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Correlation between Borg's Rate of Perceived Exertion and V̇O2max on Queens College step test in female medical students

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Abstract
Background: Vo2 max is the gold standard measure of aerobic capacity. It reflects the amount of oxygen utilized by working muscles during incremental exercise. The rate of perceived exertion (RPE) reflects the physical fitness and helps to set the exercise intensity by using Borg scale. Queens College Step Test (QCST) is a 3-min test used to determine cardio-respiratory fitness in terms of VO2max.
Methodology: 30 female participants with age group 18-22 were included. Participants were asked to perform QCT for 3 min & grade their RPE in end of test. Heart rate (HR) was taken & Vo2max was calculated. Data analysis was done by using Spearman Correlation Test.
Result: There is negative correlation between REP & Vo_2 max, HR & Vo_2 max & slight negative correlation between HR & RPE.
Conclusion: There is negative correlation between RPE & Vo2 max, HR & Vo2 max using QCT in female college students.

Keywords: QCT, RPE, VO2 Max, HR, Borg scale

1. Introduction

Measurement of the maximal amount of oxygen that the organism can use per unit of time is considered the best indicator for cardio-respiratory fitness and aerobic endurance [1]. Physical activity is important for fitness. It increases functional capacity by improving maximal oxygen consumption (Vo2 max), body composition, muscular strength and endurance, and flexibility. Exercise training is important component of preventive and rehabilitative programs designed to address metabolic and cardiovascular diseases, as well as orthopedic injuries and musculoskeletal disorders[2]. Research has shown that regular physical activity significantly reduces the risk of morbidity and mortality from coronary artery disease (CAD). The maximum oxygen uptake gives accurate measure of the aerobic power, and is highly related to the cardiac output, heart rate, and stroke volume (Astrand, 1976) [1].
Perceived exertion may be defined as the subjective feeling of effort, strain, discomfort, and/or fatigue that is experienced during physical exercise [2]. In the early 1960s, Gunnar Borg developed the 6–20 Rating of Perceived Exertion (RPE) scale. This scale has been generally useful as a valuable, reliable, and easily understood means of quantifying, monitoring and evaluating the exercise tolerance and magnitude of exertion in healthy adult populations and other groups [3]. An increase in exercise intensity is directly related to an elevation in exercise heart rate and other metabolic processes. Consequently, RPE can be used along with heart rate when monitoring exercise intensity. During aerobic activities, perceived effort is a combination of sensory input from muscles, joints, breathing rate and heart rate [4].
Data have been presented suggesting that the maximal transport of oxygen is limited by the central circulation rather than by the tissues' ability to utilize the oxygen. The maximal oxygen uptake (Vo2 max) is determined directly by group of tests (maximal) performed to exhaustion or indirectly through group of sub maximal. Vo2 max outcomes of comparisons between different tests are reported in many scientific articles [1]. Vo_2 max is the primary indicator of aerobic fitness, cardiovascular health, and endurance performance. The direct measurement of Vo_2 max is the criterion measure of aerobic capacity where the participant undergoes a maximal exercise test on a cycle ergo meter or treadmill and oxygen consumption is measured directly [5].
Step tests are one of the most widely used field tests for estimating Vo_2 max. One such test is the Queens college step test (QCT) developed by Mc Ardle *et al*, and Molanouri Shamsi *et al*. Queens College Step Test (QCST) is frequently used to determine the cardio-respiratory fitness in terms of maximum oxygen uptake or Vo_2 max. The sub-maximal QCST is a 3-minute step test. The investigators chose the bench height for convenience as most bleachers are approximately 41/3 cm. The pace is controlled by a metronome which is set to 88 beats per minute [1].

2. Materials and Method

A Randomized control trial including 30 female participants using simple random sampling was done. Participants with the age group of 18-22 years were included, and athletes, subjects with known cardiovascular diseases, neuromuscular disorders were excluded from the study. Each session lasted for 10-15

minutes including rest period. Prior to the test, participants were explained on how to use Borg's scale. Baseline parameters such as Heart rate (HR), Blood pressure and RPE were taken. A stepping bench of 16.25 inches in height was used to carry out the Queen's College Step test. The participants were asked to step up and step down in cadence with the metronome at the rate of 88 beats per minute for three minutes. At each minute, the participants were asked to grade / rate their exertion on Borg's Scale of Perceived Exertion. At the end of the 3 minutes the participants were asked to cease stepping and grade for RPE on Borg's scale and the heart rate was also taken and recorded immediately. Vo_2 max was then calculated by using the formula:

Vo_2 max for women = 65.81-0.1847* Heart rate.

