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# To determine the correlation of recovery pulse rate and $VO_2$max on performance of queen's College step test in young adult Indian females

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**Abstract**
**Aim:** To determine the correlation of recovery pulse rate and $VO_2$max on performance of Queen's college step test in young adult Indian females.
**Methodology:** 100 female subjects age ranging from 20-29 years were explained about the test procedure.
**Result:** Significant Results were obtained.
**Conclusion:** This study has demonstrated Correlation between Recovery pulse rate and $VO_2$max

**Keywords:** pulse rate, $vo_2$max, queen's college step test, Indian females

## 1. Introduction

Cardio-respiratory fitness in terms of maximum oxygen uptake ($VO_2$max) reflects physical fitness of a person.$VO_2$max is single best measure of cardio-respiratory capacity and is considered as a bench mark to quantify Cardiovascular functional capacity and aerobic fitness [1] The maximal oxygen consumption attained during a graded maximal exercise to voluntary exhaustion has long been considered by the World Health Organization as the single best indicator of Cardio-respiratory fitness [2] It also shows the amount of oxygen which is utilized by the working muscles and thus internationally accepted [3] $VO_2$max value quantitatively express a person's capacity of aerobic resynthesis of ATP. As such, it is an important factor in determining one's ability to sustain high intensity exercise for longer than 4-5minutes.[4]Value of $VO_2$max may vary depending on geographical conditions, hereditary, stature of person, BMI, mode of exercise which makes individual of different masses to be compared [5] According to Av hill and Lipton [6], the concept of $VO_2$max came into existence in relation to maximal oxygen transport from the environment to the mitochondria, to support oxidative production of ATP to do physical work.

Post-exercise heart rate recovery, though a readily obtainable parameter and a powerful and independent predictor of cardiovascular and all-cause mortality in healthy adults and in those with cardiovascular diseases, is often overlooked as an indicator of cardiovascular fitness along with $VO_2$max as a variable. Heart rate recovery (HRR) is mainly thought to be due to parasympathetic reactivation and has been shown to be a remarkable complement to a medical and/or physical assessment of an individual [7]. Cardio respiratory fitness is the ability of larger muscle group to perform moderate to high intensity exercise for prolonged period of time [8]. The execution of such exercise depends upon the functional status of respiratory, cardiovascular and musculoskeletal system. According to Noakes [9] those individual who have higher level of fitness have greater capacity to transport oxygen to the working muscles of the body and thus have higher range of $VO_2$max.

Thus, those with sedentary life style or less active individual have lower level of $VO_2$max and are prone to posses' greater risk of developing cardiovascular disease and high rate of mortality [10]. Thus it can be helpful to health care professionals to reduce the risk and increase the level of fitness of individuals, functional capacity and athletic performance.

## 2. Subjects and Methods

Depending on the inclusion and exclusion criteria 100 subjects was finally selected for the test. A written consent was taken prior to the starting of the protocol. After approval was obtained from the department each subject was given information sheet and test was explained. They were asked to wear comfortable clothing and shoes.

Resting pulse rate from right carotid artery was taken as a pre test measure and was noted down. Prior to the starting of the test each subject were asked to perform the test 1hour before so they all understands the test procedure and get accustomed to the beeps. Then the test was started by asking subject to move up and down on stool according to pre-set metronome at rate of 88 beeps per minute for a period of 3 minutes. Movement was according to beeps, on the first beep dominant leg goes up and on the second beep other leg ascends up, while on the 3$^{rd}$ beep the dominant leg descend down and on the 4$^{th}$ beep the other leg descends down from stool which goes on for 3minutes.That is up-up-down-down. After the completion of the test right carotid pulses for 15 seconds from 5$^{th}$ to 20$^{th}$ seconds soon after performance of step test as per the QCST protocol which end after three minute was taken. Then measurement obtained from 5$^{th}$ -20$^{th}$ seconds of recovery pulse rate was then multiplied to 4 to get pulse rate in beats per minute. The value obtained was then incorporated to predict maximum oxygen uptake capacity in Mc Ardle.

