Exercise Concerns in Children

- Exercise Testing
- Exercise Prescription
- Congenital Heart Diseases

Exercise Tests in Children

- Fitness Tests
  - commonly used in school-based physical education
  - field test batteries
    - Fitnessgram
    - President’s Challenge test
- Clinical Tests
  - known or suspected abnormalities
  - symptoms associated with exercise
  - measure functional capacity

Field Fitness Tests (table 11-1)

- Aerobic Capacity 1-mile walk/run
- Strength/endurance curl-ups pull-ups/push up
- Flexibility Sit-reach
- Agility Shuttle run
- Body composition BMI/SKF

Stress Testing in Children

- Most children will not give a maximal effort, crying may be the end-point
  - most children are sprinters not runners
- Treadmill testing usually is preferred over cycle
  - less leg fatigue, less need for cooperation
- Results often are related to size, rather than age

<table>
<thead>
<tr>
<th>Subject</th>
<th>Speed (mph)</th>
<th>Initial Grade (%)</th>
<th>Increment (%)</th>
<th>Stage Duration (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poorly fit</td>
<td>3.00</td>
<td>6</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Sedentary</td>
<td>3.25</td>
<td>6</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Active</td>
<td>5.00</td>
<td>0</td>
<td>2.5</td>
<td>2</td>
</tr>
<tr>
<td>Athlete</td>
<td>5.25</td>
<td>0</td>
<td>2.5</td>
<td>2</td>
</tr>
</tbody>
</table>

**TABLE 11-2. Protocols Suitable for Graded Exercise Testing of Children**

<table>
<thead>
<tr>
<th>Height (cm)</th>
<th>Initial Load (watts)</th>
<th>Increments (watts)</th>
<th>Step Duration (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;120</td>
<td>12.5</td>
<td>12.5</td>
<td>2</td>
</tr>
<tr>
<td>120–139.9</td>
<td>12.5</td>
<td>25</td>
<td>2</td>
</tr>
<tr>
<td>140–159.9</td>
<td>25</td>
<td>25</td>
<td>2</td>
</tr>
<tr>
<td>≥160</td>
<td>25</td>
<td>50 (boys)</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>25 (girls)</td>
<td></td>
</tr>
</tbody>
</table>


12 Year-Olds
Special Precautions

- children are more prone to overuse injuries or damage to bone epiphyseal plates if excessive strain is applied
  - Vary sports participation?

- children are more prone to environmental temperatures
  - smaller surface area/mass ratio
  - smaller absolute blood volume

Aerobic Prescription for kids, ACSM

- Optimum amount and type is not defined
  - individualized based in maturity, skill, medical status
  - > 6 yrs, > 30 min moderate intensity, each day
  - older children, 20-30 min vigorous ex, 3-5 d

AHA Physical Activity Standards for Children

- Walking, bicycling, backyard play; use of stairs, playgrounds, and gymnasiums; interaction with other children
- Less than 2hr/d TV and video games
- Weekly, organized sports, lessons, etc
- Daily, 20 min organized school exercises
- Regular participation in household chores
- Weekly active family outings
- Positive role models (parents, teachers)

Resistance Exercise Prescription in Kids?

- Children can participate in properly designed and supervised REX program
  - proper instruction in techniques is essential
  - slow controlled movements, no ballistic
  - avoid power lifting and body building goals
  - full ROM, multi-joint exercises

REX Prescription for Kids

- avoid maximal weights (8 or more reps/set) not to maximal exertion
- 1-2 sets of 8-10 exercises
- rest 1-2 min between exercises
- twice per week

Congenital Heart Diseases

- Atrial and ventricular septal defects
- Patent Ductus Arteriosus
- Coarctation of the Aorta
- Tetralogy of Fallot
- Uncommon
  - atriocentric septal defect
  - transposition of the great arteries
  - single ventricle (Fontan operation)
  - congenital coronary artery abnormalities
Heart Diseases: in general
- Most are recognized in the first few yrs
- Outcome is usually better if repaired early—before long-lasting effects
- Often there are residual effects after surgery
- But, patients usually can participate in sports after repair
  - depends on age and residual effects

Causes of Heart Defects
- Hereditary factor (1-2%)
- Injury to the fetus
  - vitamin deficiency, defective maternal metabolism, poor diet, drug effect, drugs and alcohol
- Diseases during pregnancy
  - German measles, rubella

Congenital Heart Disease
- Occurs in 0.8% of all live births
- Most common kind of congenital defect
- 98% of the time, diagnosed by 4 yrs of age
  - well-publicized exceptions
- children are usually at low risk for sudden death during exercise
  - side effects haven’t developed yet

Atrial and Ventricular Septal Defects
- Atrial (5-10% of congenital heart disease)
- Ventricular (15-20%)
- Hole between the left and right chambers
  - left to right shunt
  - pulmonary hypertension
  - atrial and ventricular hypertrophy

