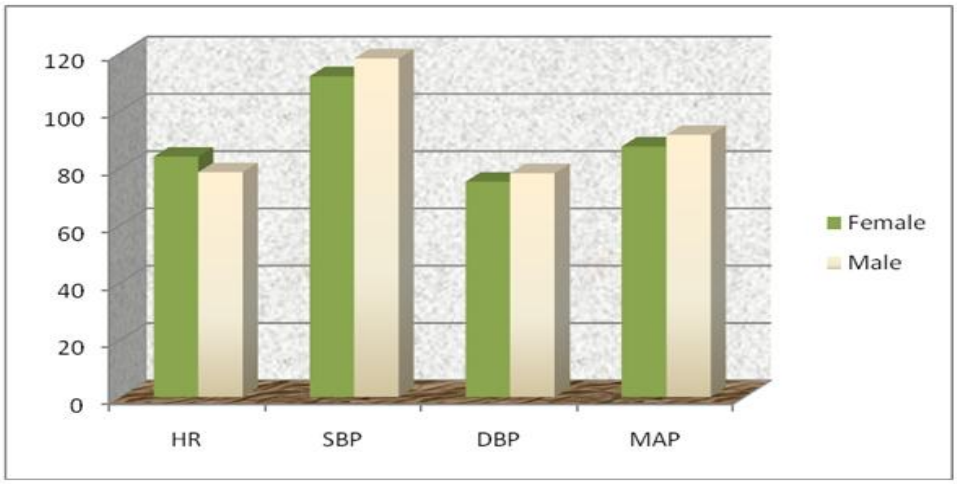
Sr No.	Parameters	Pre-exercise	Post-exercise
1	HR	81.23±8.75	88.57 ±7.7
2	SBP	115.13 ±10.67	122.43 ± 10.53
3	DBP	76.7 ± 9.06	79.47 ± 8.48
4	MAP	89.51 ± 8.56	93.79 ±7.88



Graph I

Table 2 Comparison of pre-exercise cardiovascular parameters amongst males and females

Sr No.	Parameters	Female	Male
1	HR	83.93 ± 9.06	78.53 ± 7.65
2	SBP	112 ±8.6	118.27 ± 11.72
3	DBP	75.2± 8.98	78.2 ± 9.03
4	MAP	87.47± 7.65	91.56 ± 9.05



Graph II

Table 3 Correlation between BMI and cardiovascular parameters in females

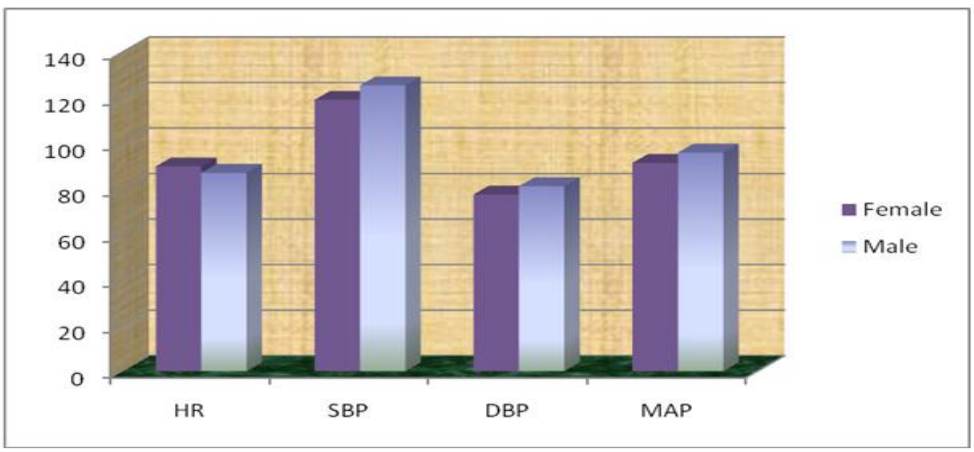
Sr No.	BMI Vs Parameters	Inference
1	HR	Negative
2	SBP	Negative
3	DBP	Positive
4	MAP	Negative

Table 4 Correlation between BMI and cardiovascular parameters in males

Sr No.	BMI Vs Parameters	Inference
1	HR	Negative
2	SBP	Negative
3	DBP	Positive
4	MAP	Positive

Table 5 Comparison of post-exercise cardiovascular parameters amongst males and females

Sr No.	Parameters	Female	Male
1	HR	90	87.13 ± 8.03
2	SBP	119.27±8.6	125.6 ± 12.04
3	DBP	77.67± 7.54	81.27 ± 9.09
4	MAP	91.53± 6.33	96.04 ± 8.7



Graph III

V. Discussion

In the present study, we compared the effect of isometric upper limb exercise on cardiovascular parameters in young males and females who had no prior endurance training. The males have more muscle mass as they have higher day to day activity than females. The body mass index (BMI) in males (19.55± 2 kg/m^2) was slightly higher than their female (19.22± 2 kg/m^2) counterparts.