$PVO_2$max(ml/kg/min)=65.81-(0.1847xRecovery pulse rate in beats/min)

**Table 1**

| N= No of subjects | 100 female's subject age 20-29years was included. |
|---|---|
| Pre test protocol | • 120-subjects were willing to participate<br>• 110-subjects where shortlisted<br>• 100- participated according to inclusion and exclusion criteria was taken<br>• Written consent was filed |
| Pre test measure/reading | • 1 hour prior subjects were allowed to perform the test so that they get used to do the beeps.<br>• Resting pulse rate was measure from right carotid artery same day |
| Protocol | • Movement was according to beeps<br>• Subjects moved up and down on stool at rate of 88 beeps/min for 3 minutes<br>• Movement started with right leg up followed by left leg and then right descend down first followed by left on stool.<br>• i.e-up-up-down-down. |
| Post test measure | • Right carotid pulse for 15 seconds from 5$^{th}$ to 20$^{th}$ sec after completion of procedure was taken<br>• Readings obtained was multiply by 4 to obtain beats per minute<br>• Post test reading was noted<br>• Result was statistically analyzed. |

## 3. Results

**Table 2**

| Pre test measure | | | | |
|---|---|---|---|---|
| | **Age** | **Resting pulse rate** | **Recovery pulse rate** | **$PVO_2$ max** |
| Mean | 24.29 | 74.04 | 142.8 | 39.43 |
| S.D | ±2.82 | ±3.56 | ±16.55 | ±3.05 |
| Post test measure relation of variables and $PVO_2$max | | | | |
| | Age | Resting pulse rate | Recovery pulse rate | |
| P Value | <0.0001 | <0.0001 | <0.0001 | |
| R value | -0.3993 | -0.3872 | -1 | |
| Significance | High significance | High significance | Perfect negative correlation | |

| Variables | Total number of females | Mean | S.D. | Range |
|---|---|---|---|---|
| Age in years | 100 | 24.29 | ± 2.82 | 20-29 |
| Resting pulse rate in bpm | 100 | 74.04 | ± 3.56 | 70-80 |
| Recovery pulse rate in bpm | 100 | 142.8 | ±16.55 | 80-168 |
| $PVO_2$ max in ml/kg/min | 100 | 39.43 | ± 3.05 | 34.78-51.03 |

Table 2: Table showing statistics of study variables used in the study for 100 females where

- Age in years ranging from 20-29 shows mean 24.29, S.D ±2.82
- Resting pulse rate ranging from 70-80 shows mean 74.04 and S.D ±3.56
- Recovery pulse rate in bpm ranging from 80-168 shows mean 142.8 and S.D ± 16.55
- $PVO_2$max 39.43 and S.D ± 3.05 in ml/kg/min ranging from 34.78-51.03

