Chapter 26: Exercise Assessment in Special Populations

The physiologic reserve of mother and fetus allow for short periods of exercise to be tolerated, but must consider:
- Fetal blood flow
- Fetal temperature
- Potential exacerbation of uterine contractions

The American College of Obstetricians and Gynecologists (ACOG) suggests that pregnant women without medical or obstetric complications can follow the American College of Sports Medicine’s (ACSM) and Surgeon General’s recommendation to accumulate 30 or more minutes of moderate exercise on most, if not all, days of the week.

Potential benefits:
- Reduced preeclampsia risk
- Reduced gestational diabetes risk
- Improved mental health
• Pretesting screening
  – Physical Activity Readiness Medical Examination, termed the PARmed-X for Pregnancy
  – Pregnant woman’s physician should approve

• Exercise testing
  – Typically, maximal exercise testing is not recommended for pregnant women.
  – If performed, must be physician supervised and best to use non–weight-bearing mode
  – Can estimate peak work capacity if gas exchange analysis not performed: 
    \[ \text{VO}_2\text{peak (predicted)} = \left( 0.055 \times \text{peak HR} \right) + \left( 0.381 \times \text{incline} \right) + \left( 5.541 \times \text{speed} \right) + \left( -0.090 \times \text{BMI} \right) - 6.846 \]
### TABLE 26-1. PHYSIOLOGIC RESPONSES TO ACUTE EXERCISE DURING PREGNANCY COMPARED WITH PREPREGNANCY

<table>
<thead>
<tr>
<th>OXYGEN UPTAKE (DURING WEIGHT DEPENDENT EXERCISE)</th>
<th>INCREASE $\dot{V}O_2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heart rate</td>
<td>Increase</td>
</tr>
<tr>
<td>Stroke volume</td>
<td>Increase</td>
</tr>
<tr>
<td>Cardiac output</td>
<td>Increase</td>
</tr>
<tr>
<td>Tidal volume</td>
<td>Increase</td>
</tr>
<tr>
<td>Minute ventilation</td>
<td>Increase ($\dot{V}E$)</td>
</tr>
<tr>
<td>Ventilatory equivalent for oxygen</td>
<td>Increase $\dot{V}E/\dot{V}O_2$</td>
</tr>
<tr>
<td>Ventilatory equivalent for carbon dioxide</td>
<td>Increase $\dot{V}O_{2\text{max}}/\dot{V}CO_2$</td>
</tr>
<tr>
<td>Systolic blood pressure (SBP)</td>
<td>No change/decrease</td>
</tr>
<tr>
<td>Diastolic blood pressure (DBP)</td>
<td>No change/decrease</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>MOTHER</th>
<th>FETUS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Concern Solution</strong></td>
<td><strong>Concern Solution or Effect</strong></td>
</tr>
<tr>
<td>Poor balance while running or jogging because of shifts in weight distribution and center of gravity.</td>
<td>Slow down, run cautiously and never alone.</td>
</tr>
<tr>
<td>Overheating and dehydration. Pregnancy elevates body core temperature by approximately 0.5°C, elevating resting metabolic rate by 15%-20%. Excessive sweating might reduce blood volume.</td>
<td>Drink plenty of fluids before, during, and after exercise. Use appropriate exercise clothing and/or avoid exercise during extremely hot and humid weather.</td>
</tr>
<tr>
<td>Leg, hip, and abdominal pain. Reduced circulation to lower extremities during late pregnancy, extra weight to carry.</td>
<td>Never forget to stretch and warm up before any exercise session. Wear cushioned and comfortable shoes.</td>
</tr>
<tr>
<td>Nutrient availability. Pregnancy increases energy requirements by approximately 300 kcal/day.</td>
<td>It is expected for pregnant women to gain 25-40 lbs.</td>
</tr>
<tr>
<td>Reduced oxygen availability for aerobic exercise. Cardiovascular drift: added blood circulation to placenta.</td>
<td>Modify exercise intensity. Never exercise to the point of fatigue or exhaustion. Avoid intense and prolonged exercise. Monitor heart rate and rates of perceived exertion. Continuous/aerobic exercises are more acceptable than intermittent/anaerobic exercises.</td>
</tr>
<tr>
<td>Musculoskeletal injury. Ballistic movements, sudden postural changes can increase the risk of injury. However, the risk of injury for fit pregnant women should be lower.</td>
<td></td>
</tr>
</tbody>
</table>
PARmed-X for PREGNANCY

