PHYSICAL PERFORMANCE, EXERCISE TRAINING AND BODY COMPOSITION IN CONGENITAL HEART DISEASE

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CHD - Heterogenous disease

1:100 children born with CHD

Diller et al.
FACTORS RELATED TO LIMITED AEROBIC CAPACITY

- Ventricular function - Stoke volume
- Heart rate
- Muscle function
- Pulmonary function
- Pulmonary blood flow
- Cyanosis
- Physical activity

Cardiac output
VENTRICULAR FUNCTION (STROKE VOLUME)

• Valvular stenosis/regurgitation, shunt, hypertension
• Right ventricle as systemic ventricle (TGA)
• Absence of sub pulmonary ventricle (TCPC)
HEART RATE

• Chronotropic incompetence
• Complex heart lesion
• Increasing age
• Sick-sinus, Beta blockers, injury during surgery
FACTORS RELATED TO LIMITED AEROBIC CAPACITY

• Ventricular function - Stoke volume
• Heart rate

\[ \text{Cardiac output} \]

• Muscle function
• Pulmonary function
• Pulmonary blood flow
• Cyanosis
• Physical activity
Muscle function

- Impaired muscle endurance
- Impaired muscle strength
- Impaired muscle metabolism

- Connection muscle strength – peak aerobic capacity (peak VO$_2$)

FACTORS RELATED TO LIMITED AEROBIC CAPACITY

- Ventricular function - Stoke volume
- Heart rate

Cardiac output

- Muscle function
- Pulmonary function
- Pulmonary blood flow
- Cyanosis
- Physical activity
Pulmonary function
  o More common in complex CHD
  o Hypoplasia
  o Restrictivity

Pulmonary blood flow
  o Right ventricular outflow tract restriction
  o Passive pulmonary blood flow
  o Increased pulmonary blood pressure
FACTORS RELATED TO LIMITED AEROBIC CAPACITY

- Ventricular function - Stoke volume
- Heart rate
- Muscle function
- Pulmonary function
- Pulmonary blood flow
- Cyanosis
- Physical activity

Cardiac output
CYANOSIS

↑ CO₂ in blood → ↑ ventilation

FACTORS RELATED TO LIMITED AEROBIC CAPACITY

- Ventricular function - Stoke volume
- Heart rate
- Muscle function
- Pulmonary function
- Pulmonary blood flow
- Cyanosis
- Physical activity??

Cardiac output
Clinical Research

Habitual Physical Activity in Adults With Congenital Heart Disease Compared With Age- and Sex-Matched Controls

Camilla Sandberg, RPT, MSc, a,b Jeremy Pomeroy, PhD, c Ulf Thilén, MD, PhD, d
Anna Gradmark, MD, PhD, a Karin Wadell, RPT, PhD, b and Bengt Johansson, MD, PhD a

80 adults with CHD
32 women
Mean age 37.0±15.3 years
Complex lesions n=40
Simple lesions n=40

42 controls
16 women
36.9±15.0 years
MATERIAL AND METHOD

• Actiheart, 4 days
• Time spent $\geq$ moderate activity ($\geq$3MET)
RESULTS

• Equally active as their healthy peers
• \( \approx 50\% \) did not reach current WHO recommendations on physical activity
Objectively measured physical activity levels of young children with congenital heart disease

Nicola Stone,¹ Joyce Obeid,¹ Rejane Dillenburg,² Jovana Milenkovic,¹ Maureen J. MacDonald,³ Brian W. Timmons¹,³

- Children 3-5 years
- CoA n=6
- ToF n=4
- Accelerometer
- Equally active
- >50% did not reach recommendations
Reduced physical exercise and health-related quality of life after Fontan palliation

Eva R. Hedlund (eva.rylander-hedlund@karolinska.se)¹, Bo Lundell¹, Li Villard²³, Gunnar Sjöberg¹

Table 2  Self-reported exercise and accelerometry

<table>
<thead>
<tr>
<th></th>
<th>Patient</th>
<th>Control</th>
<th>p</th>
<th>Valid N patient</th>
<th>Valid N control</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Self-reported exercise</strong></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Physical exercise, minutes per week</td>
<td>113.5 ± 66.1</td>
<td>227.6 ± 147.2</td>
<td>&lt;0.001</td>
<td>30</td>
<td>25</td>
</tr>
<tr>
<td>Physical exercise, mean intensity in Borg</td>
<td>13.0 ± 2.1</td>
<td>14.3 ± 1.9</td>
<td>&lt;0.05</td>
<td>24</td>
<td>25</td>
</tr>
<tr>
<td><strong>Accelerometer</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total vector magnitude 7 days, counts</td>
<td>$19.2 \times 10^6 \pm 4.6 \times 10^6$</td>
<td>$18.9 \times 10^6 \pm 4.7 \times 10^6$</td>
<td>0.79</td>
<td>30</td>
<td>25</td>
</tr>
<tr>
<td>Sedentary %</td>
<td>48.6 ± 4.4</td>
<td>51.8 ± 5.2</td>
<td>&lt;0.05</td>
<td>30</td>
<td>25</td>
</tr>
<tr>
<td>Light %</td>
<td>41.1 ± 3.3</td>
<td>38.4 ± 3.6</td>
<td>&lt;0.01</td>
<td>30</td>
<td>25</td>
</tr>
<tr>
<td>Moderate %</td>
<td>10.3 ± 4.2</td>
<td>9.8 ± 3.7</td>
<td>0.67</td>
<td>30</td>
<td>25</td>
</tr>
<tr>
<td>Vigorous %</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Values presented as mean ± 1SD.
Physical activity in adolescents and adults with congenital heart defects: individualized exercise prescription†