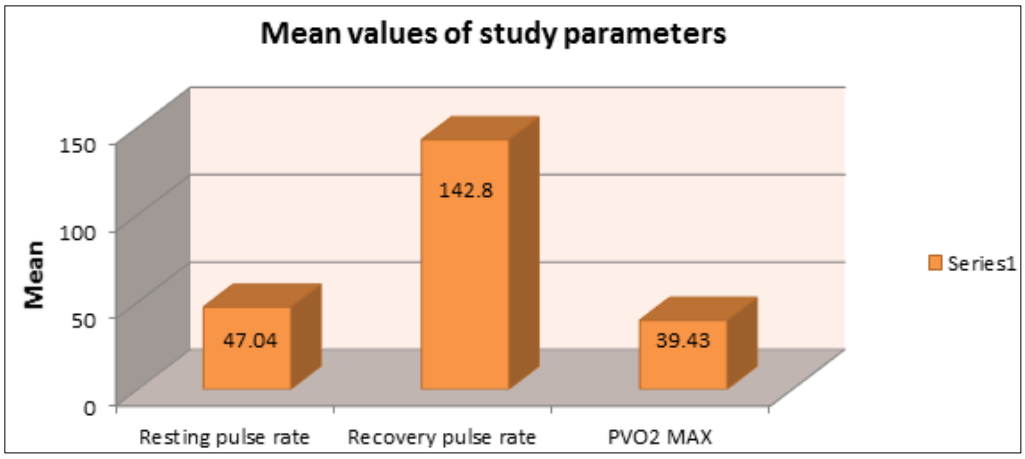


**Fig 1:** Showing variables such as resting pulse rate, Recovery pulse rate and $PVO_2$max on X axis and values of Resting pulse rate - 47.04, Recovery pulse rate -142.8 and $PVO_2$max-39.43 on Y axis.

**Table 3:** Showing the mean 39.43 and S.D± 3.05 for $PVO_2max$ in ml/kg/min between age group 20-29yrs.Statisticalyr-value was found to be-0.3993 and p-value<0.0001.This show high significance relation among the variables.

| Age | $PVO_2max$ | | r-value | p-value | Significance |
|---|---|---|---|---|---|
| | Mean | S.D. | | | |
| 20-29 | 39.43 | ±3.05 | -0.3993 | < 0.0001 | Highly Significant |

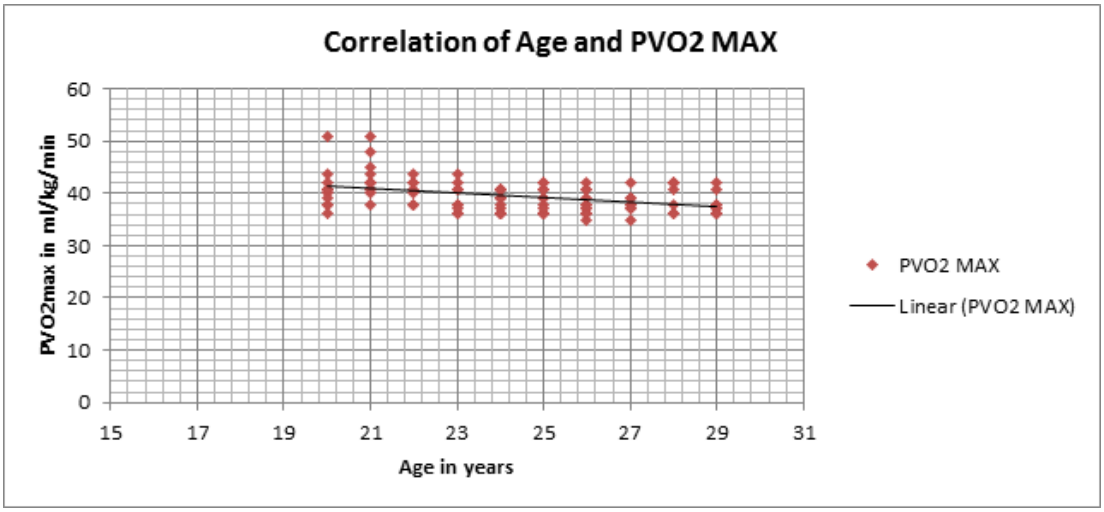


**Fig 2:** Showing scatter diagram between age 20-29yrs and $PVO_2max$ in ml/kg/m.X axis showing age whereas y axis shows $PVO_2max$ in ml/kg/min.There is a significance relation between the variables age and $PVO_2$showing as age increases $PVO_2max$ decreases.

