

## Comparison of Cardiovascular Response between Men and Women to Isometric Exercise of Lower Limb

Hariraja Muthusamy, Salameh Aldajah, Sivanandan Ramar, Akram Omoush

### Abstract

**Background:** Isometric exercise remains an important modality in patient's rehabilitation and also employed in advanced strength and endurance training programs. The average isometric strength is generally about thirty percent greater in men than in women in different muscle groups, and that difference may reflect on the cardiovascular response to isometric exercise

**Purpose:** To study cardiovascular responses in men and women to isometric exercise.

### Methods and Materials:

Thirty male subjects and thirty female subjects were randomly selected.. Isometric exercise to bilateral quadriceps muscles was performed for 2 minutes in supine position. Systolic blood pressure, Diastolic blood pressure and the Heart rate were taken for all the subjects by using Sphygmomanometer.

### Results:

The post mean of DBP for male was 84.43 and for women was 80.47, it was statistically significant ('t' value = 2.27, df =58) at 0.05 level. So the DBP is significantly more among men than women. The post mean of SBP and for male was 125.47 and for women was 120.3, it was statistically significant ('t' value = 2.14, df = 58) at 0.05 level. So the SBP is significantly more among men than women.

### Conclusion:

Hence the results of this studies should be kept in mind while prescribing Cardiovascular patients with Isometric exercise since specific job tasks may require isometric or combined isometric and dynamic activities. This approach to cardiac rehabilitation may facilitate patients who wish to return to a job requiring frequent isometric muscle contraction.

**Keywords:** Cardiovascular, Isometric exercise, Lower limb, men and women, blood pressure

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**INTRODUCTION:**

Static exercise is known to increase heart rate (HR) and cardiac output (CO) and raise systolic (SBP) and diastolic (DBP) blood pressures<sup>1</sup>. These responses are related mainly to the neural effects on the heart including changes in the activities of both parasympathetic and sympathetic systems elicited by central command and to ascending mechanoreceptor and mechanoreceptor inputs that contribute to the sympathetic response<sup>1</sup>. Exercise is a form of self-induced stress leading to circulatory and respiratory adjustments in the body to the resultant increased metabolic demand<sup>2</sup>. 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<sup>3</sup>. The average isometric strength estimate is generally about thirty percent greater in men than in women in different muscle groups<sup>1</sup>.

Isometric exercise remains an important modality in patient's rehabilitation and also employed in advanced strength and endurance training programs<sup>2</sup>. The metabolic demands of the exercising muscle increases, depending upon the intensity of the exercise and these are met with various changes in the circulatory and respiratory system. The sympathetic system plays a key role in these changes resulting in increased heart rate, systolic and diastolic blood pressure and an increased respiratory rate during the

exercise. The raised systolic blood pressure is because of increased cardiac output and the raised diastolic blood pressure is due to increased peripheral resistance during the exercise<sup>4</sup>.

In isometric exercises, in addition to the concentric action of the smooth muscles in the endothelial layer due to neurological reflex, the small groups of muscles around blood vessels remain in the contracted state throughout the exercise resulting in the compression of the blood vessels and hinder blood flow to active muscle. Thus it has been observed in that there is a difference in circulatory response to isometric exercises as compared to isotonic exercises<sup>4</sup>. Isometric exercise has been found to increase, Systolic Blood Pressure (SBP), Diastolic Blood Pressure (DBP) and Heart Rate (HR). Larger the muscle groups that are involved in isometric tension, greater the consequent cardiovascular responses to it<sup>5,6,7</sup>. Cardiovascular response to exercise is used as major criteria in exercise prescription for both patients and healthy people. Numerous studies attempting to explain gender differences in cardiovascular response to isometric exercise are inconsistent at best and conflicting. 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<sup>8,9</sup>.

Isometric exercises have a considerable value in enhancing cardiovascular function and such activities

impose a pressure overload as opposed to the volume overload on the left ventricle that is normally observed from continuous aerobic activities, which increase cardiac output, respiratory rate and reduce peripheral resistance<sup>10, 11, 12, 13</sup>.

This study analyzes the changes in the cardiovascular responses occurs in the body as a result of isometric exercises of lower limb. There have been reported gender difference in the cardiovascular response to exercise of different region of the body; and this study further analyzes the differences seen in this response amongst the men and women subjects, when subjected to isometric exercises of the lower limbs

A research model with isometric exercise pertinent to cardiovascular changes for rehabilitation is important to be discussed. This model has important implications for healthcare workers like physiotherapists interested in cardiac rehabilitation and other preventive programs. The purpose of this study is to prepare the reader for the comprehensive prevention agenda that is necessary to influence our health care system and to improve the health and well-being of our population.

