Cycle Ergometer VO2 Max Test (Male vs. Female Athlete and Male vs. Female Non-Athlete)

Exercise Science Department
Eric Jamison, Adonus Lee, Kira Ramsey, Brandon Thoms
Gardner-Webb University

Introduction

Measuring maximal oxygen consumption (VO_2) is a good indication of overall health and performance. VO_2 represents the maximal amount of oxygen (mL) a person utilizes over a unit of time (Pocari, Bryant, Comana, 2015, p. 871). In an exercise state, VO_2 is used to measure the effectiveness of the cardiovascular system to deliver oxygenated blood to the exercising skeletal muscles. An individual with a higher VO_2 is seen to have a greater amount of oxygen utilization and capacity for physical work. To measure Vo2, data variables of heart rate (HR) and minute ventilation (VE) were taken into account. HR is the the number of heart beats per minute (Pocari, et al., 2015, p. 869). VE measures the amount of air that passes through the lungs in 1 minute (Pocari, et al., 2015, p. 873).

Various factors can affect the VO_2 , one of the greatest factors is gender. According to McArdle, Katch & Katch (2015), women typically achieve VO_2 max scores 15-30% below values of males. Trained endurance athletes still fall below their male counterparts, but it is only seen to be 15-20% less. The differences are seen due to the body composition of the males and females. The body composition affects the hemoglobin concentration of an individual. Women tend to have more body than their male counterparts, while athletes regardless of male or female have lessened body fat. Increased muscle mass provides creates higher hemoglobin concentration allowing more oxygen to be carried in the blood to the skeletal system.

The research question posed is, how does relative VO_2 of males or females compare to each other? Research has shown that males will have an overall higher VO_2 than females. Also, trained individuals will have a higher VO_2 than those who are untrained. The purpose of this study is conduct VO_2 max tests on trained and untrained males and female to observe the differences in VO_2 . If the subject is a male, then the VO_2 will be higher than the females regardless of training.

Methods

To conduct this test, the team will arrive 45 minutes before the test is to start. The cart needs to be turned on, to warm-up at least 30 minutes prior to calibration. During the 30 minute time period, the mask will be put together, all additional equipment will be gathered, and the room will be set up in order to perform the test. The table should be moved out of the way and the bike should be on a level platform with the wheel down. The additional equipment to be gathered includes hose, mask, nose pieces, heart rate monitor, and stopwatches. Heart rate monitors should be checked before hand to make sure they are connected correctly to gather information. If the subject is a female, they will need the blue mask, the males will need to wear the headgear. After the 30 minutes, the cart is ready to be calibrated, this process should take about 10 minutes.

Methods

For calibration, the correct gas tank needs to be hooked up to the calibration machines, and the clear valve of the mask should be connected to the tube. The bike is not connected to the computer, so it should be set on the terminal and manual setting.

The subject should arrive around the time the cart is being finished calibrated. The subject should be resting in a chair for 5 minutes before the resting HR can be collected. Once the resting data is collected, the subject will be put on the Monarch Cycle Ergometer to perform the Astrand-Rhyming test. One person will control the cart while another will monitor the subject and the bike. The cart will collect the information that is needed every 30 seconds.

For the testing protocol, the subject will begin stage 0 (warm-up) at 0.0 kp with 90 rpm – 2 minutes. Once completing the warm up, the test will begin. The test will proceed as follows: Stage 1 – 0.5 kp at 90 rpm – 3 minutes, Stage 2 – 1.0 kp at 90 rpm – 3 minutes, Stage 3 – 1.5 kp at 90 rpm – 3 minutes, Stage 4 – 2.0 kp at 90 rpm – 3 minutes, Stage 5 – 2.5 kp at 90 rpm – 3 minutes. Each stage will continue by increasing 0.5 kp for each stage @ 90 minutes for 3 minute stages. The test will be completed once the subject quits. When the subject completes the test, they will follow with a cool down for 2 minutes at 0.0 kp.

After the warm-up is completed, the subject will be helped off the bike and taken to sit down for 5 minutes so that recovery HR can be collected. The subject will need to be shadowed for 5 minutes. At the 2 minute recovery mark, recovery HR should be taken. Equipment will need to be cleaned and data needs to be exported. This same process will be repeated for all 4 subjects.

Independent variable: Test protocol
Dependent variable: Subject, VO2 max, VE, HR
Data points: Vo2, HR, VE

Results

In figure 1 there is a direct correlation with a correlation value of 0.76. Figure 1 shows a male athlete and a female athlete's complete VO_2 max cycle ergometer test. As predicted the male had reached a higher VO_2 max than the female athlete. The male athlete maintained a higher VO_2 max than the female almost the entire test. In Figure 2 the correlation value between the male and female non-athlete is 0.45. The male reached a VO_2 max of 32.77 at 20 minutes while the female reached a Vo_2 max of 26.63 at 12 minutes. In both Figures, once peak VO2 was reached it declines rapidly in all 4 subjects. In table 1, VO_2 (ml/kg/m) average for the male and female were different but had a similar average heart rate. Table 2 is very similar to table 1, due to the males VO_2 (ml/kg/m) average being higher than the females but having a similar average heart rate throughout the test. The male's variables were all higher than the female variables due to physiological differences. Regardless of an athlete or non-athlete the males had a greater VO2 peak, HR, and VE than the females.