**Table 4:** Showing $PVO_2max$ in ml/kg/min and Resting pulse rate was ranging from 70-80 including 100 females with mean 74.04 and S.D ± 3.56.Statistically p value <0.0001 and r value -0.3872 was calculated which shows high significant correlation between this two variables.

| Resting Pulse Rate | Number of Females | $PVO_2max$ | | r-value | p-value | Significance |
|---|---|---|---|---|---|---|
| | | Mean | S.D. | | | |
| 70-80 | 100 | 74.04 | ±3.56 | -0.3872 | <0.0001 | Highly Significant |

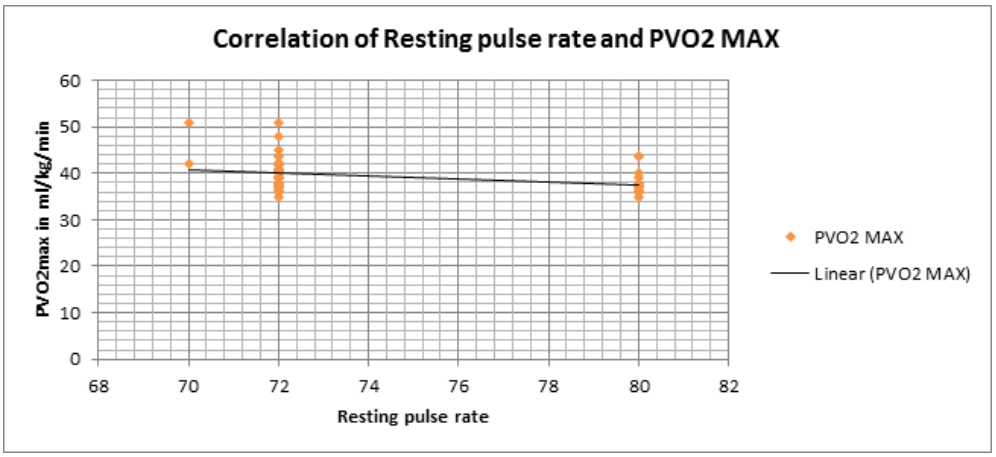


**Fig 3:** Showing Resting pulse rate in beats/minute on X axis and $PVO_2max$ in ml/kg/min on Y axis. Correlation was documented were significance relation between two variables is seen showing as resting pulse increases there is decrease in $PVO_2max$ value.

**Table 5:** Showing $PVO_2max$ in ml/kg/min and correlation between Recoverypulse rate in beats per minute (bpm).Recovery pulse rate ranges between 80-168 for 100 female subjects.The mean $PVO_2max$ was calculated to be 142.8 and S.D ±16.55.Statistically p valuewas highly significant<0.0001 and r value was having perfect negative correlation that is -1.

| Recovery pulse rate | Number of Females | $PVO_2max$ | | r-value | p-value | Significance |
|---|---|---|---|---|---|---|
| | | Mean | S.D. | | | |
| 80-168 | 100 | 142.8 | 16.55 | -1 | <0.0001 | Highly Significant |

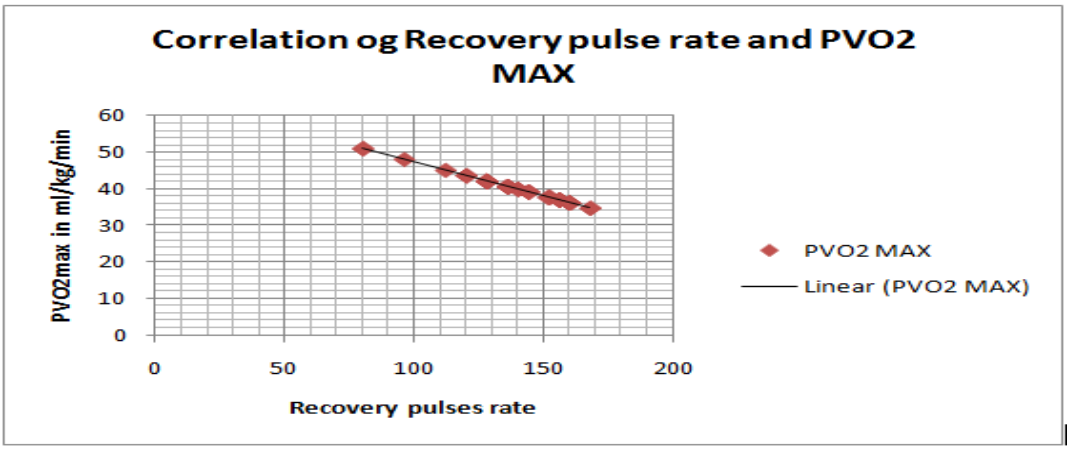


**Fig 4:** Showing Recovery pulse rate on X axis from80-168 and $PVO_2max$ on Y axis. Correlation between two variables shows when $PVO_2max$ increases Recovery pulse rate decreases.

