

# Differences in $VO_2$ Maximum Value Post Resistance Exercises Between Male and Female

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**Abstract:**  $VO_2$  max is commonly used in clinical science as an indicator of cardiovascular fitness and its associated pathology. A sub maximal exercise test called the Queen's College Step Test (QCT) is used to gauge cardio respiratory fitness. This study was a Pilot type of study comparing two groups (Group A - Males, Group B - Females). 30 students were randomly selected where 15 were males and 15 females of age group between 20 - 25 yrs. After assessing strength of all students using Repetition maximum method, the average weight selected for the resistance training was 3Kg. 8 students were excluded as they were unable to meet the inclusion criteria of lifting 3Kg weight. Both the groups were given resistance exercises for 4 weeks, 3 days per week. Pre and Post completion of the exercises their  $VO_2$  max was calculated. Statistical analysis were done using SPSS v26 software and the data were tested using paired t - test. We have compared the pre and post intervention data within groups and post intervention data between groups using paired t - test. After the intervention, both males and females experienced similar positive changes in their  $VO_2$  max. However, comparatively Female Population has shown better improvement as compared to Male population in their  $VO_2$  max value.

**Keywords:**  $VO_2$  max, Repetition maximum, Resistance exercise, Queen's college step test

## 1. Introduction

The greatest quantity of oxygen a person can inhale is known as their  $VO_2$  max, and this number remains constant over time despite an increase in activity. Absolute  $VO_2$  max is stated in liters/min, and relative  $VO_2$  max is expressed in milliliters/kg/min. Maximal or submaximal tests, as well as direct or indirect techniques, can be used to estimate the  $VO_2$  max. The most popular tests are those that include walking or running, followed by those that use cycling and steps.  $VO_2$  max is commonly used in clinical science as an indicator of cardiovascular fitness and its associated pathology. The gold standard for determining someone's cardio - respiratory endurance is their  $VO_2$  max. Low  $VO_2$  max persons have a higher risk of early death as well as the onset of many chronic diseases, whereas high  $VO_2$  max individuals have a lower risk of chronic diseases, all - cause mortality, and coronary artery disease [4]. Maximal aerobic capacity ( $VO_2$  max) has become a powerful indicator of unfavorable health outcomes, including cardiovascular disease and all - cause mortality, over the past 30 years. Increases in  $VO_2$  max can be attained through exercise training, and a rise of one metabolic equivalent (3.5 ml  $O_2$  kg<sup>-1</sup> min<sup>-1</sup>) is linked to a 10–25% increase in survival. So, for adults who are currently in good health, fitness training represents a potentially significant preventative strategy to lower the chance of disease development. Exercise prescription needs to be optimised in order to prescribe the exercise intensity that will improve  $VO_2$  max, just like any other preventative medical measure [1].

A number of societies have released separate guidelines for resistance exercise training to maximize muscle growth, strength as well as increase in  $VO_2$  max [2]. Reduced preload, greater afterload, and improved contractility together

account for the relatively stable or decreased stroke volume that has been observed after resistance training. Peripheral skeletal muscle quantity and quality is a definitive determinate of cardiorespiratory fitness [3].  $VO_2$  max can be improved with resistance training exercises in young adults if their initial  $VO_2$  max is lower than 40ml/kg/min. According to research, youth of all ages can benefit from properly planned and closely monitored resistance training programmes. In particular, resistance training gives the brain maturation that is occurring as an additional stimulation, resulting in further development in comparison to kids who do not participate in resistance training. A suitable programme has been shown to improve bone health, reduce the risk of cardiovascular disease, reduce metabolic risk factors, improve body composition and boost self - esteem [5].

In order to assess the adaptive response to an exercise intervention plan, skeletal muscular strength is frequently measured. Although one - repetition maximum (1 - RM) testing on apparatus designed for training is more frequently used, dynamometry is still the "gold standard" for evaluating muscular strength in vivo. A person's maximal weight that they can lift during a specific rep range of an exercise is known as their repetition maximum (abbreviated "rep - max" or "rep - max"). It serves as a gauge for the strongest force a person is capable of producing and can be used to calculate how much weight to employ during a workout [7, 8].