Demographic data was collected and analysed for Vo2 max, RPE and HR. Analysis was done using Fig pad Instat demo version. Data was collected and presented in tabular form and analysed by using the Students Unpaired "t" test and Spearman correlation to compare mean values.

2.1 Data analysis

Table 1: Represent Pre & Post HR, RPE & Vo2 max

	Mean		Result
	Pre	Post	
HR	81.067	126.93	Significant, P<0.0001
RPE	6	15.13	Significant, P<0.0001
Vo2 Max	50.96	42.16	Significant, P<0.0001

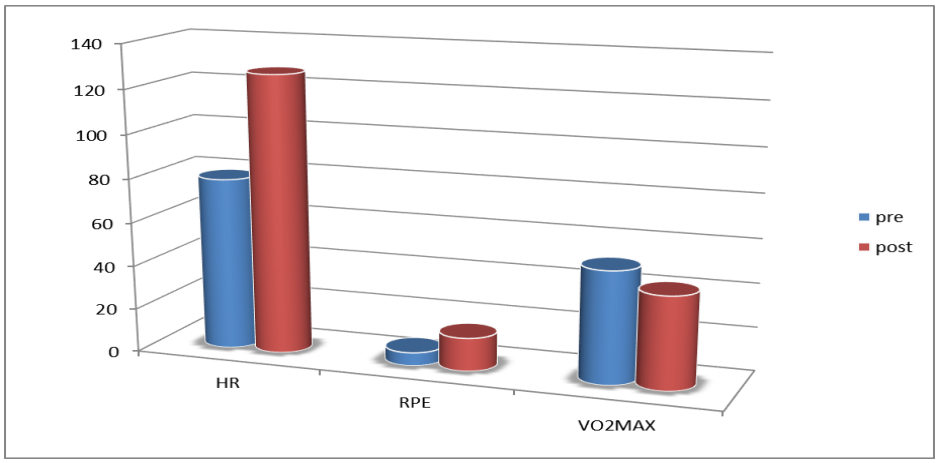

Fig 1: Demographic Representation of Pre & Post HR, RPE & Vo2 max

Table 2: Represents the mean values of post exercise heart rate, post exercise Rate of perceive exertion and Vo2 max.

	Mean	
	Pre	Post
HR	81.06	126.93
RPE	6	15.13
Vo2 Max	50.96	42.16

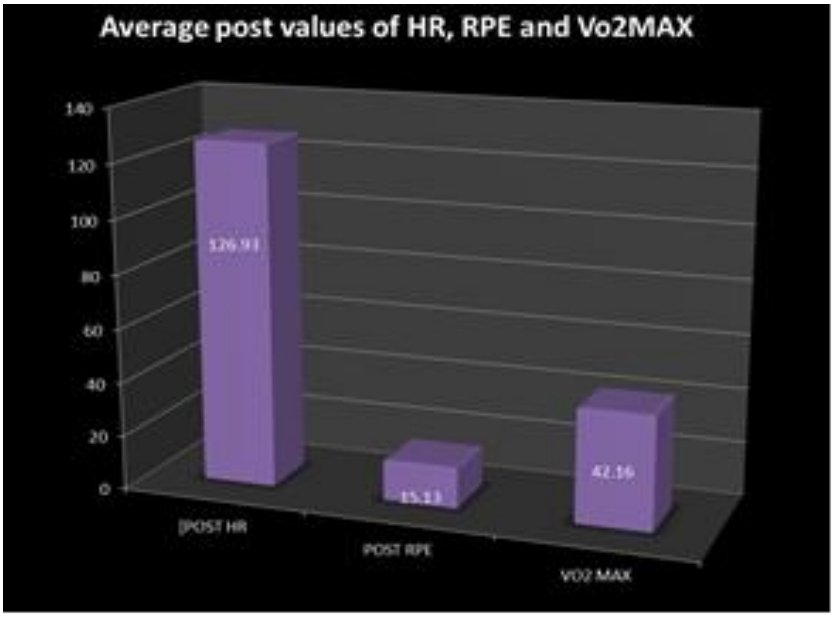

Fig 2: Represents the mean values of post exercise heart rate, post exercise Rate of perceive exertion and Vo2 max.

