Automobile Physiology...Performance related to size

Outline
- Equipment & protocols
- Adult – child differences in CPET parameters
- Example: CPET in CF

Equipment for Pediatric CPET
- Oxygen saturation
- Pediatric probe
- Small mask
- Sensitive flow meter
- Small cuff
- Small electrodes
- Small bike
- Modified protocol
- Different norm values

Protocols for pediatric CPET
Aim: 6-10 min young children, 8-12 min adolescents

Hebestreit H, et al. Respiration. 2015 epub
A Systematic Review of Reference Values in Pediatric Cardiopulmonary Exercise Testing
Samuel Mottu1, Jole Bertaud2, Francois-Herve Costi2, Frederic Billaud1
values. Each laboratory should select the set of reference values that best represent their patient’s characteristics while favoring studies of good methodological quality with appropriate validation.

Order via t.takken@umcutrecht.nl

Standard design cardiopulmonary system
VO2 max most important design parameter
All mammals have standard blue print:

- Heart
- Lungs
- Vascular system
- Muscles

Adult Child Differences in CPET parameters

Peak Heart Rate

Cardiac Stroke Volume

Cardiac Output

Prado et al 2006
### Arterio-venous Oxygen Difference

<table>
<thead>
<tr>
<th></th>
<th>Child</th>
<th>Adult</th>
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<tbody>
<tr>
<td>40W</td>
<td><img src="Arterio-venous_Oxygen_Difference_40W.png" alt="Bar Graph" /></td>
<td><img src="Arterio-venous_Oxygen_Difference_Adult_40W.png" alt="Bar Graph" /></td>
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<tr>
<td>60W</td>
<td><img src="Arterio-venous_Oxygen_Difference_60W.png" alt="Bar Graph" /></td>
<td><img src="Arterio-venous_Oxygen_Difference_Adult_60W.png" alt="Bar Graph" /></td>
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</tbody>
</table>

Prado et al 2006

### VO\textsubscript{2}max (L/min) - Dutch Norms

♂ +169%  ♀ +136%

### VO\textsubscript{2}max/kg - Dutch Norms

♂ ~48-50  ♀ ~40-41


### Blood Pressure

![Graph](Blood_Pressure.png)

### RER peak

- Boys
- Girls

![Graph](RER_peak.png)

### Breathing pattern at Peak Exercise

- Boys +206%
- Girls +163%

- Boys -20%
- Girls -23%
Peak minute ventilation

Ventilatory Drive (VE/VCO₂ slope)

Criteria for maximal effort

Subjective criteria:
- Unsteady walking, running or biking
- Sweating
- Facial flushing
- Clear unwillingness to continue CPET despite encouragement

Objective criteria:
- RERpeak > 1.0
- HRpeak > 180 beats/min
- VO₂ plateau in final minute (infrequently observed)
- NB: never stop test if criteria are met

Important Adult-Child Differences

**Hemodynamic**
- VO₂peak (L/min) Lower
- Submaximal HR Higher
- SV (sub)max Lower
- CO at %VO₂peak lower
- Δ aV̄O₂ at %VO₂peak Higher
- Blood flow to muscle
- SBP, DBP
- Myocardial ischemia

**Ventilatory**
- Tidal Volume Lower
- Respiratory Rate Higher
- VE peak Lower
- Ventilatory drive Higher
- Ventilatory efficiency Lower

**Metabolic**
- Glycolytic activity Lower
- Fat oxidation Higher
- CHO oxidation Lower
- Peak blood lactate Lower
- Lactic capacity Same
- Lactate clearance Faster
- Recovery after high intensity exercise Faster

**Important Adult-Child Differences cont’d**
**Example: Exercise Testing in Patients with Cystic Fibrosis**

![Diagram of exercise testing](image)

**WHY: CPET in CF - Applications**

- Routine monitoring and assessment of exercise-related symptoms
- Pretransplant assessment
- Physical activity counselling/recommendations/exercise prescription
- Interim functional assessment

**VO₂MAX & Survival (CF PATIENTS)**

![Graph showing VO₂MAX and survival rates](image)

**Survival in contemporary 11-14 year old children with CF**

- 127 CF patients
- Mean age 12.7 years
- FEV1: 77%
- CPET (bike)
- 7.5 years follow-up

**Exercise Limiting Factors in CF**

*More than lung disease*

![Diagram showing exercise limiting factors](image)

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Poor relation between VO_{2}peak and FEV_{1} (Children with CF)

Unpublished observation WKZ

Relationship walk distance and FEV_{1} (Adult CF patients)

Doeleman, Takken, Bronsveld & Hulzebos, Physiotherapy, accepted

Gender differences in CF

Unpublished observation WKZ

Take-Home Messages

• Also in children, never underestimate the power of CPET

• When testing children, appropriate equipment and protocol should be used;

• Because of the differences in physiology, pediatric reference values for CPET parameters should be used.

Thank You

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