

Measuring vo2 max: maximal oxygen consumption tests

[Environment](#), [Nature](#)



\n[[toc title="Table of Contents"](#)]\n

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1. [Methods](#) \n \t
2. [Procedure](#) \n \t
3. [Results](#) \n \t
4. [Discussion](#) \n

\n[/toc]\n \n

Maximal aerobic power (MAP) is described as the cardiorespiratory systems ability to function at full capacity, another way to look at it is the maximum rate the body can use oxygen during an intense exercise over a duration of a certain time frame. The rate at which an individual could extract and use the oxygen from the blood and supply it to their muscles would determine how high of a cardiorespiratory fitness the individual has. A gold standard way of testing cardiorespiratory fitness is by performing a VO₂ - max test. A VO₂ - max test is a direct measurement tool, it looks at the maximal amount of oxygen the whole body consumes during incremental exercise to the point of volitional exhaustion (2).

The Bruce Treadmill test is one kind of method used to evaluate an individual's VO₂ max score. The test involves 3-minute stages, each stage increases in speed and inclination; the stages are not gradually introduced, they occur abruptly at each 3-minute mark. Most Bruce Treadmill tests only occur for 8 to 12 minutes, at this point most individuals reach their highest level of exertion. Due to the intense speeds and inclination of the test this type of VO₂ max testing is not be suitable for untrained individuals. The

<https://assignbuster.com/measuring-vo2-max-maximal-oxygen-consumption-tests/>

Cooper 12-minute run test is another type of testing that is used to assess an individual's VO2 max. This test was one of the first types of max VO2 testing to be developed, it tests individuals VO2 max by having them complete a twelve-minute single stage test. The point of the test is to complete as many meters as possible during the timed run. This type of testing has been strongly correlated in young healthy adults; in other populations the data may not be as accurate since there is still a lack of reliability and accuracy in this type of VO2 max testing.

In 2017, a study was conducted using the Cooper 12-minute test to try and understand the tests-retest reliability. The experiment had 15 male amateur athletes run the Cooper 12-minute run twice over a period of 48 hours. The results showed that there were no major differences in the male athletes VO2 max scores between the two runs, the data also showed that their heart rates had no significant differences between the two tests. This recent study contradicted many past studies showing that Cooper's test is reliable and accurate in amateur long-distance runners, but it still did not prove that the test would be reliable and accurate for non-athletic individuals.

The purpose of conducting the Bruce Treadmill test and the Cooper 12-minute Run test is to gain knowledge and understanding of two gold standard tests that evaluate cardiovascular endurance or aerobic fitness. As well as become familiar with the field based predicative test for maximal aerobic power and understand the importance of metabolic calculations and their limitations. The independent variable for the Bruce Treadmill test is time, and the dependent variable is the individuals' VO2. In the Cooper 12-

minute test, the independent variable is time, and the dependent variable is the distance the individual covers in meters. It is hypothesized, that the individuals who participated in the Bruce Treadmill test will have a higher VO₂ max the longer they run on the treadmill, and the students VO₂ max will increase as they cover more distance in the Cooper 12-minute run test.

Methods

For the measuring VO₂ max lab, two different experiments were conducted to show how maximal oxygen consumption can be measured. The first test done to measure VO₂ max was the Bruce Treadmill test. Twelve participants from four Kinesiology Exercise Physiology Lab Sections were chosen for the experiment since they volunteered. Subject (series) 1 was a male and he weighed 89.3 kg and was 173 cm tall, subject 2 was a male as well and he weighed 76.6 kg and was 171 cm tall, and subject 3 was a female and she weighed 58.5 kg and was 164 cm tall. Subject 4 was female and weighing in at 72 kg and was 170 cm tall, subject 5 was female weighing in at 62 kg and she was 169 cm tall, and subject 6 was male weighing in at 81.1 kg and was 181 cm tall. Subject 7 was male and was 72 kg in weight and had a height of 170 cm, subject 8 was male and was 81.8 kg and had a height of 177 cm, and subject 9 was also a male weighing in at 110 kg and had a height of 189 cm. Lastly, subject 10 was a female who weighed 54.1 kg and was 168 cm in height, subject 11 was a female who weighed 51 kg and was 157 cm in height and subject 12 was a male who weighed 99 kg and was 178 cm in height.

The second test done to measure VO₂ max was the Cooper 12-minute run test. All students from the Acadia Kinesiology 3010 D1 Physiology Lab but one who was injured participated in this study. In total, 79 students participated in this experiment; 27 males, two of which were between the ages of 15-19, and twenty-five were between the ages of 20-29. 52 females took part in the study, 4 were between the ages of 15-19, and 48 of those 52 women were between the ages of 20-29.