A sub maximal exercise test called the Queen's College Step Test (QCT) is used to gauge cardio respiratory fitness. Stepping up and down on a 15 - inch step for 3 minutes at a fixed rate of 22 steps per minute constitutes the test. The maximum amount of oxygen that a person will consume during a test is known as  $VO_2$  max.  $VO_2$  max is a widely

regarded benchmark for evaluating cardio respiratory fitness. Cardiovascular disease is strongly predicted by a reduced maximum oxygen uptake <sup>[6]</sup>. An estimation of VO<sub>2</sub>max can be calculated after Queen's College Step Test using the formula:

Men: VO<sub>2</sub>max (ml/kg/min) = 111.33 - (0.42 x Heart Rate (bpm)) (1)

Women: VO<sub>2</sub>max (ml/kg/min) = 65.81 - (0.1847 x Heart Rate (bpm)) <sup>[6]</sup>. (2)

**Table 1:** VO<sub>2</sub>max norms for Men

Age	Very poor	Poor	Fair	Good	Excellent	Superior
13 - 19	<35.0	35.0 - 38.3	38.4 - 45.1	45.2 - 50.9	51.0 - 55.9	>55.9
20 - 29	<33.0	33.0 - 36.4	36.5 - 42.4	42.5 - 46.4	46.5 - 52.4	>52.4
30 - 39	<31.5	31.5 - 35.4	35.5 - 40.9	41.0 - 44.9	45.0 - 49.4	>49.4
40 - 49	<30.2	30.2 - 33.5	33.6 - 38.9	39.0 - 43.7	43.8 - 48.0	>48.0
50 - 59	<26.1	26.1 - 30.9	31.0 - 35.7	35.8 - 40.9	41.0 - 45.3	>45.3
60+	<20.5	20.5 - 26.0	26.1 - 32.2	32.3 - 36.4	36.5 - 44.2	>44.2

**Table 2:** VO<sub>2</sub>max norms for Women

Age	Very poor	Poor	Fair	Good	Excellent	Superior
13 - 19	<25.0	25.0 - 30.9	31.0 - 34.9	35.0 - 38.9	39.0 - 41.9	>41.9
20 - 29	<23.6	23.6 - 28.9	29.0 - 32.9	33.0 - 36.9	37.0 - 41.0	>41.0
30 - 39	<22.8	22.8 - 26.9	27.0 - 31.4	31.4 - 35.6	35.7 - 40.0	>40.0
40 - 49	<21.0	21.0 - 24.4	24.5 - 28.9	29.0 - 32.8	32.9 - 36.9	>36.9
50 - 59	<20.2	20.2 - 22.7	22.8 - 26.9	27.0 - 31.4	31.5 - 35.7	>35.7
60+	<17.5	17.5 - 20.1	20.2 - 24.4	24.5 - 30.2	30.3 - 31.4	>31.4

## 2. Aim and Objectives

### Aim

To identify the difference of VO<sub>2</sub>max value post resistance exercises between male and female.

### Objectives:

- To determine the VO<sub>2</sub>max value post resistance exercises in male.
- To determine the VO<sub>2</sub>max value post resistance exercises in female.
- To determine the difference of VO<sub>2</sub>max value post resistance exercises between male and female.

## 3. Need of the Study

The purpose of the study is to find out the impact of resistance exercises on cardiovascular system and whether there is any difference in VO<sub>2</sub>max values post resistance exercises in male and female.

## 4. Research Questions

- Is there any effect of resistance exercises on cardiovascular system?
- Is there any difference in VO<sub>2</sub>max value post resistance exercises in males and females?

## 5. Hypothesis

### 5.1 Alternative Hypothesis

- There are changes noted on cardiovascular system post resistance exercise.

- There is a difference noted in VO<sub>2</sub>max value post resistance exercise in males and females.

