# Cardiorespiratory Assessment

**Topics include:**

- Common definitions
- Maximal vs. submaximal assessment
- Termination of the assessment/contraindications
- Metrics
    - Ventilatory threshold
    - Rating of perceived exertion (RPE) and the ventilatory response to exercise
    - Talk test
- YMCA step test

Although, as discussed in Chapter 1, the recommended amount of moderate intensity aerobic activity or exercise is 150 minutes per week (Garber et al., 2011), it is important to remember that if a client has been sedentary or is deconditioned, the main goal of a beginning aerobic program is to improve function by reversing physical deconditioning, improve physical function, improve activities of daily living, and increase health and well-being (Durstine et al, 2000). The prescribed exercise should induce the desired response without inducing any abnormal reactions. In the early stages of training, a deconditioned client may only be able to achieve a few minutes of exercise at a time, making any assessment difficult. The American Council on Exercise (Galati, 2015) suggests clients at this base-level of training do not need to perform a cardiorespiratory assessment until they are comfortable with the chosen assessment criteria and can sustain 20-minutes of cardiorespiratory activity. Intensity can be progressed when a client can maintain steady-state cardiorespiratory exercise for 20-30 minutes.

**Definitions**

Assessments are not meant to diagnose a medical condition, but rather to obtain a base level for program design, to track progress, and to give a medical fitness specialist insight for exercise frequency, duration, and intensity. To avoid confusion of nomenclature, her are a few definitions:

- Heart rate reserve (HRR) –The difference between maximal heart rate and resting heart rate. It is based on the hearts ability to increase beats and output above a resting level, and indicates the reserve capacity of the heart.
- $VO_2$ max – Also referred to as maximal oxygen consumption, maximal oxygen uptake, or maximal aerobic capacity, is the maximum amount of oxygen used in 1 minute.
- $VO_2$ reserve ($VO_2R$) – The difference between $VO_2$ max and $VO_2$ at rest.

- Max heart rate – MHR (HRmax) is the highest heart rate that can be achieved.
- Target heart rate – Target heart rate or training heart rate, is the heart beats per minute used to determine training intensity.

**Maximal vs. Submaximal**

Aerobic assessments are used to determine $VO_2$max, which refers to the maximum amount of oxygen an individual uses during intense exercise and is considered the best measurement of cardiovascular capacity. If an assessment is performed, a maximal or submaximal test can be used. Maximal testing is considered the gold-standard to assess maximal aerobic capacity. A maximal test is usually performed on a bicycle or treadmill using a graded exercise protocol where the intensity increases as the test continues and stops when a client can no longer sustain the workload or continue the assessment. $VO_2$max is determined when oxygen consumption plateaus (Noonan & Dean, 2000).

Because maximal testing requires maximal exertion (Sartor et al., 2013), many clients who have chronic disease, an injury, or have been sedentary may not be able to perform a maximal aerobic assessment, and will need to perform a submaximal assessment. Submaximal assessments are often preferred over maximal tests because they can be measured in smaller increments, and the results are extrapolated based on predetermined norms. Submaximal assessments can also be performed on a variety of equipment allowing the test to be conducted in almost any setting as no special or expensive equipment is needed (Sartor et al., 2013). Examples of submaximal aerobic assessments are the modified Bruce treadmill test, the Rockport walk test, the timed up and go test, the YMCA cycle test, the Harvard step test, and the YMCA 3-minute step test. The guidelines for the YMCA 3-minute step test are located in Appendix C.

## Termination of Assessment

Regardless of maximal or submaximal, some clients with physical limitations may never adequately perform an aerobic assessment. Risk factors that need to be considered with cardiorespiratory exercise include history of injury or disease, level of conditioning, and level of stability and mobility (American College of Sports medicine [ACSM], 2018). Additionally, ACSM (2018) recommends stopping the assessment for any of the following reasons:

- Onset of angina or similar symptoms.
- Drop in SBP of $\geq$ 10mm Hg with an increase in work rate, or if SBP decreases below the value obtained in the same position prior to testing.
- SBP rises above 250mm Hg and/or DBP rises above 115mm Hg.
- Shortness of breath, wheezing, leg cramps, or claudication (lower leg cramps).
- Signs of light headedness, confusion, ataxia, pallor, nausea, or cold and clammy skin.
- Failure of HR to increase with increased exertion
- Noticeable change in heart rhythm, palpitations, or auscultation.
- Participant requests to stop.
- Physical or verbal manifestations of severe fatigue.
- Equipment failure.