PARmed-X for PREGNANCY is a guideline for health screening prior to participation in a prenatal fitness class or other exercise.

Healthy women with uncomplicated pregnancies can integrate physical activity into their daily living and can participate with significant risks either to their health or to their unborn child. Most studies of physical activity in pregnancy indicate that maternal fitness, posture, appropriate weight gain, and satisfaction of labor are important factors influencing pregnancy outcomes. Regular exercise may also help to prevent gestational glucose intolerance and the related condition of diabetes.

For this reason, the Canadian Society for Exercise Physiology has developed a pre-exercise health checklist and a physical activity readiness questionnaire for use by health care providers to evaluate pregnant patients who wish to enter a prenatal fitness program and for ongoing supervision of selected pregnant patients.

The body of evidence reviewed in this document is based on a literature search of current and recent literature. The recommendations are based on current evidence available and the risk/benefit considerations for the pregnant woman.

You can find the complete guidelines at www.csep.ca.

Pre-Exercise Health Checklist

PART 1: General Health Status

1. Have you ever had a heart attack? (yes/no) [ ]
2. Have you ever had high blood pressure? (yes/no) [ ]
3. Have you ever been diagnosed with diabetes? (yes/no) [ ]
4. Have you ever had a health problem that was marked by fatigue? (yes/no) [ ]
5. Are you currently taking any medication for health-related problems? (yes/no) [ ]
6. Do you currently smoke? (yes/no) [ ]
7. Are you currently taking any vitamins or supplements? (yes/no) [ ]
8. Have you had a health problem that was marked by fatigue in the last 10 years? (yes/no) [ ]
9. Are you currently taking any medications for health-related problems? (yes/no) [ ]
10. Do you currently smoke? (yes/no) [ ]
11. Are you currently taking any vitamins or supplements? (yes/no) [ ]
12. Have you had a health problem that was marked by fatigue in the last 10 years? (yes/no) [ ]

Part 2: Status of Current Pregnancy

1. Are you planning to deliver the baby? (yes/no) [ ]
2. Are you currently taking any medications for health-related problems? (yes/no) [ ]
3. Are you currently taking any vitamins or supplements? (yes/no) [ ]
4. Have you had a health problem that was marked by fatigue in the last 10 years? (yes/no) [ ]
5. Are you currently taking any medications for health-related problems? (yes/no) [ ]
6. Do you currently smoke? (yes/no) [ ]
7. Are you currently taking any vitamins or supplements? (yes/no) [ ]
8. Have you had a health problem that was marked by fatigue in the last 10 years? (yes/no) [ ]
9. Are you currently taking any medications for health-related problems? (yes/no) [ ]
10. Do you currently smoke? (yes/no) [ ]
11. Are you currently taking any vitamins or supplements? (yes/no) [ ]
12. Have you had a health problem that was marked by fatigue in the last 10 years? (yes/no) [ ]
13. Are you currently taking any medications for health-related problems? (yes/no) [ ]
14. Do you currently smoke? (yes/no) [ ]
15. Are you currently taking any vitamins or supplements? (yes/no) [ ]
16. Have you had a health problem that was marked by fatigue in the last 10 years? (yes/no) [ ]
17. Are you currently taking any medications for health-related problems? (yes/no) [ ]
18. Do you currently smoke? (yes/no) [ ]
19. Are you currently taking any vitamins or supplements? (yes/no) [ ]
20. Have you had a health problem that was marked by fatigue in the last 10 years? (yes/no) [ ]