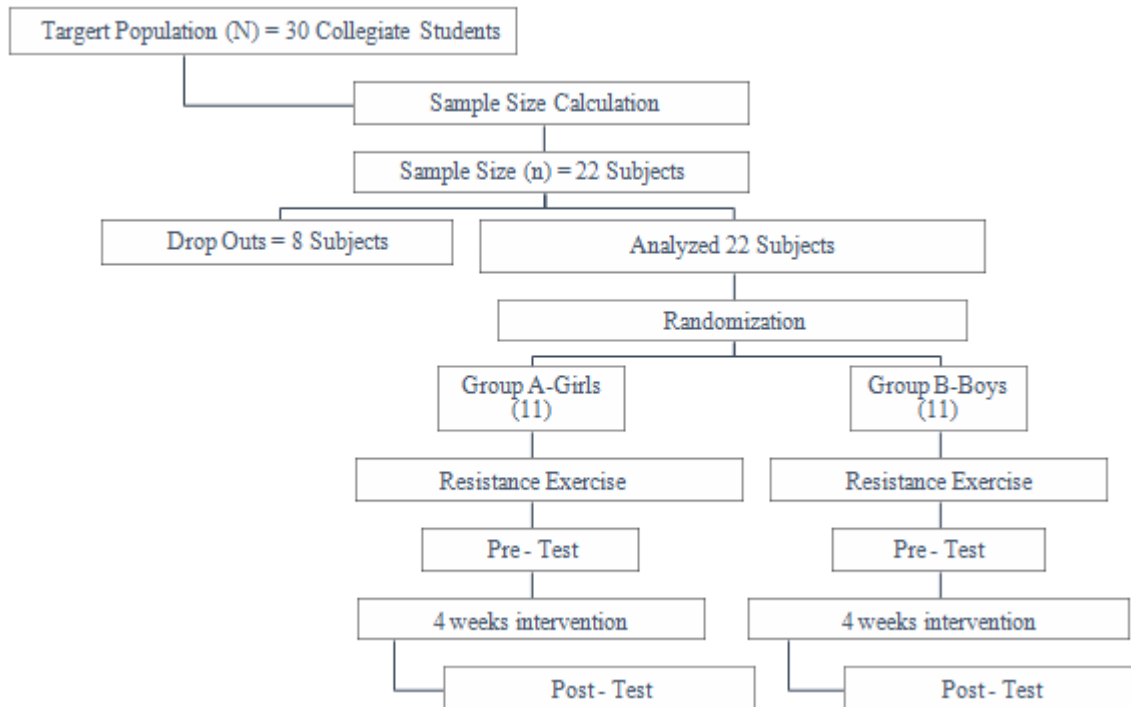
### 5.2 Null Hypothesis

- There are no changes noted on cardiovascular system post resistance exercise.
- There is no difference noted in VO<sub>2</sub>max value post resistance exercise in males and females.

## 6. Methodology

### 6.1 Methods

This study was a Pilot type of study comparing two groups (Group A - Males, Group B - Females). Consent was taken from all participants before participation and the participants were taken from Physiotherapy Department of School of Health Science, The Neotia University, Sarisha, West Bengal. 30 students were randomly selected where 15 were males and 15 females of age group between 20 - 25 yrs. After assessing strength of all students using Repetition maximum method, the average weight selected for the resistance training was 3Kg. 8 students were excluded as they were unable to meet the inclusion criteria of lifting 3Kg weight. Both the groups underwent Queen's College Step Test and their VO<sub>2</sub> max was calculated. Both the groups were given resistance exercises for 4 weeks, 3 days per week. Post completion of the exercises after 4 weeks, again their VO<sub>2</sub>max was calculated. Subjects unable to lift 3Kg of weight with 10 repetition maximum and subjects with health problem such as serious congenital diseases, history of musculoskeletal issues, history of neurological issues, and history of cardio - respiratory issues were excluded from the study.



Flow Chart 1: Randomization

## 6.1 Outcome Measures:

- 6.1.1** An estimation of VO<sub>2</sub>max calculated after Queen's College Step Test using the formula: As equation no. (1) for Men and (2) for women
- 6.1.2** An estimation of strength calculated after Repetition Maximum (RM) scale

## 6.2 Procedure:

**6.2.1 Queen's College Step Test (QCT):** Subjects were asked to step up and down on a 15 - inch step for 3 minutes at a fixed rate of 22 steps per minute. After completion the subjects were asked to sit down on a chair and their heart beats were counted for 1 min. Now an estimated VO<sub>2</sub>max was calculated using the formula: As equation no. (1) for Men and (2) for women

**6.2.2 Repetition maximum (RM):** Subjects were given 1Kg of weight and were asked to lift 10 times completing full range of motion. They could successfully complete it. Then the same procedure was repeated but the weight was increased to 2Kg than to 3Kg than to 4Kg. It was observed that the target population was able to lift 3Kg appropriately completing the full range. However, with 4Kg they were facing difficulties. So 3Kg weight was selected for performing the research.