Table 3: Represent the correlation between RPE and Vo2 max

	Mean	
	Pre	**Post**
RPE	6	15.13
VO2 max	50.96	41.76

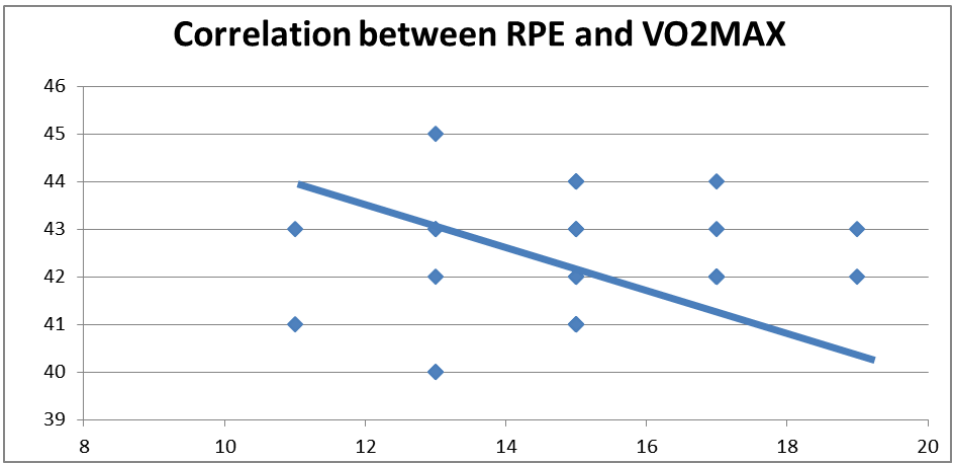

Fig 3: Represent the correlation between RPE and Vo2 max

By using Spearman Correlation test, it is found that there is negative correlation between RPE and Vo2 max with r value of -0.1600.

Table 4: Represent the correlation between Heart rate and Vo2 max

	Mean	
	Pre	**Post**
HR	81.06	126.93
Vo2 max	50.96	41.76

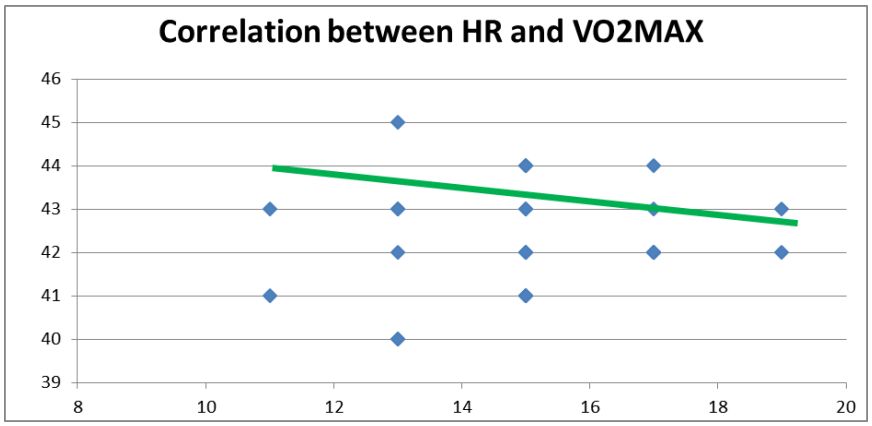

Fig 4: Represent the correlation between Heart rate and Vo2 max.

By using Spearman correlation test, it was found that there is negative correlation between Heart rate and Vo2 max with r value of -0.3327.

Table 5: Represent the Correlation between Rpe & Hr

	Mean	
	Pre	**Post**
RPE	6	15.13
HR	81.06	126.93

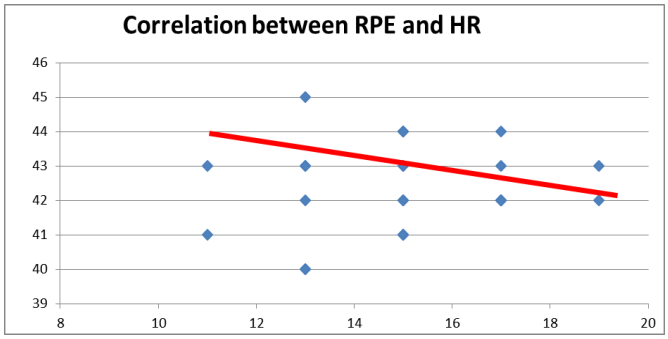

Fig 5: Represent the Correlation between Rpe & HR

By using Spearman Correlation test, it is found that there is sligh t negative correlation between RPE and HR with r value of -0.079.

3. Discussion

The result obtained in this study indicated that there is negative correlation between REP & Vo_2 max, HR & Vo_2 max and there is slight negative correlation between HR & RPE.