Part 3: Activity Habits During the Past Month

1. Do you currently engage in any physical activity? (yes/no) [ ]
2. If yes, how often do you engage in physical activity? (yes/no) [ ]
3. If yes, how many hours per week do you engage in physical activity? (yes/no) [ ]
4. If yes, what type of physical activity do you engage in? (yes/no) [ ]
5. If yes, what is the intensity of your physical activity? (yes/no) [ ]
6. If yes, what is the duration of your physical activity? (yes/no) [ ]

Part 4: Physical Activity Intentions

1. Do you plan to engage in any physical activity in the future? (yes/no) [ ]
2. If yes, how often do you plan to engage in physical activity? (yes/no) [ ]
3. If yes, how many hours per week do you plan to engage in physical activity? (yes/no) [ ]
4. If yes, what type of physical activity do you plan to engage in? (yes/no) [ ]
5. If yes, what is the intensity of your planned physical activity? (yes/no) [ ]
6. If yes, what is the duration of your planned physical activity? (yes/no) [ ]

Physical Activity Recommendation

A summary of the guidelines for physical activity in pregnancy is provided in the following tables. The tables include recommendations for the intensity, duration, and frequency of physical activity, as well as the types of activities that are recommended. The tables also include guidelines for performing activities during pregnancy, as well as recommendations for the use of assistive devices during pregnancy.

The tables are divided into three sections: the first section contains recommendations for physical activity in pregnancy, the second section contains recommendations for the use of assistive devices during pregnancy, and the third section contains guidelines for the use of assistive devices during pregnancy.

The guidelines are based on the current evidence available and the risk/benefit considerations for the pregnant woman. The guidelines are intended to provide a framework for the development of individualized exercise programs for pregnant women and to help health care providers make informed decisions about the safety and feasibility of physical activity during pregnancy.

The guidelines are intended to be used as a tool to assist health care providers in making informed decisions about the safety and feasibility of physical activity during pregnancy. The guidelines are not intended to be used as a substitute for professional medical advice.

The guidelines are available in a downloadable PDF format, and the downloadable PDF format is available at www.csep.ca.

For more information, contact the Canadian Society for Exercise Physiology at 1-800-668-0024, or visit the website at www.csep.ca.
• Older adult refers to individuals 65 years of age and those between 50 and 64 years of age with clinically significant chronic conditions or physical limitations that affect movement, physical fitness, or physical activity.

• Age is a risk factor for many chronic diseases.

• Clinical evaluation
  – Recommended that these individuals undergo a medical examination and a medically supervised exercise test before engaging in vigorous activity [60% VO$_{2\text{max}}$ or 6 metabolic equivalents (METs)], especially if other risk factors are present
  – For moderate activity (40%–60% VO$_{2\text{max}}$ or 3–6 METs), a medical examination and medically supervised exercise test are not considered essential, although either would not be considered inappropriate.
• Practical considerations of routine exercise testing
  - For those in the 60 to 69 age range, there is a high probability (90%) of coronary disease for those with typical/definite angina pectoris, intermediate pretest probability (10%–90%) for those with atypical/probable angina pectoris as well as nonangina chest pain, and low probability (10%) for those who are asymptomatic.

• Exercise testing considerations
  - Mode is important; if performing for exercise safety or prescription purposes, then must perform exercise
  - Consider pharmacologic only for diagnostic purposes and only in those who cannot exercise
**TABLE 26-2. EXERCISE TESTING FOR THE ELDERLY**

**1.5.11-ES:** Address exercise testing and training needs of elderly and young patients.

**1.3.22-HFI:** Ability to modify protocols and procedures for cardiorespiratory fitness tests in children, adolescents, and older adults.