## Metrics

### Ventilatory threshold

Many of the methods to determine the training heart rate based on HRmax can have a variance of up to +/- 14 beats/minute (Galati, 2015). When developing a cardiorespiratory training program for a client with chronic disease, a variance of 14 beats per minute can be detrimental to progression, or in the worst-case scenario, a client's health. Ventilation linearly

increases with oxygen consumption and carbon dioxide production. Accordingly, there are two ventilatory threshold levels that can be determined via submaximal testing. The first ventilatory threshold (VT1, often referred to as lactate threshold or anaerobic threshold) is the point during exercise training at which ventilation is disproportionately high with respect to oxygen consumption as the body clears lactate in the blood. Breathing becomes labored and talking is difficult at VT1 and is usually reached at around 50–60% of peak $VO_2$ or 60–70% of peak heart rate (American Council on Exercise, n.d.; Mezzani et al., 2012). The second ventilatory threshold (VT2 or respiratory compensation threshold) occurs when blood lactate can no longer be effectively cleared and starts to accumulate. VT2 is recognized by heavy breathing and the inability to talk (many clients may never or should not attempt to achieve VT2), and is usually reached at 70–80%peak $VO_2$, and 80–90%peak heart rate (American Council on Exercise, n.d.; Mezzani et al., 2012).

**Rating of perceived exertion and talk test**

Because most gyms and fitness studios do not have expensive equipment for testing $VO_2$, there are a number of field tests that require no equipment, and can accurately determine VT1. Borg's Rating of Perceived Exertion (RPE) scale and the talk test (TT) have been determined to be valid indicators for VT1 (lactate, or anaerobic threshold). As discussed, VT1 occurs when breathing is slightly labored, and talking is possible but difficult (Woltmann et al., 2015). The TT is conducted by incrementally increasing the intensity of the exercise (treadmill, cycle, elliptical, etc.) until a performer can no longer recite a predetermined passage without compromising the integrity of the passage. The TT is easy to conduct and allows for individual programing. The RPE test is based on a scale of 6-20; 6 = no exertion and 20 = maximal exertion (ACSM, 2018). The RPE scale corresponds to metabolic markers and is easy to

teach. An RPE of 11-13 corresponds to VT1 and is a recommended starting point for clients who are at a base level (Scherr et al., 2013). For some clients (and trainers) using an RPE scale of 0-10, 0 = no exertion, and 10 = maximal exertion, may be easier to understand. Using an RPE of 0-10, 3-4 corresponds to a base level just at or below VT1, and 7-10 corresponds to VT2.

**EPOC**

During aerobic exercise, the supply of oxygen does not always meet the need for oxygen, leaving the body with a deficit. Excess post-exercise oxygen consumption (EPOC) is the oxygen needed after a workout in order for the body to return to its resting state and temperature. The oxygen is used by the body to clear $CO_2$ from tissue, deplete lactic acid, restore adenosine triphosphate (ATP) levels, and increase blood oxygen levels. Because the use of oxygen burns calories (5 calories for every liter of oxygen), as many as 150 calories can be burned during EPOC (Anderson, 2015). This is important to remember as recovery time differs for clients with chronic disease, and exercise programming needs to be adjusted accordingly.

**Discussion and application**

1. Define lactate threshold and anaerobic threshold, and how they relate to RPE.
2. Assessing maximal cardiorespiratory capacity can be expensive, time consuming, and may require specialized personnel and equipment. Which assessment is best suited for your situation? Describe the procedure, and how you would explain the benefits to a client

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