Table 1

Table 1. *Averages of $\dot{V}O_2$ (relative), heart rate, and ventilation for athletes*

	Male		
	Standard deviation	Mean	Range
VO_2 (ml/kg/m)	5.80	20.48	9.08-30.85
HR (bpm)	19	156	65-183
VE (L/min)	17.71	49.12	21.51-87.35
	Female		
VO_2 (ml/kg/m)	6.03	13.20	4.37-26.84
HR (bpm)	34	150	70-202
VE (L/min)	10.24	19.97	7.47- 43.08

Table 2

Table 2. *Averages of VO_2 (relative), heart rate, and ventilation for non-athletes*

	Male		
	Standard deviation	Mean	Range
VO_2 (ml/kg/m)	7.37	18.98	2.52- 32.76
HR (bpm)	28	140	85-188
VE (L/min)	20.40	39.35	6.25- 91.46
	Female		
VO_2 (ml/kg/m)	18.85	11.80	6.75- 26.63
HR (bpm)	18	136	96- 167
VE (L/min)	7.68	25.09	12.56- 45.38

Figure 1

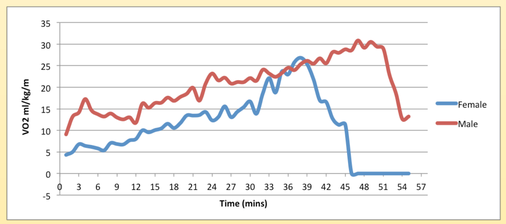

Figure 1. *VO2 max comparison between two athletes.*

Figure 2

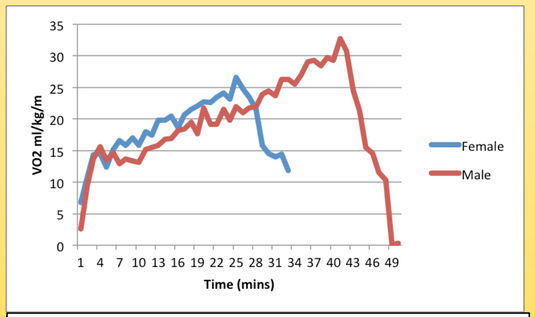

Figure 2. *VO2 max comparison between two non-athletes.*

Discussion

During the max VO_2 test we have found that the highest VO_2 was the untrained male patient. The hypothesis stated that the trained male would have the highest VO_2 because he is a football player. According to Randkovic (2010), football players are seen to have a higher Vo2 max than non-athletes. The average football player has a Vo2 max on 4.25 ml/kg/min while the average non-athlete has a Vo2 of 3.19 (Rankovic, G., Mutavdzic, V., Toskic, D., Preljevic, A., Kocic, M., Nedin Rankovic, G.,Damjanovic, 2010, p.46). This is stating that the football players should have the higher VO_2. Based on research you can see that the males had a higher VO_2 than females by a wide margin. The ranges for fair VO_2 for males are between 25-33.9 and the fair for females is 24-30.9 (McArdle, Katch, F, Katch, V, 2015, p.167). The ranges for average in the male category based off of age of the untrained male is 31-41.9 (McArdle, Katch, F, Katch, V, 2015, p.167). The male trained VO_2 max was 30.84 (ml/kg/m) this shows that he is in the fair category based off normative data found in textbook. This is a number that was expected to be higher based on the research done prior to the test. The female trained VO_2 was 26.83 (ml/kg/m) this number also puts her in the fair category based off the normative data that was found in our textbook. The untrained males maximum VO_2 was 32.76 (ml/kg/m) this places the individual the average category based of the normative data that is found in the textbook. The untrained females maximum VO_2 was 26.63 (ml/kg/m) this would put this patient into the fair category based on normative days found in the text book. This information tells us a lot about the patients back ground. This test showed that the untrained male had the highest VO_2. According to Haugen, et al. national-team soccer players had 5% higher VO_2 max than 1st-division players, 13% higher than 2nd-division players, and 9% higher than junior players. Midfielders had 8% higher VO_2 max than goalkeepers (Haugen et al, 2006). There were no significant differences were observed across outfield players or different age categories (Haugen et al, 2006). This is something that we also thought would play a huge role between the VO_2 differences of the two trained athletes. The difference between the trained subjects was 4.01. Because the trained male was supposed to have the highest VO_2 max we were saying that the trained female would give us the second highest VO_2 max. There was a very small difference in the VO_2 max between the trained male and female. The untrained male and the untrained female had a way bigger gap between their VO_2 max numbers. The difference between the max VO_2 for the untrained subjects was 6.13.

Discussion

One source of error was that the subjects did not reach their full VO2 max because they stopped when they got tired and did not go until they physically couldn't go anymore. The fact that the patients stopped when they got tired and not when they physically couldn't go anymore means that their VO2 max is not the max number that they could have gotten. If the subject would have pushed through, then their VO2 max would have been higher.

Gender is a big determinate in best athletic performances, due to the physiological difference (Hanjabam, Jyotsna ,2016, p.10). The average gender difference in aerobic capacity as measured by VO2 max. The average female value of VO2 max is about 70-75% of that of a male after he goes through puberty (Hanjabam, Jyotsna ,2016, p.10). This relates to our study because the male subjects had higher VO2 maxes than the females. This was the cause no matter what the background of the patient and if the patient was an athlete are not.

Conclusion

The purpose of this study is to conduct VO_2 max tests on trained and untrained males and female to observe the differences in VO_2. If the subject is a male, then the VO_2 will be higher than the females regardless of training. This study was conducted to see if the training would make the difference between male and female Vo2 max closer. According to the results, trained individuals had a decreased difference between male and female. This test proved the hypothesis wrong because the trained male should have had the higher VO_2. This did not take place however, the trained male had a higher Vo2 than the females as predicted.

References

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