<table>
<thead>
<tr>
<th>CHARACTERISTIC</th>
<th>SUGGESTED TEST MODIFICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low $\dot{V}O_{2\text{max}}$</td>
<td>Start at a low intensity (2–3 METs)</td>
</tr>
<tr>
<td>More time required to reach a steady state</td>
<td>Long warm-up (3 + min); small rise in power output (0.5–1 MET) and/or 2–3 min at each stage</td>
</tr>
<tr>
<td>Increased fatigability</td>
<td>Reduce total test time to 12–15 min or use an intermittent protocol</td>
</tr>
<tr>
<td>Increased need to monitor ECG, BP, and HR</td>
<td>Bike &gt; treadmill &gt; step test</td>
</tr>
<tr>
<td>Poor balance</td>
<td>Bike &gt; treadmill &gt; step test; use treadmill built into the floor</td>
</tr>
<tr>
<td>Poor strength (especially upper thighs)</td>
<td>Treadmill &gt; bike or step test</td>
</tr>
<tr>
<td>Less ambulatory ability</td>
<td>Increase treadmill grade rather than speed (maximum of 3–3.5 mph)</td>
</tr>
<tr>
<td>Poor neuromuscular coordination</td>
<td>Increase amount of practice; may require more than one test</td>
</tr>
<tr>
<td>Difficulty holding mouthpiece with dentures</td>
<td>Add support or use face mask to measure VO$_2$</td>
</tr>
<tr>
<td>Impaired vision</td>
<td>Bike &gt; treadmill or step test</td>
</tr>
<tr>
<td>Impaired hearing</td>
<td>Treadmill &gt; bike or step test, if person needs to follow a cadence; difficulty understanding and responding in a noisy environment (use electronic bike)</td>
</tr>
<tr>
<td>Senile gait patterns and foot problems</td>
<td>Bike &gt; treadmill or step test</td>
</tr>
<tr>
<td>(e.g., bunions and calluses)</td>
<td></td>
</tr>
</tbody>
</table>

ECG, electrocardiogram; BP, blood pressure; HR, heart rate.


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• Prognostic assessment with exercise testing
  – The Duke Treadmill Score appears to provide useful information.
  – Adding a stress echo might improve those with intermediate Duke scores.
    • Note that adding tests increases cost significantly.
  – There are little data on risk stratification in the very old (>75 to 80 years).

• Exercise protocols
  – Mode is important due to high incidence of balance problems and joint-related pain (e.g., arthritis).
  – Bruce protocol may be difficult for those with low peak work capacities.
  – Low-level treadmill or cycle protocols with shorter stages and lower MET or work rate increases may be more appropriate.

• Medication use
  – High incidence of prescribed and over-the-counter (OTC) medication use
  – Many medications influence the ECG, blood pressure, or heart rate responses to exercise; understanding the influence of medications is vital in any testing situation, especially with the elderly.
Indications for exercise testing of children include the following:

- Evaluating cardiac and pulmonary functional capacity
- Detecting myocardial ischemia
- Evaluating cardiac rhythm and rate
- Determining blood pressure response
- Assessing symptoms with exercise
- Detecting and managing exercise-induced asthma
- Assessing physical fitness
- Charting the course of a progressive disease and evaluating therapy
- Assessing the success of rehabilitation programs
Children

- Children present a greater challenge in exercise testing because of their smaller body size, relatively poor peak performance (in contrast to the work rate increments possible with exercise equipment), potentially shorter attention span, and reduced motivation.

- Exercise testing considerations
  - Consider allowing parents/guardians in testing room.
  - Test explanation must be clear and understood for valid results.

- Equipment used in testing
  - Treadmills and cycle ergometers most common and appropriate modes.
  - ECG, blood pressure monitoring (with appropriate-sized cuff), and gas exchange analysis (with smaller sized mouthpieces) are common assessments.
### TABLE 26-3. HEMODYNAMIC AND RESPIRATORY CHARACTERISTICS OF CHILDREN’S RESPONSES TO EXERCISE