3.1 Rate of Perceived Exertion & Vo2 max

Rate of perceive exertion was measured by using Borg's scale. The mean baseline RPE before performing QCT was 6 and after the test it was 15.13. The mean baseline value of Vo2 max before performing the QCT was 50.96 and after QCT it was 41.76 with the mean difference of 9.20. Rate of perceive exertion and Vo2 max was correlated by using Spearman correlation and the study found out that there was negative significant correlation between RPE and Vo2 max with value of -0.1600 and p value 0.3983.

RPE during the intermittent work may be due to increased contribution of anaerobic mechanism to energy provision. RPE represent perception of training stress which can include both physical and psychological stress whereas Borg's scale is considered as a global indicator of exercise intensity including the physiological and psychological factor. Perceived exertion reflects the interaction between the mind and body. This psychological parameter is linked to many physiological events that occur during physical exercise. These physiological events can be divided into respiratory/metabolic such as ventilation and oxygen uptake and peripheral such as cellular metabolism and energy substrate consumption. Previous studies have demonstrated that an increase in ventilation, increase in oxygen uptake, increase metabolic acidosis or a decrease in muscle carbohydrate are associated with more intense perceptions of exertion [6]. Hetzler RK et.al in their study concluded that exercise modality does not affect the perception of exertion at Vo2 max, or maximal exercise and that a strong relationship exists between RPE and blood lactate concentrations [7]. Result obtained from the present study and from the above mentioned study, it was found that there was a negative correlation between RPE & Vo2 max.

3.2 Heart Rate and Vo2 max

HR before performing QCT was 81.06 and after the test it was 126.93 and of Vo2 max before performing the QCT was 50.96 and after QCT it was 41.76. Heart rate and Vo2 max was correlated by using Spearman correlation and the study found out that there was no significant correlation between Heart rate and Vo2 max with r value of -0.3327 and p value -0.724.

Vo2 max is the amount of maximal oxygen that body takes during exercise requiring near-maximal or maximal exertion/effort. Whereas, Heart rate is the pace at which heart beats per minute. It also suggested that those with a high Vo2 max will probably have a lower resting heart rate, lower blood pressure. High Vo2 max and a low resting heart rate are both associated with good cardiovascular fitness. Swain DP, *et al* in their study conclude that %HRR should be considered as an indicator of %VO2R, not %Vo2 max, when prescribing treadmill exercise [8]. Result obtained from the present study and from the above mentioned study shows that there was negative correlation between HR and Vo2 max suggesting that if one component increases the other will decrease

3.3 RPE and Heart Rate

The mean baseline RPE before performing QCT was 6 and after the test it was 15.13. The mean baseline value of HR before performing the QCT was 81.06 and after QCT it was 126.93. RPE & Heart rate was correlated by using Spearman correlation and the study found out that there was slight negative correlation between Heart rate and Vo2 max with r value of -0.0798 and p value 0.675

Used together, RPE and heart rate gives a more complete picture of fitness and overall health. If the heart rate is normal for a given activity, but RPE is higher than the normal, that could be a sign of getting sick or overtraining. If RPE and heart rate are lower than usual indicate that the body is likely to get adapted. Becoming familiar with RPE and heart rate assists with learning how body responds to exercise. This in order is helpful in shaping training zones, designing workout programs and assessing overall cardiovascular fitness. The increase of vagal reactivation in heart rate that accompanies exercise is due to a reduction in vagal tone. Recovery of the heart rate immediately after exercise is a function that a delayed fall in the heart rate after exercise might be an important prognostic marker [9]. The rise in heart rate during exercise is considered to be due to the combination of parasympathetic withdrawal and sympathetic activation. A drop in heart rate immediately after exercise is considered to be a reactivation of the parasympathetic nervous system. The physiological processes thought to be associated with a central signals of exertion dynamic exercise include heart rate (HR), ventilation (VE), respiratory rate (RR), and oxygen uptake (Vo2 max). Parallel changes in HR and rating of perceived exertion (RPE) were not clear when HR was manipulated experimentally. Heart rate does not appear to be related with a strong central signal of exertion. Sensations of ventilator function and discomfort are the only central signals that are consciously monitored [10]. Roger G. Eston *et al*. in their study found that the RPE is a good predictor of exercise intensity as heart rate in both the graded exercise test and the effort production test [11]. Result obtained from the present study and from the above mentioned study shows that there was slight negative correlation between HR and RPE.

4. Conclusion

The present study concludes that there is negative correlation between RPE & Vo2 max, HR & Vo2 max using QCT in female college students.

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