**6.2.3 Resistance exercise:** Before initiating with the resistance training, 10 min of warm up was done. Each group were given 4 types of resistance exercises with 3Kg of weight with 10 repetitions thrice a week for 4 weeks.

**6.2.3.1 Biceps curl:** Subjects were made to stand tall with their feet hip width apart. 3 Kg weight cuffs were wrapped in each wrist with their hands hanging at the side of their body with palms facing forward. They were asked to bend their elbows and lift the weight approaching their shoulder, complete range of movements were performed.

**6.2.3.2 Triceps curl:** Subjects were made to stand tall with their feet hip width apart. 3 Kg weight cuffs were wrapped in each wrist with their hands above the head and were asked to bend their elbow back down to complete the range of motion.

**6.2.3.3 Hamstring curl:** Subjects were made to stand tall with their feet hip width apart. 3 Kg weight cuffs were wrapped in each ankles. Hands were placed in the waist. Subjects were asked to slowly bend the right knee, bringing the heel towards the butt. Similarly repeated with other leg.

**6.2.3.4 Quadriceps curl:** Subjects were made to sit on a chair, with their feet together. 3Kg weight cuffs wrapped around their ankle. Subjects asked to straighten the knees. Similarly repeated with other leg.

## 7. Data Analysis

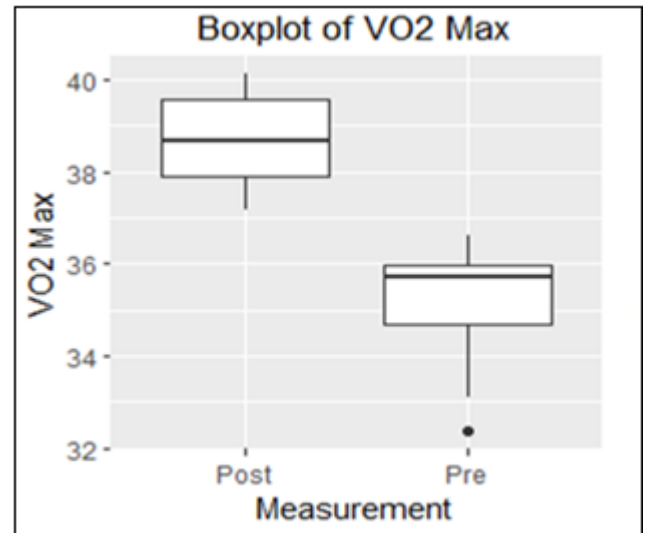
All statistical analysis were done using SPSS v26 software and the data were tested using paired t - test. We have compared the pre and post intervention data within groups and post intervention data between groups using paired t - test. While the p - value suggests the probability of tracking such a difference due to nothing more than random chance, the t - value indicates the magnitude of the difference that can be observed between the means of the two groups. This is done under the assumption that there is no real difference between the groups.

### 7.1 Result

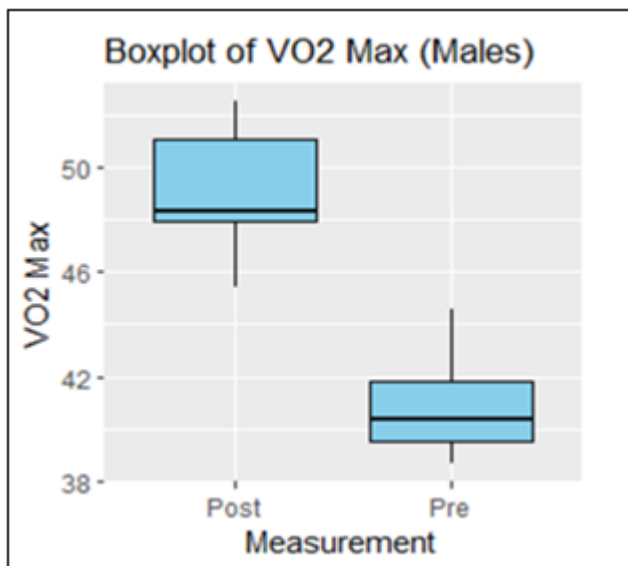
The statistical significance of the findings can be evaluated using the p - value ( $\leq 0.05$ ) as a basis for comparison. The results of the paired t - test for VO<sub>2</sub> max show a significant difference in VO<sub>2</sub> max before and after the intervention among the boys, with a t - value of - 9.638632 and a p - value of 2.224996e - 06, respectively. Also, the t - value for

the paired t - test of VO2 max in females is - 5.759327, which indicates that there is a significant difference between the measurements taken before and after the intervention. The p - value comes in at 0.0001828218, which is lower than the traditionally accepted threshold of 0.05 for significant difference. Therefore, we are able to draw the conclusion that there is a statistically significant difference in the VO2 max of females both prior to and after the intervention.