Atrial Septal Defect
- Evander Holyfield, boxer of the decade, 1990-2000
- small atrial septal defect was found while training

Septal Defects
- Symptoms
  - fatigue, increased respiratory illnesses, shortness of breathe, pulmonary hypertension
  - murmur, splitting of the second heart sound
  - arrhythmias, atrial & ventricular hypertrophy
  - limited exercise capacity
A-V Septal Defects

- Treatments
  - closure during childhood
  - open heart surgery or transcatheter repair
- Residual effects
  - arrhythmias, RBBB
  - sinus node dysfunction
- 80% normal exercise tolerance after repair

A-V Septal Defects

- Exercise Guidelines
  - small defect w/o pulmonary hypertension
    - participate in all sports
  - mild pulmonary hypertension
    - low intensity sports only
  - markedly elevated right heart pressures
    - should not participate in competitive sports

Patent Ductus Arteriosus

- DA is a normal connection between the pulmonary artery and the aorta in the fetus
  - closes within hrs of birth due to increased oxygen
- 5-10% of congenital heart disease—hole remains open

Patent DA, symptoms

- In adult, patent DA allows blood to flow from aorta to pulmonary artery
  - increases lung bf
  - left ventricle must work extra hard
  - Increased bf in lungs
  - left atrial and left ventricular dilation
  - pulmonary vascular disease (high pressures)
  - murmur

Patent DA, exercise effects

- Small DA
  - participate in all sports
- Moderate or large DA with ventricular enlargement and severe pulmonary hypertension
  - Must close DA
  - restricted from all sports until 3 months after repair

Coarctation of the Aorta

- 8-10% of congenital heart disease
- narrowing of the aorta
- elevated blood pressures in the upper body
- lower blood pressures in the lower body
- reduced development of the lower limbs
**Coarctation of the Aorta**
- Chris Waller
- 1992 Men’s National Gymnastic champion
- successful coarctation repair
- shortened lower body segment is an advantage in some sports

**Coarctation, symptoms**
- Murmur
- cold feet, leg cramps, nosebleeds, headaches
- much higher blood pressures/pulse in upper body than lower body
- hypertension
dilated ascending aorta
- reduced exercise capacity, increased SBP

**Coarctation, exercise effects**
- Pressure gradient between upper and lower body < 20 mmHg, normal resting bp, peak exercise SBP < 230 mmHg
  - all but static sports, no power-lifting
- Pressure grad > 20 mmHg, hypertension, peak exercise SBP > 230 mmHg
  - low intensity exercise only

**Tetralogy of Fallot**
- Blue Baby Syndrome
- 6% of congenital heart disease
- 4 characteristics
  - pulmonary artery stenosis
  - right ventricular hypertrophy
  - ventricular septal defect
  - Enlarged aorta

**Blue Baby Syndrome**
- Cyanotic cardiac disease
- hypoxic spells, relieved by squatting-
  - increase pressure in the left ventricle, closing the septal shunt so venous blood won’t bypass the lungs
  - murmur and right ventricular hypertrophy
  - impaired exercise responses

**Tetralogy, repair**
- Surgical closure of the shunt and opening of the pulmonary outflow tract
- 80-85% will have a normal exercise capacity
- 73% will have ventricular arrhythmias
- 34% supraventricular tachycardia
Tetrology, exercise effects

- Normal or near-normal right-sided heart pressures, no residual shunt, no arrhythmias
  - all competitive sports
- Marked pulmonary regurgitation, elevated right ventricular pressure, arrhythmias
  - low physical activity only
  - restrict static exercises

Congenital Valve Diseases

- Pulmonary valve stenosis, 8-12 % of congenital heart disease
- Aortic valve stenosis, 3-6 %
- Increased pressures in right or left ventricles, respectively
- Decreased exercise capacity
- Risk of sudden death

Valve Repair

- Balloon valvoplasty
- Homograft
  - pulmonary valve moved to aortic valve
  - “homograft” valve put in pulmonary position
- Prosthetic valves
- Advantages of homograft
  - valve grows with child
  - avoidance of anticoagulants

Prosthetic Valve

Valve replacement, exercise effects

- Usually some remaining regurgitation
- New valve is weaker and prone to stenosis and blood clotting
- Subject may be on anti-coagulant therapy
  - care with high static sports
  - care with contact sports

Conclusions:

- Children after the age of 6 have similar exercise guidelines as adults, except
  - limit maximal aerobic or resistive exercise
  - special precaution in hot or cold weather
- Children with heart diseases
  - usually are diagnosed before they begin sports
  - may be diagnosed from an unusual exercise response
  - have minimal long-lasting effects when diagnosed early