

VO₂ Max - Maximal Oxygen Uptake Testing

Short Title	VO ₂ Max Testing
Effective Date	July 4, 2017
Approved by REB	July 4, 2017
Version Number	1

A. PURPOSE AND BACKGROUND

A graded maximal exertion test is used to determine maximal aerobic capacity by measuring the maximal amount of oxygen that can be utilized by the body during intense exercise. The test involves an incremental increase in exercise intensity until maximal effort is achieved. Expired air is collected concurrently to measure the gas concentrations and determine the maximal volume of oxygen (VO₂ max or VO₂ peak), measured in liters of oxygen per minute (L/min), that the body is utilizing. This can be conducted using any stationary modality (such as, but not limited to: treadmill, stationary bike, arm ergometer, rowing ergometer, skate treadmill, NuStep machine). The purpose of this SOP is to set a minimum standard of safeguards to mitigate risks associated with VO₂ max testing.

This SOP applies to tests conducted on:

1. **Healthy adult populations** (i.e., no concerns from a PAR-Q or medical clearance from a physician).
 - a. *For children:* refer to this SOP and additionally submit:
 - i. The testing values (e.g., speed and increments)
 - ii. Screening form for maximal effort exercise
 - iii. Any additional risks associated with children
 - b. *For older adults:* refer to this SOP and additionally submit:
 - i. The testing values (e.g., speed and increments)
 - ii. Screening form for maximal effort exercise
 - iii. Any additional risks associated with older adults
 - c. *For sedentary individuals:* refer to this SOP and additionally submit:
 - i. The testing values (e.g., speed and increments)
 - ii. Screening form for maximal effort exercise
 - iii. Any additional risks associated with sedentary individuals
 - d. *For spinal cord injury and multiple sclerosis patients:* see Section C.
 - e. *For other populations:* a full protocol, risk assessment, and screening form must be submitted.

B. PROCEDURES/STUDY PROTOCOL

Are there any controlled act(s) to be performed: Yes No

VO₂ Max - Maximal Oxygen Uptake Testing

Please note: the following protocols should be amended based on testing modality, health status, age, gender, etc.

1. Participants (healthy adults) must complete the PAR-Q without any health concerns or have medical clearance for maximal effort exercise from their primary physician.
2. Explain procedure to the participant. Ensure they are wearing proper attire (e.g., running shoes, no untied laces, etc.) and a heart rate monitor that is recording concurrently.
3. Ensure the participant understands the incremental nature of the test and how to stop the test if needed (i.e., signaling to the tester with a predetermined signal, grabbing the handrails and stepping onto the side plates if on a treadmill, etc.).
4. Establish hand signals with the participant to communicate during the test as speaking can interrupt the airflow and skew test results. Common signals include 'thumbs up' if the participant is doing well, 'thumbs down' if the participant is starting to feel nauseous or faint, 'stop signal' if they want the test to be discontinued, at which point the investigator will stop the treadmill and tell the participant to grab the handrails or stop pedaling.
5. Have the participant place the facemask over their mouth and nose, or secure the mouthpiece and noseclip. Confirm the appropriate size of mask was selected based on coverage and participant comfort. Secure and tighten the straps of the facemask to participant comfort.
6. If using a facemask, have the participant check the seal by covering the mouthpiece with the palm of their hand and trying to breathe. A full seal around the mouth and nose should be achieved.
7. The participant should wear the mask for approximately 1 minute before mounting the testing modality to ensure the participant is comfortable with the mask and that the equipment is functioning normally.

Note: the following portion of the protocol uses **approximate values** taken from the most common protocols submitted to the REB. Any values should be adjusted based on testing modality, health status, age, gender, etc.

8. The participant will step on the treadmill or get on the bike and begin with a 5-minute warm-up, ranging from approximately 3-5 miles per hour (mph) on a treadmill or 30 to 100 Watts (W) on a bike.
9. After the 5-minute warm-up there will be an increase every 1-2 minutes in either speed (approximately a 1-2 mph increase) or incline (approximately a 1-2% increase) in the case of a treadmill test, or in wattage (15-30 W increase) in the case of a cycle test. These incremental amounts should be adjusted for the participant's demographics. Note that with increased treadmill incline there is an increased risk of falling.

VO₂ Max - Maximal Oxygen Uptake Testing

10. Verbal encouragement can be provided during the test; however, participants should be reminded that they are in complete control of the test and that they can stop at any time.
11. Once the participant has elected to stop the test (grabbed the handrails or stopped pedaling) the investigator will first stop the treadmill belt or apply the wheel brake, they will then remove the participant's mask, and ensure that the participant is feeling well (i.e., is not at risk of fainting or vomiting). The participant should remain on the treadmill or bike to cool down at a self-selected pace for as long as desired.
12. The participant should be monitored for signs of nausea or fainting (e.g., ashen face) for approximately 5 minutes during cool down.

Protocol Discrepancies: the stated protocols for bike and treadmill tests should be amended based on testing modality, health status, age, gender, etc. ***If your protocol differs from the protocol listed above your ethics application should include either:**

- a) The specific ways in which it differs (e.g., alternate increments of wattage) *if small discrepancies exist;*
- b) An explanation of the entire protocol *if large discrepancies exist.*

C. PROTOCOL ADJUSTMENT FOR SPECIAL POPULATIONS

Protocol for Spinal Cord Injury (SCI) and Multiple Sclerosis (MS) Patients

The same steps listed above (section B) apply with the following adjustments:

1. The machine used for testing is a recumbent arm-leg exercise machine (NuStep), a recumbent arm-leg exercise machine utilizing functional electrical stimulation (Restorative Therapies RT200), or an arm ergometer.
2. Participants can either remain in their wheelchair (in the case of the arm ergometer), transfer independently to the arm-leg ergometer if able, or transfer with the assistance of the trained research assistant.
3. The intensity increments are "1 resistance unit" per minute on the NuStep machine, 1 Nm per minute on the RT200, or 10 watts per minute on the arm ergometer.