<table>
<thead>
<tr>
<th>FUNCTION</th>
<th>TYPICAL FOR CHILDREN (COMPARED WITH ADULTS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HR at submaximal intensity</td>
<td>Higher, especially at first decade</td>
</tr>
<tr>
<td>HR max</td>
<td>Higher</td>
</tr>
<tr>
<td>Stroke volume (submax and max)</td>
<td>Lower</td>
</tr>
<tr>
<td>(\dot{Q}) at given (\dot{V}O_2)</td>
<td>Somewhat lower</td>
</tr>
<tr>
<td>AV difference for (O_2) at given (\dot{V}O_2)</td>
<td>Somewhat higher</td>
</tr>
<tr>
<td>Blood flow to active muscle</td>
<td>Higher</td>
</tr>
<tr>
<td>SBP, DBP submax and max</td>
<td>Lower</td>
</tr>
<tr>
<td>(\dot{V}E) at given (\dot{V}O_2)</td>
<td>Higher</td>
</tr>
<tr>
<td>(\dot{V}E) “breaking point”</td>
<td>Similar</td>
</tr>
<tr>
<td>Respiratory rate</td>
<td>Higher</td>
</tr>
<tr>
<td>Vt/VC</td>
<td>Lower</td>
</tr>
</tbody>
</table>

HR, heart rate; AV, arteriovenous; SBP, systolic blood pressure; DBP, diastolic blood pressure.

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>TREADMILL</th>
<th>CYCLE ERGOMETER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expense</td>
<td>More expensive</td>
<td>Less expensive</td>
</tr>
<tr>
<td>Noise</td>
<td>Louder</td>
<td>Quieter</td>
</tr>
<tr>
<td>Safety</td>
<td>More dangerous</td>
<td>Less dangerous</td>
</tr>
<tr>
<td>Workload adjustments</td>
<td>Easy to adjust workload by speed and grade changes</td>
<td>Easy to adjust work rate</td>
</tr>
<tr>
<td>Determination of work efficiency</td>
<td>More difficult to quantify work rate because of influence of body size, weight, gait, and stride length</td>
<td>Electronically braked ergometers provide a more accurate measurement of mechanical power output than mechanically braked ergometers</td>
</tr>
<tr>
<td>Measurement ease</td>
<td>More difficult to obtain blood pressure because of movement artifact</td>
<td>Easier to obtain blood pressure and measures of gas exchange</td>
</tr>
<tr>
<td>Space</td>
<td>Require more laboratory space</td>
<td>Require less laboratory space</td>
</tr>
<tr>
<td>Other</td>
<td>Easier to calibrate than either mechanically braked or electronically braked cycle ergometers</td>
<td>More difficult to maintain workload as younger children may not maintain a steady cadence</td>
</tr>
</tbody>
</table>

Maximal effort criteria and other measures

- Criteria commonly used to verify maximal effort in children include:
  - Respiratory exchange ratio of $\geq 1.10$
  - Peak heart rate approaching 200
  - Subjective observation of experienced testers
- The children’s OMNI scale of perceived exertion is useful for evaluating rating of perceived exertion levels.

Indications and contraindications for stress testing

- Children with severe limitations requiring surgery or other significant intervention should not be tested.
- Because the goal of most stress testing is to elicit symptoms and access cardiopulmonary reserves, maximal effort is desired.
Exercise protocols

- Goal time of test is 10 ± 2 minutes.
- Standard protocols (e.g., Bruce) can be used, but might consider child-specific protocols (e.g., James cycle ergometer, Godfrey test).

Pharmacologic stress testing and echocardiography

- In some instances, these may be appropriate in children for the same reasons as adults.
- Pharmacologic tests are also occasionally needed (e.g., those too young to be able to exercise or understand the test).

### TABLE 26-5. RELATIVE RISKS FOR STRESS TESTING

#### 2.2.1-HFI: Knowledge of cardiovascular risk factors or conditions that may require consultation with medical personnel before testing or training, including inappropriate changes of resting or exercise heart rate and blood pressure; new onset discomfort in chest, neck, shoulder, or arm; changes in the pattern of discomfort during rest or exercise; fainting or dizzy spells; and claudication.