The aim of this study is to find the cardiovascular responses to isometric exercise in young men and women.

### Material and Methods

#### Subjects

Thirty male subjects and thirty female subjects were randomly selected as per the inclusion and exclusion criteria and constituted the sample size of 60 for this research. Inclusion Criteria; Age group between 20 and 30 yrs. Exclusion Criteria; Known subjects of Cardio pulmonary disorders, Smokers, Alcoholics, Hypertensive subjects and Diabetic subjects.

Before the data collection procedures, the purpose and benefits of the study and the exercise were explained to the subjects. A 10 minutes rest was given before the independent variables are introduced and then the pretest scores of Systolic blood pressure, Diastolic blood pressure and the Heart rate were taken for all the subjects by using Sphygmomanometer (FUZZY LOGIC-PRESSURE MONITOR, ITALY). Room temperature was adjusted to be 27C degree. Isometric exercise to bilateral quadriceps muscles was performed for 2 minutes. The Isometric exercise was performed with the subjects in supine position and then the subjects were asked to push their knee back (or) to press the knee down and tighten their thigh muscles of bilateral side. Post test scores of Systolic blood pressure, Diastolic blood pressure and the Heart rate are taken immediately after performing the isometric exercise.

Hippocampal sections were transferred to a

### DATA ANALYSIS

Data were collected and tabulated, statistical analysis was administered using paired t-test and Unpaired t- test.

### RESULTS

This study was done to compare the Heart rate, Systolic blood pressure and Diastolic blood pressure of the Men and Women in response to isometric quadriceps exercise.

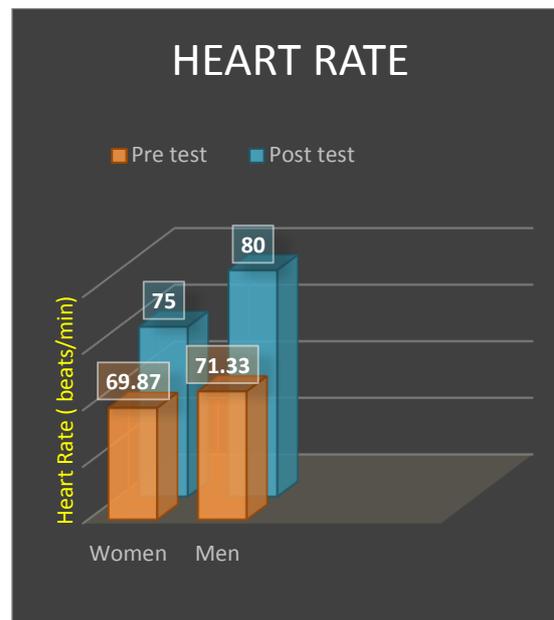
A statistically significant difference in cardiovascular responses was seen in Men and Women to isometric exercises.

The following results were obtained after using statistical analysis include paired 't' test and unpaired 't' test. The post mean of HR for men was 80.00 which is comparably more than the post mean 75.00 of women. The independent 't' test was found to be significant with 't' value 3.15 for 58 df at 0.01 level. The post mean of SBP for male was 125.47 and for women was 120.3, it was statistically significant ('t' value = 2.14, df = 58) at 0.05 level. So the SBP is significantly more among men than women.

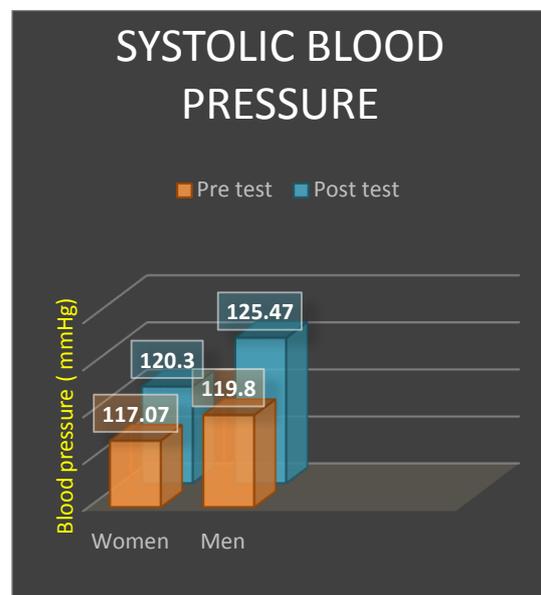
The post mean of DBP for male was 84.43 and for women was 80.47, it was statistically significant ('t' value = 2.27, df = 58) at 0.05 level. So the DBP is significantly more among men than women.