Additional Notes:

- Participants will need medical clearance from a physician, as the PAR-Q is not appropriate for this population.
- Researchers and test administrators will need training to properly perform a wheelchair transfer in the case of the arm-leg ergometer machines.
- This SOP **does not** cover the use and application of functional electrical stimulation (FES). If FES is used in conjunction with VO₂ max testing (i.e., in

VO₂ Max - Maximal Oxygen Uptake Testing

the case of the RT200), all settings, risks, safeguards, and training credentials related to the FES must be submitted for review.

D. EQUIPMENT (MAINTENANCE, CALIBRATION AND CLEANING)

1. Metabolic Cart: the cart should be maintained according to manufacturer recommendations and the flow sensors and gas analyzers should be calibrated with precision compressed gases according to manufacturer recommendations before each test.
2. Facemasks and Accessories: Facemasks, mouthpieces, nose clips, straps, turbines, valves, and tubing should be cleaned between each use according to manufacturer recommendations. Alconox® Powdered Precision Cleanser at a 1% dilution, or Glutaraldehyde according to manufacturer recommendations are suggested cleansing products. Turbines/valves that are not unidirectional (1-way) must be completely disassembled during cleaning between each use.

E. TRAINING REQUIRED FOR RESEARCHERS AND TEST ADMINISTRATORS

- First Aid and CPR with AED training
- A minimum of two (2) researchers must be present at all times for the duration of testing.
- For special populations: training in wheelchair transfer

F. DESCRIPTION TO STUDY PARTICIPANTS

1. List sequentially (i.e., in a step-by-step format) how a study participant would experience the procedures and equipment.
2. Explicitly state the total number of VO₂ max trials that will be performed over the course of the study.
3. State the approximate amount of time that the test will take (i.e., approximately 17-22 minutes including warm-up and cool-down) as well as the amount of time the entire session will take.

G. RISKS

PARTICIPANTS

1. The testing protocol involves exercise to exhaustion, therefore the inherent side effects of exhaustive exercise may be present including but not limited to: fainting, chest pains, weakness, vomiting, muscle soreness, and headache.
2. For treadmill tests: A risk of falling is present due to the incline and speed of the treadmill during exhaustive exercise.

VO₂ Max - Maximal Oxygen Uptake Testing

3. Asthmatics may find breathing difficult, or a perception that breathing is difficult, due to the mask and turbine or tubes.
4. Feelings of panic or claustrophobia may occur due to the mask worn during heavy breathing.
5. Multiuse facemasks and accessories (e.g., turbines and tubing) may allow for the transfer of fluids (e.g., saliva) or infectious agents between participants.

Remember to report any adverse events to the Research Ethics Office (reb@brocku.ca).

RESEARCHERS

Test administrators should be prepared to deal with the side effects of exhaustive exercise such as:

1. For treadmill tests: The risk of falling from the participant may put the test administrator at risk if they attempt to stabilize or catch the participant, or if the attached tubing pulls the equipment towards them.
2. The risk of the participant vomiting may put the test administrator at risk for person-to-person transmission of airborne diseases or illnesses.

H. SAFEGUARDS/SAFETY PROCEDURES

PARTICIPANTS

1. Side effects of exhaustive exercise (as listed above): the PAR-Q (Physical Activity Readiness Questionnaire) or equivalent health assessment form must be completed by the participant before any strenuous exercise is performed. Two investigators (or test administrators) must be present and within arms reach during the test protocol. A chair and water must be immediately accessible to participants.
2. Risk of falling: participants will be reminded that they should hold the handrails and step onto the side plates when they are too fatigued to continue running. The test administrator should indicate to participants when they are too far back on the treadmill (behind the half-way point). If the participant cannot move forward the test administrator must stop the test and therefore the treadmill belt.
3. Asthmatics: participants will breathe into the facemask or mouthpiece for at least 1 minute prior to mounting the treadmill or bike. This will help to acclimate participants to the facemask. Participants will be reminded that they can discontinue the test at any point, particularly if they have difficulty breathing due to the facemask or exercise.
4. Panic or claustrophobia: participants will breathe into the facemask or mouthpiece for at least 1 minute prior to mounting the treadmill or bike. This

VO₂ Max - Maximal Oxygen Uptake Testing

will help to acclimate participants to the facemask. Participants will be reminded that they can discontinue the test at any point, particularly if they have difficulty breathing due to the facemask or exercise.

5. Multiuse facemasks and accessories: facemasks, mouthpieces, nose clips, tubing, turbines, and valves will be cleansed and disinfected between each participant according to manufacturer recommendations. Turbines/valves that are not unidirectional (1-way) must be completely disassembled during cleaning between each use.

RESEARCHERS

1. Risk of falling: participants will be reminded that they should hold the handrails and step onto the side plates when they are too fatigued to continue running. The test administrator should indicate to participants when they are too far back on the treadmill (behind the half-way point). If the participant cannot move forward the test administrator must stop the test and therefore the treadmill belt.
2. Risk of the participant vomiting: the test administrator should remind participants that they can discontinue the test if they are feeling nauseated. A garbage/bucket/bag should be readily available in case the participant. In the rare case that a participant vomits health and safety protocols must be followed.

I. REFERENCES (if applicable)