

VO₂ Max Testing

Introduction

University of Minnesota kinesiology students use treadmills and respiratory gas analyzers to measure “maximal oxygen consumption” or “VO₂ max.”

The purpose of this activity is to learn how VO₂ max data are collected and used in the kinesiology lab, and then engage in a simple walking activity to determine students’ own VO₂ max.

Basic Questions Relating to VO₂ Max Testing

After you have reviewed the materials on this site, and completed the “walk a mile” activity, you should be able to answer the following questions.

1. In your own words, what does the VO₂ max test measure?
2. Why are carbon dioxide levels measured during VO₂ max testing?
3. How does VO₂ max data relate to the phrase “transport and use oxygen”?
4. What is a typical VO₂ max number for college males? Females? Professional endurance athletes?
5. “220 - age” is a formula used to calculate what piece of human performance data?
6. Explain the difference between aerobic and anaerobic respiration?
7. How does VO₂ max data relate to overall athletic performance? What other factors can become involved with overall athletic performance?
8. What body systems are involved in VO₂ max testing?
9. Explain how, or if, weight gain affects VO₂ max data.
10. Max VO₂ does not occur right at the end of the test, but usually during the last few minutes of the subjects’ exertion. Explain.

Basic Graphing Exercises

The following simple graphing questions require the use of the file “VO2MaxData-FiveSubjects.xls” which can be downloaded from the main web page.

1. Construct a graph comparing the VO₂ max data (use the highest numbers) for the five subjects in the videos (Jordan, Lenord, Mike, Andy, and Danielle). Who has the highest VO₂ max?
2. Construct line graphs that show heart rate vs. time for one of five individuals. How does the heart rate data compare to the VO₂ max data? Does the person with the highest VO₂ max also have the highest heart rate? Or maybe the lowest maximum heart rate?

3. Given the datasets for the five runners, construct a graph that shows a comparison other than VO₂ max or heart rate.

After completing the “walk a mile” activity, make a graph and answer this question:

Graph the VO₂ max data that was collected in your course. What was the average VO₂ max for your section?

Intermediate Questions relating to VO₂ Max Testing

If you are interested in the area of exercise physiology, the following questions are typical of what you might see in a sophomore-junior level course.

1. What is the respiratory exchange ratio (RER)? Explain how it is used to determine energy expenditure from fats and carbohydrates.
2. What is maximal oxygen uptake? How is it measured?
3. How does maximal oxygen uptake relate to sport performance?
4. Why is oxygen consumption often expressed as mL/kg/min?
5. What determines the limits of maximal oxygen uptake (VO₂ max)?
6. During endurance training, what physiological changes happen to increase both VO₂ max and performance?
7. How important are genetics to VO₂ max values?

Intermediate Graphing Exercises

1. Graph one subject's VCO₂ and VO₂ on the same graph (put stages on the x-axis). What is happening at the crossover?
2. Graph all the VO₂ of each subject on one graph (put stages on the x-axis). Explain the difference you seen in the subjects' data.
3. With the following equations for predicting VO₂ on a treadmill, choose one subject and predict what the VO₂ should be for each stage and graph it against the actual VO₂ in each stage. Explain any differences you see.

If WALKING (less than 4.2 mph):

$$\text{VO}_2 \text{ ml/kg/min} = (0.1 * S) + (1.8 * S * G) + 3.5$$

If RUNNING (4.2 or greater mph):

$$\text{VO}_2 \text{ ml/kg/min} = (0.2 * S) + (0.9 * S * G) + 3.5$$

S = Speed meters/min = (1 mph = 26.8 m/min)

G = % Grade (e.g., 10% grade = 0.10 in the equation)

Reference for Intermediate Questions

Wilmore J, Costill D, Kenney W, eds. *Physiology of Sport and Exercise*. 4th ed. Champaign, IL: Human Kinetics, 2008.

Other References for VO₂ Maximum

Billat V, Faina M, Sardella F, Marini C, Fanton F, Lupo S, Faccini P, et al. A comparison of time to exhaustion at VO₂ max in elite cyclists, kayak paddlers, swimmers, and runners. *Ergonomics* 39: 267-277, 1996.

Goedecke JH, Gibson AS, Grobler L, Collins M, Noakes TD, Lambert EV. Determinants of the variability in respiratory exchange ratio at rest and during exercise in trained athletes. *American Journal of Physiology – Endocrinology and Metabolism* 279(6): E1325-334, 2000.

Hermansen L, Saltin B. Oxygen uptake during maximal treadmill and bicycle exercise. *Journal of Applied Physiology* 26: 31-37, 1969.

Mayers JN. The physiology behind exercise testing. *Primary Care* 28: 5-28, 2001.

Shvartz E, Reibold RC. Aerobic Fitness Norms for Males and Females Aged 6-75: A review. *Aviation, Space and Environmental Medicine* 61:3-1, 1990.