For the Bruce Treadmill test, the equipment is the same for all twelve participants. First, the participants height and weight are measured by the Detecto Weight Scale and put into the computer. Then, the individual stands straight up and places a Polar Heart Rate Monitor System around their chest, the heart monitor has Signa Electrode Gel on it. Next, the individual uses a Hans Rudolph 2700 Series Metabolic Kit, they place all the headgear on their head, put the mouthpiece in their mouth and the nose clip on their nose. Once they have all the gear in place, it is hooked up to the Parvo Medics TrueOne 2400 Metabolic Measurement System; the Parvo Medics OUSW 4. 3 Software is then used to analyze the data coming in. To get the data for the software system, the individual runs on a Trackmaster TMX425C Treadmill. Once the experiment is complete, all of the Hans Rudolph 2700 Series Metabolic Kit is sanitized in West Penetone Totacide Cold Sterilizer System. Once the all the data is collected, it is then transferred over to the Excel Statistical Program. For the Cooper 12-minute run test, the equipment needed was the same for all individuals. Individuals run on a measured track, which allows for running distances to be measured. A sportline stopwatch is

used to time 12 minutes, and a whistle was blown at the 6-minute mark, and at the 11-minute mark. The distance the runners ran in meters is then entered into the Excel Statistical Program.

Procedure

To begin the Bruce Treadmill test, the individual who volunteered to take place in the experiment is asked to measure his height and weight, so it can be imputed into the Parvo Medics OUSW 4.3 Software. Once all the measurements are taken, the individual puts on a heart monitor around his chest, to measure heart rate. Once the monitor is in place, the individual then places a nose clip on his nose to keep air from exiting throughout the test. The individual then places the headgear on his head and puts the mouthpiece in his mouth. The device records the body's oxygen consumption (VO₂) and carbon dioxide consumption (VCO₂). Once the individual's headgear is hooked up to the Medics TrueOne 2400 Metabolic Measurement System the testing begins. To start, the individual places one foot on either side of the Trackmaster TMX425C Treadmill and adjusts to the speed of the treadmill by "skateboarding". Once the individual has adjusted to the speed, they step onto the treadmill and the testing begins. This test is a progressive test, meaning the speed and inclination of the treadmill increase every three minutes until the participants reaches volitional exhaustion. For the sake of time, the first time and speed interval are skipped. Which means, the participant starts at 2.5 miles per hour at a 12% incline. From minute 6-9, the speed increases to 3.4 miles per hour at a 14% incline and from minute 9-12, the speed increases to 4.2 miles per hour at a

16% incline. The speed and incline keep increasing until the 18-21 minutes mark, at that time the maximum speed is 6 miles per hour with a 22% incline; most individuals don't make it that far. Once the subject has made it to their volitional exhaustion, the testing stops, and a cool-down takes place. After the individual is cooled down, the mouthpiece, headgear and nose clip can be taken off and sanitized. This procedure is conducted for all 12 individuals who participated in the Bruce Treadmill test.

To begin the Cooper 12-minute run, all individuals are lined up at the starting line on the Acadia track. The instructor blows the whistle, and all individuals take off. The goal is to run around the track for 12 minutes and run as fast and as far as you can during the duration of those 12 minutes. At the 6-minute mark, the instructor blows the whistle to let all the runners know they are half way through the test, allowing them to pace themselves. Then when there is only 1-minute left of the run, the instructor blows the whistle and for the last minute everyone pushes themselves as hard as they can. Once the twelve minutes have passed, the instructor blows the whistle three times, and everyone stops running and cools down. Then using a mathematical equation, a calculation can be made to calculate the individuals max VO₂ based on the distance the individual ran in kilometers.

Results

The data shows that participant (series) 9 reached the highest VO₂ max at 4.95L/min with a time of 10.76 minutes and ignoring the skew at the end of participant 6's data, participant 11 had the lowest max VO₂ at 2.18L/min at 8.51 minutes. The data also reads that participant 10 was able to run on the

treadmill for the longest period of time, lasting 13.27 minutes, with a max VO₂ of 3.14L/min, and participant 12 lasted the shortest amount of time with a max VO₂ of 3.95L/min at 8.01 minutes. Results show that 0 males and 2 females scored excellent on their VO₂ max, 7 males and 4 females scored very good, 2 males and 8 females scored good, 9 males and 3 females score fair and 9 males and 35 females scored poor. Showing that only 2.5% of the Acadia Kinesiology Exercise Physiology Lab Sections have excellent VO₂ max scores, 13.9% have very good, 12.7% have good, 15.2% have fair and 55.7% have poor.