With whole body endurance activity, systolic blood pressure increases in direct proportion to increased exercise intensity. Increased systolic blood pressure results from the increased cardiac output that accompanies increasing rates of work. This helps to drive the blood quickly through the vasculature. Increased systolic blood pressure facilitates the delivery process. Diastolic blood pressure changes little during endurance exercise, regardless of the intensity. When females and males are exposed to an acute bout of exercise, responses differ between the sexes in terms of strength, cardiovascular, respiratory responses and metabolic responses. Exercise cardio-acceleration results from release of parasympathetic inhibition at low exercise intensities and from both parasympathetic inhibition and sympathetic activation at moderate intensities. The hand grip exercise produced significant increase in systolic and diastolic blood pressure in all participants and the reason may be due to the stressor effect of isometric exercise such as hand grip on the cardiovascular system[7].

Age, Sex, education, Body weight, alcohol consumption, physical fitness, and medication have all been shown to affect the BP response to exercise independently and significantly[8]. In general, most quantitative values for women- such as muscle strength, pulmonary ventilation, cardiac output , all of which are related mainly to the muscle mass- vary between two thirds and three quarters of the values recorded in men. When measured in terms of strength per square centimeter of cross-sectional area, the female muscle can achieve almost exactly the same maximal force of contraction as that of the male- between 3& 4 kg/cm^2. Therefore, most of the difference in total muscle performance lies in the extra percentage of the male body that is muscle, caused by endocrine differences[9]. One of the most important male characteristics is development of increasing musculature after puberty, averaging about a 50% increase in muscle mass over that in the female. Because of the great effect that testosterone and other androgens have on the body musculature, synthetic androgens are widely used by athletes to improve their musculature performance[10].

Changes in the BP are usually mediated by the baroreflex mechanism via HR changes. This baroreflex mediated response of HR to changes in arterial BP indicate the capacity of reflex cardiac autonomic modulation. Laitinen T et al evaluated the correlates of baroreflex sensitivity (BRS) and the role of sympathovagal balance in healthy subjects. They concluded that physiological factors age and gender have significant impact on BRS in healthy subjects[11].

In 1967, Donald et al.' demonstrated that sustained isometric contraction, involving the extensor groups of the lower extremities at the knee (leg pressure) or the flexor groups of the forearm at the elbow (sustained handgrip) resulted in a marked increase in systolic, mean and diastolic blood pressure. In these normal volunteers, this increase in arterial pressure was due primarily to an increase in cardiac output associated with an increase in heart rate, with little change in stroke volume or systemic vascular resistance. The increase in arterial pressure was supposed to maintain blood flow through the muscles subject to static contraction. The marked increase in coronary blood flow and myocardial oxygen consumption produced by handgrip indicates the magnitude of the stress imposed upon the heart by isometric exercise[12].

Krzeminski showed significant increase in both systolic and the diastolic blood pressures with the isometric hand grip exercise and the findings were similar to our study results. The rise in blood pressure was explained on th**e** basis of the activation of sympathetic adrenergic system, which was indicated by an increase in the plasma catecholamine level[13]. Bakke EF et al, also showed an increase in mean arterial pressure, which was significant with our study results. An increased total peripheral resistance was the main factor which caused an increase in the blood pressure.

The isometric hand grip exercise activates the mechanoreceptors immediately due to the increased muscle tension. The recruitment of new motor units to maintain the muscle tension, increases the excitatory state of the central nervous system and results in a possible increase in the sympathetic outflow and a decrease in parasympathetic outflow which explain the increase in the blood pressure response[14].

It has been postulated that the pressor response to the isometric exercise is reflex in origin which serves to increase the perfusion pressure to the active muscles, in which the blood flow is impeded by the sustained muscle contraction[15]. The increased blood pressure may also have been caused by the increased post-junctional alpha-1 receptors during the isometric hand grip exercise[16]. Static exercise increases the systolic and diastolic blood pressures mainly by central commands, causing changes in the activity of both the sympathetic and the parasympathetic system. However, Haskell and Martin found that a rise in the BP during the handgrip could also be achieved by an increased peripheral vascular resistance alone[17,18]. It causes cardiovascular strain, which forms the basis for prediction and prevention of excessive cardiac load in a normal person. At any level of physical activity, exercise training increases cardiovascular functional capacity in

healthy persons and in person's with cardiovascular disease.