## 4. Discussion

The result of the present study indicates the mean $PVO_2max$ derived on performance of QCST was 39.43± 3.05 ml/kg/min and Recovery pulse rate was 142.8± 16.55. This determination was based on indirect estimation of maximum oxygen uptake after performance of QCST and correlating it with recovery pulse rate in healthy young adult Indian females which was the objectives of study. Direct estimation has high degree of accuracy and has to be measured directly with graded exercise testing in the laboratory set up which is impractical when day to day measurements are taken. Moreover, when large numbers of population have to be studied to determine the $VO_2max$ directly, then it consumes lot of time. So in such situations, indirect methods to estimate $VO_2max$ can be made use of and the same has been done in the study. In daily practice where large group is to be calculated a field test are more applicable. Queens's college step test not only save time but also is economical and can be implemented at ease even in the outpatient departments to determine the fitness.

In the current study, the prediction are based on the 15 second recovery pulse rate after performance of QCST. The predicted $VO_2max$ achieved in this study for the study population was having a mean of 39.43±3.05ml/kg/min and ranged between 34.78-51.03ml/kg/min for the age group of 20-29 years having the mean age of 24.29±2.82 years of females was highly significant with p-value=<0.0001 and this value was obtained by Shamsi, *et al.* 2011 [11]. Chatterjee S & Bandhopadhyayet *et al.* [12], done a study in India were they worked on female students with application of QCST for estimation of maximum oxygen uptake on the subjects who had a mean age of 21.9± 3.2 years.

Contrary to this study Chatterjee et al. [12] done as study in India but eastern region also computed an equation with SEE=0.344 ml/kg/min and was found to be more different when compared to Mc Ardle's equation. The perfect negative correlation suggest than higher recovery pulse rates are always found to produce lesser $VO_2max$ indicates poor physical fitness. But in our study the study sample was physically fit and was normal healthy Indian females based on the values.

The recovery pulse rate was taken for 15 seconds that is within the $5^{th}$ -$20^{th}$ second after performance of QCST which shows the fact that heart rate slow down during the 1-2 minute after the completion of the exercise and then slowly thereafter. This is due to loss of central command, activation of the baro reflex and other mechanism which contributes to the rise in parasympathetic activity and thus cause decrease in heart rate despite maintained sympathetic activation, this is could be further trained to achieve good endurance by working on aerobic fitness of subjects. In the current study the error is small and if the errors are smaller the prediction scores are likely to be correct and thus can be utilized in clinical trainings where direct measurements are not feasible and possible.

## 5. Conclusion

This study has demonstrated Correlation between Recovery pulse rate and $VO_2max$ which was estimated indirectly by the application of QCST in Indian Females aged 20-29 years and this value was found to be of $VO_2max$ 39.43±3.05ml/kg/min and ranging between 34.78 to 51.03ml/kg/min and Recovery pulse rate 142.8 ± 16.55 and ranging between 80-168. The equation obtained from the current study which has shown a more proximity with Mc Ardel's equation further signifies the validation and accuracy of predicted $VO_2$ max. This study is only useful on same geographical location. Therefore whenever QCST is applied it is suggested not to apply in its original form but with the modified equation obtained from the population in which it has to apply.

Furthermore, the findings of the current study reported a significant and a perfect negative correlation between 15sec pulse rate converted to bmp with that of $VO_2max$ which stresses the fact that 15 sec recovery pulse rate is sufficient enough to determine $VO_2max$ after performing of QCST.

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