#### 3.2.1-HFI: Knowledge of pulmonary risk factors or conditions that may require consultation with medical personnel before testing or training, including asthma, exercise-induced asthma/bronchospasm, extreme breathlessness at rest or during exercise, bronchitis, and emphysema.

<table>
<thead>
<tr>
<th>LOWER RISK</th>
<th>HIGHER RISK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Symptoms during exercise in an otherwise healthy child who has a normal cardiovascular exam and ECG</td>
<td>Patients with pulmonary hypertension</td>
</tr>
<tr>
<td>Exercise-induced bronchospasm studies in the absence of severe resting airway obstruction</td>
<td>Patients with documented long-QTc syndrome</td>
</tr>
<tr>
<td>Asymptomatic patients undergoing evaluation for possible long-QTc syndrome</td>
<td>Patients with dilated/restrictive cardiomyopathy with congestive heart failure or arrhythmia</td>
</tr>
<tr>
<td>Asymptomatic ventricular ectopy in patients with structurally normal hearts</td>
<td>Patients with a history of a hemodynamically unstable arrhythmia</td>
</tr>
<tr>
<td>Patients with unrepaired or residual congenital lesions who are asymptomatic at rest (including left to right shunts, obstructive right heart lesions without severe resting obstruction, obstructive left heart lesions with severe resting obstruction, regurgitation lesions regardless of severity)</td>
<td>Patients with hypertrophic cardiomyopathy who have symptoms, greater than mild left ventricular outflow tract obstruction, and documented arrhythmia</td>
</tr>
<tr>
<td>Routine follow-up of asymptomatic patients at risk for myocardial ischemia, including Kawasaki disease without giant aneurysm or known coronary stenosis, after repair of anomalous left coronary artery, after arterial switch procedure</td>
<td>Patients with greater than moderate airway obstruction on baseline pulmonary function tests</td>
</tr>
<tr>
<td>Routine monitoring in cardiac transplant patients not currently experiencing rejection</td>
<td>Patients with Marfan syndrome and activity-related chest pain in whom a noncardiac cause of chest pain is suspected</td>
</tr>
<tr>
<td>Patients with palliated cardiac lesions without uncompensated congestive heart failure, arrhythmia, or extreme cyanosis</td>
<td>Patients suspected to have myocardial ischemia with exertion</td>
</tr>
<tr>
<td>Patients with a history of hemodynamically stable supraventricular tachycardia</td>
<td>Routine testing of patients with Marfan syndrome</td>
</tr>
<tr>
<td>Patients with stable dilated cardiomyopathy without uncompensated congestive heart failure or documented arrhythmia</td>
<td>Unexplained syncope with exercise</td>
</tr>
</tbody>
</table>
OMNI Scales of Perceived Exertion for Cycling and Walking/Running
BOX 26-3 Usual Indications for Test Termination

1.3.2-ES: Knowledge of exercise testing procedures for various clinical populations including those individuals with cardiovascular, pulmonary, and metabolic diseases in terms of exercise modality, protocol, physiologic measurements, and expected outcomes.

1. Decrease in ventricular rate with increasing workload associated with extreme fatigue, dizziness, or other symptoms suggestive of insufficient cardiac output
2. Failure of heart rate to increase with exercise and extreme fatigue, dizziness, or other symptoms suggestive of insufficient cardiac output
3. Progressive fall in systolic blood pressure with increasing workload
4. Severe hypertension, > 250 mm Hg systolic or 115 mm Hg diastolic, or blood pressures higher than can be measured by laboratory equipment
5. Dyspnea that the patient finds intolerable
6. Symptomatic tachycardia that the patient finds intolerable
7. Progressive fall in oxygen saturation to < 90% or a 10-point drop from resting saturation in a patient who is symptomatic
8. Presence of ≥3 mm flat or downward sloping ST-segment depression
9. Increasing ventricular ectopy with increasing workload, including a > 3-beat run
10. Patient requests termination of the study


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