VI. Conclusion

The study concludes that,

1. The resting heart rate and systolic blood pressure were greater in men than that in women.
2. The post-exercise heart rate, systolic blood pressure, diastolic blood pressure and mean arterial pressure were higher than pre-exercise values for both the genders.
3. The rise of systolic blood pressure and mean arterial pressure was greater in men than women.
4. The men were having positive correlation between DBP, MAP and BMI.
5. The women were having positive correlation between DBP and BMI.

So, this type of stress due to isometric handgrip exercise may be useful in evaluating the hemodynamic reserve of patients with heart disease. The factors responsible for differences in cardiovascular response due to gender appear to be numerous and further study is essential to elucidate the specific mechanisms.

References

[1]. Lind AR, Taylor SH, Humpreys PW, Kennelly BM, Donald KW: The circulatory effects of sustained voluntary muscle contraction Clin Sci 27: 229, 1964.
[2]. Stefadouros MA, Grossman W, El Shahawy M, Witham AC: The effect of isometric exercise on the left ventricular volume in normal man. Circulation 49: 1185, 1974.
[3]. Gatzke A . Gender Differences in Athletic Performance. How Women Differ from Men; ABC Body Building Company 2005.
[4]. Ohler, R.R.V., Bocalini, D.S., Bacurau, R.F., et al. 2013.Isometric hand grip does not elicit cardiovascular overload or post exercise hypotension in hypertensive older women. Clinical Intervention Aging 8: 649-655.
[5]. Hamza, S.A., Wahba, H.M.F., Hegazy, M.M. 2013. Assessment of handgrip strength variables in a population of Egyptian elderly. Middle East Journal of Age and Ageing 10(3): 20.
[6]. Bakke, E.F., Hisdal, J., Kroese, A.J., Jorgensen, J. and Stranden, E. 2007. Blood pressure response to isometric exercise in patients with pheriperal atherosclerotic disease. Clinical Physiology Functional Imaging 27: 109.
[7]. Wilson MF, Sung BH, Pincomb GA, Lovallo WR; Exaggerated blood pressure response to exercise in men at risk for systemic Hypertension. Am J Cardiol; 1990; 66:731-6.
[8]. Criqui MH, Haskell WL, Heiss G, Tryoler HA, Green P, Rubenstein CJ; Predictors of systolic blood pressure response to treadmill exercise: the Lipid Research Clinics Program Prevalence Study. Circulation 1983; 68: 225–33.
[9]. Guyton and Hall, Text book of medical Physiology, A south Asian Edition, page no. 632.
[10]. Guyton and Hall, Text book of Medical Physiology, Twelfth Edition, page no.103
[11]. FitPro TC; Blood pressure and exercise. American Fitness Professionals and Associates: 1998; retrieved on Nov 28, 2006
[12]. Donald KW, Lind AR, Flue D, Mcnicol GW, Humphreys PW, Taylor SH, Stanton HP: Cardiovascular responses to sustained static contraction. Circ Res 21: 1, 1967.
[13]. Krzeminski K, Cybulski A, Ziemba A,Nazar K. Cardiovascular and hormonal responses to static handgrip in young and older healthy men. Eur J App Physiol. 2012; 112(4):1315-25.
[14]. Heitanen E. . Cardiovascular responses to static exercise. Scand J work environ Health.1984;10:379-402.
[15]. Mc Donald HR, Sapru RP, Taylor SH, Donald KW. Effects of intravenous propranolol (Inderal) on the systemic circulatory response to sustained handgrip. Amer j Cardio.18:333-1966.
[16]. Hamada Mareomi, Kazatani Yukio Shigematsu Yuji, Ito Taketoshi, Kokubu, Tatsuo Ischise, et al. Enhanced BP response to isometric hand grip exercise in patients with essential hypertension: Effects of propranolol and prazocin. Journal of hypertension. 1987; 5(3): 305-09.
[17]. Haskell WL, Savin WM, Schroeder JS, et al. Cardiovascular responses to isometric hand grip exercise in patients following cardiac transplantation. Circ Res 1981; 48: 156-61.
[18]. Martin CE, Shaver JA, Leon DF, Thompson ME, Reddy PS, Leonard JJ. Autonomic mechanisms in haemodynamic responses to isometric exercise. J clin Invest. 1974; 54: 104-15.