By the above analysis the Heart rate, Systolic blood pressure and Diastolic blood

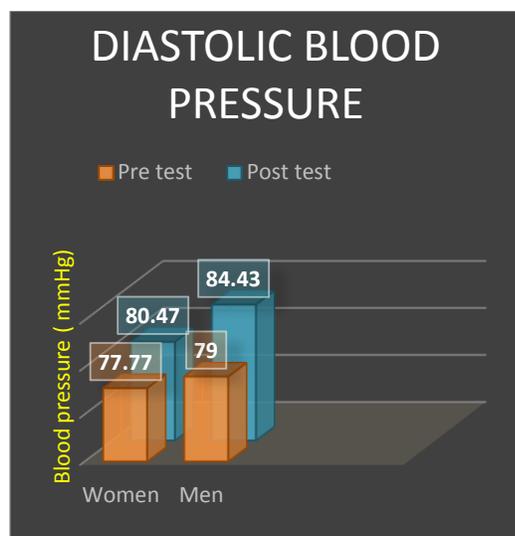
pressure were significantly increased in Men when compared to that in Women.



**Figure 1** – Comparison of Pre and Post test scores of Heart rate



**Figure 2** - Comparison of Pre and Post test scores of Systolic blood pressure



**Figure 3:** Comparison of Pre and Post test scores of Diastolic blood pressure

## DISCUSSION

In this study we have compared the effect of isometric quadriceps exercise on cardio vascular parameters between men and women. This study showed a highly significant increase in post exercise HR, SBP and DBP than the pre exercise values. These changes in the hemodynamic parameters were more marked in males as compared to females which is similar to many other studies

Krzeminski et.al (2012)<sup>14</sup>, 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 the basis of the activation of sympathetic adrenergic system, which was indicated by an increase in the plasma catecholamine level<sup>13, 14, 15</sup>.

In the present study, the Cardio vascular responses of both Men and Women are increased to isometric exercise. Isometric exercise greatly increases resistance to blood flow in the active muscles during the sustained contraction. In fact, intra muscular fluid pressure increases linearly with all levels of Isometric contraction force up to maximum. This causes significant rise both in arterial blood pressure and in the workload of heart throughout the exercise<sup>16</sup>. The static exercises obliterate the blood vessels in the active exercising muscle, raising the total peripheral resistance (TPR), thus increasing the pressure load or the after load on the heart. It is documented that the males have higher plasma levels of all three catecholamine's out of which plasma levels of epinephrine are higher, as compared to the females<sup>15</sup>.

Isometric exercise produces a characteristic pressor increase in blood pressure which may be important in maintaining perfusion of muscle during sustained contraction. This response is mediated by combined central and peripheral afferent input to medullary cardiovascular centers. In normal individuals the increase in blood pressure is mediated by a rise in cardiac output with little or no change in systemic vascular resistance<sup>15</sup>. Gatzke A (2005)<sup>16</sup>, found that the leg strength of Women scores averaged about only 72% of maximum values recorded by Men.

The result of this study implies why individuals with heart and vascular disease should refrain from all-out straining exercises such as isometrics or heavy lifting, and should seek more rhythmic muscular activity that results in a steady flow of blood and only moderate increases in arterial blood pressure and subsequent strain on the heart (William D. Mc Ardle et al, 1991)<sup>15</sup>.

Hence the results of these studies

should be kept in mind while prescribing Cardiovascular patients with Isometric exercise. Cardiac patients should be gradually exposed to sub maximum isometric training in supervised cardiac rehabilitation programs. Specific job tasks that require isometric or combined isometric and dynamic activities may be evaluated by work simulation studies<sup>17,18</sup>. This approach to cardiac rehabilitation may facilitate patients who wish to return to a job requiring frequent isometric muscle contraction<sup>19</sup>,

Finally, there is a need for additional research on the long-term effects of isometric exercise training on diseased cardiac system and performance.

### **Conclusion**

There is a significant increase in post isometric exercise Heart rate, Systolic blood pressure and Diastolic blood pressure in males and females. Hence the results of this studies should be kept in mind while prescribing Cardiovascular patients with Isometric exercise since specific job tasks may require isometric or combined isometric and dynamic activities.

**LIMITATION OF THE STUDY**

1. The study sample size was 60 subjects. So the result of this study cannot be generalized over the whole population.
2. As this study was conducted only in the age group of 20-30 years, the results cannot be generalized.
3. Only normal individuals were included in this study.

**SUGGESTIONS FOR FUTURE STUDY**

1. The study can be extended on a larger sample.
2. Similar studies can be conducted on males and females of different age group.
3. Similar studies can be done with other forms of exercises.
3. Similar studies can be conducted with various duration of static contraction.
4. Similar studies can be performed with other group of muscles.

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