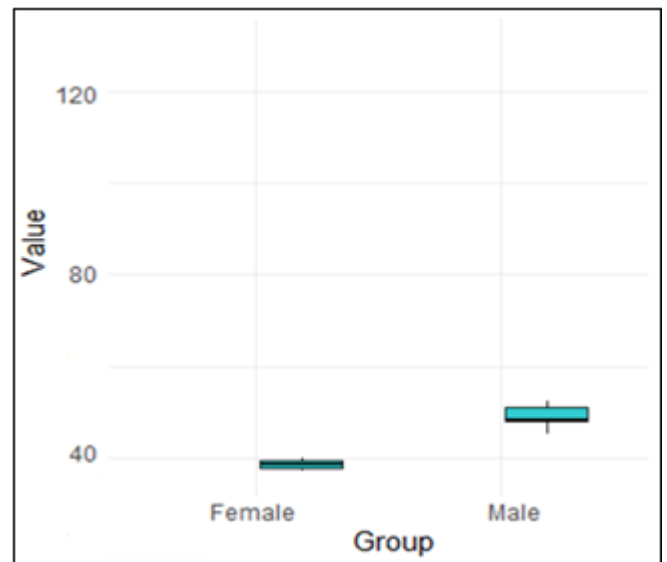
After the intervention, both males and females experienced similar positive changes in their VO2 max, as was highlighted by the comparative analysis between the two genders. Both males and females exhibited statistically significant changes in their VO2 max throughout the course of the study. This suggests that the intervention was successful in improving both the cardiovascular health and levels of fitness of both sexes. However, comparatively Female Population has shown better improvement as compared to Male population in there Vo2 max value. Female Vo2 max value Post Training is 0.0001828218 and Male population Vo2 max value is 2.224996e - 06. Therefore we can conclude that VO2 max Value improved in both the population post training but Female population showed significant improvement.



Graph 2: Comparison of VO2 max pre and post intervention among females



Graph 1: Comparison of VO2 max pre and post intervention among males



Graph 3: Comparison of VO2 max post intervention among both males and females

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**References**

[1] TRISHA D. SCRIBBANS, † STEPHAN VECSEY, \* PAUL B. HANKINSON, \* WILLIAM S. FOSTER, \* and BRENDON J. GURD‡. (n. d.). *The Effect of*

*Training Intensity on VO<sub>2</sub>max in Young Healthy Adults: A Meta - Regression and Meta - Analysis.*

- [2] Hayao Ozaki & Jeremy P. Loenneke & Robert S. Thiebaud & Takashi Ab. (n. d.). *Resistance training induced increase in VO<sub>2</sub>max in young and older subjects.*
- [3] DENISE L. SMITH & BO FERNHALL. (n. d.). *CARDIAC RESPONSES TO ACUTE RESISTANCE EXERCISE Resistance exercise is seldom used with the expressed purpose of enhancing cardiovascular function, but it does result in acute and chronic cardiovascular changes. This section details the acute cardiac responses to resistance exercise.*
- [4] Danielle L Kirkman, P. R. D. L. P. F. S. C. (n. d.). *Resistance Exercise for Cardiac Rehabilitation.*
- [5] Hayao Ozaki, J. P. L. R. S. T. & T. A. (n. d.). *Resistance training induced increase in VO<sub>2</sub>max in young and older subjects.*
- [6] Newland, A. N. K. (n. d.). *Queen's College Step Test and Its Validity of VO (2max) Prediction on Young Healthy Females.*
- [7] Kalin Strength Standards. (n. d.). *Repetition Maximum Guide: What It Is & How To Use It.*
- [8] Vivo in humans Lex B. Verdijk, L. van L. K. M. & Hans H. C. M. S. (n. d.). *One - repetition maximum strength test represents a valid means to assess leg strength in vivo in humans.*