Discussion

The VO₂ max values are not consistent with one another, predicting the VO₂ max from an equation does not give the same score as the gas collection does. All equation VO₂ max values are lower than the gas collection values, except for in one case. The only time the equation's predicted VO₂ max score was higher than the gas collections score was with participant (series) 6's data, participant 6 is the individual where the data appears skewed since his VO₂ max dropped rapidly. Reasons for the inconsistency of the data are likely due to an calculation error from the individual not finishing the test, or the individual giving up before they reached their VO₂ max. Traditionally, VO₂ measures the cardiorespiratory system on its capability to maximally receive oxygen and send to the working muscle. The muscle then extracts and uses the oxygen in mitochondrial respiration to give the muscle enough energy to contract.

The Bruce Treadmill test and the Cooper 12-minute test are two types of traditional tests since only fit and younger populations can complete the tests easily and get reliable data. Since more traditional types of VO₂ max testing require the individuals being tested to be fit, new methods to test max VO₂ have been developed over the past couple of years. These VO₂ max tests are advantageous to research since they are developed to accompany all types of populations and many use prediction equations to evaluate an individual's max VO₂. The biggest disadvantage when using a prediction equation is its reliability, however, the biggest cause of error when predicting VO₂ max is the change in the heart rate due to submaximal exercise. The accuracy of predicting max VO₂ scores could change drastically if the difference in the way the heart rate responds to submaximal exercise could be decreased. In VO₂ max tests, there are two ways to measure it, the first is in litres/minute (L/min) and the second is millilitres/minute per kilogram of body weight (mL/min/kg). There is value in presenting our relative data in ml/kg/min because the VO₂ tests that were completed in the lab are weight bearing. The weight of the individual plays a role in the individual's VO₂ max, if the participant was to then lose weight, their relative VO₂ max value would go up. Whereas, the individual's aerobic capacity does not necessarily change, the aerobic capacity will only change if the individual's ability to extract and use the oxygen in the muscle is increased. When comparing aerobically untrained and trained subjects it is recommended that you use the unit mL/min/kg, but when comparing an anaerobically trained and untrained individual it is recommended to use the L/min unit. When comparing male and female subjects the unit L/min should

be used rather than ml/kg/min since males often have a higher body weight than females. However, when comparing pre to post training values it is beneficial to use the ml/kg/min unit since individuals often lose weight while training, meaning their VO₂ max will increase in that case.

A study done in 2017 by M. Badawy and Q. Muasdi looked at design of the Bruce Treadmill test. They conducted a study to try and make the test more comfortable and safe for the patient while still maintaining accurate results. The participants they tested were between the ages of 23 to 38, similar to the age of the participants in this study but theirs were slightly older.

Another difference between studies is only trained triathlon or football players were selected for Badawy and Musadi's study, whereas individuals in this study came from various athletic backgrounds ranging from varsity athletes to individuals who exercised on their own time at the gym. Their data showed that on average their VO₂ max score was 53.36 ml/min/kg in triathlon players, and 52.35 ml/min/kg in football players. The data from the study conducted at Acadia University shows that the average VO₂ max from the twelve participants who performed the Bruce Treadmill data is 47.41 ml/min/kg. Showing that both test shared similar VO₂ scores, with Acadia's VO₂ score being only 5.85 ml/min/kg away from being approximately the same.

Overall, M. Badawy and Q. Muasdi had a more controlled group of participants than Acadia did, and their VO₂ max was higher due to it. The calculated r value using the Pearson correlation for the twelve participants who completed both the Cooper 12-minute test and the Bruce Treadmill test

is approximately 0.75. This indicates that there is a moderate positive correlation between the results and the two tests. Therefore, the data shows that the Cooper 12-minute test is not a perfect field test when assessing VO₂ max, but it is still valid.

Overall, as hypothesized, the more distance the individual covered in the Cooper 12-minute run test the higher the individual's VO₂ max was, however, in the Bruce Treadmill test the longer the participant ran the more stable the VO₂ increased over time, but it was not the highest VO₂ max recorded. The highest VO₂ max (4.95L/min) recorded was 10.76 minutes, but the longest an individual ran during the Bruce Treadmill test was 13.27 minutes, with a max VO₂ of only 3.14L/min.