Werner Budts¹,², Mats Börjesson³, Massimo Chessa⁴, Frank van Buuren⁵, Pedro Trigo Trindade⁶, Domenico Corrado⁷, Hein Heidbuchel¹,², Gary Webb⁸, Johan Holm⁹, and Michael Papadakis¹⁰

Recommendations for physical activity, recreation sport, and exercise training in paediatric patients with congenital heart disease: a report from the Exercise, Basic & Translational Research Section of the European Association of Cardiovascular Prevention and Rehabilitation, the European Congenital Heart and Lung Exercise Group, and the Association for European Paediatric Cardiology

T Takken¹, A Giardini², T Reybrouck³, M Gewillig⁴, HH Hövels-Gürich⁵, PE Longmuir⁶, BW McCrindle⁷, SM Paridon⁸ and A Hager⁹
Fig. 1. Number of participants per study, if applicable; summarised per group. Ordered by year of publication, the oldest publication is placed last.

PHYSICAL ACTIVITY AND EXERCISE

• General recommendations on physical activity to promote health - moderate activity:
  o ≈30 min/day for adults
  o ≈60 min/day for children

• Most persons with CHD can perform exercise training without restrictions

• Individually adjusted prescription is recommended
Home-Based Interval Training Increases Endurance Capacity in Adults with Complex Congenital Heart Disease

Camilla Sandberg\textsuperscript{a,b}, RPT, MSc, Magnus Hedström\textsuperscript{a}, MD, Karin Wadell\textsuperscript{b}, RPT, PhD, Mikael Dellborg\textsuperscript{c}, MD, PhD, Anders Magnusson\textsuperscript{c}, MD, Anna-Klara Zetterström\textsuperscript{d}, RPT, Amanda Ljungqvist\textsuperscript{d}, RPT and Bengt Johansson\textsuperscript{a}, MD, PhD.

Submitted
MATERIAL AND METHOD

Complex Congenital heart disease
eg. ToF, TGA, ccTGA Fontan/TCPC

23 adults (11 women)
33,9±13,6 years
MATERIAL OCH METOD

• Incremental CPET
  - Peak VO$_2$, peak work load, peak HR

• Constant work rate CPET
  - 75% of peak work load
  - Test duration (min)
MATERIAL AND METHOD

• 13 exercise training, 10 control

• Home based interval training
  o Ergometer cycle
  o 40 min 3 t/w 12 weeks
  o 70-80% of peak VO$_2$

• Controls 12 weeks of everyday activities
RESULTS PEAK VO$_2$

Figure 2

$p=0.03$
RESULTS AEROBIC ENDURANCE

Figure 1

$\text{Difference in duration at constant work rate CPET (min)}$

$p=0.001$
DOES AEROBIC EXERCISE HAVE ADVERSE EFFECTS ON THE HEART?

• No adverse effect on ventricular function in short term

MUSCLE TRAINING?
Resistance training improves cardiac output, exercise capacity and tolerance to positive airway pressure in Fontan physiology

Rachael L. Cordina a,b, Shamus O'Meagher a,b, Alia Karmali a, Caroline L. Rae c,d, Carsten Liess e, Graham J. Kemp f, Raj Puranik a,b, Nalin Singh g,h, David S. Celermajer a,b,*

- Fontan/TCPC
- 6 training, 5 controls, 32±2 years
- Muscle training 60 min 3t/w 20 weeks
- Increased strength
- Increased muscle mass
- Increased peak VO₂ (increased stroke volume)
2424 patients (SWEDCON)
• 538 complex lesions (18-40 years)
• 1886 simple lesions (18-50 years)

4605 controls (SCB)
• 1845 (18-40 years)
• 2760 (18-50 years)
RESULT

Tabell 1. Height, weight and BMI in adult men and women with congenital heart disease.

<table>
<thead>
<tr>
<th></th>
<th>Complex lesions 18-40 years</th>
<th>Simple lesions 18-50 years</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Men</td>
<td>Women</td>
</tr>
<tr>
<td>Height</td>
<td>↓</td>
<td>↓</td>
</tr>
<tr>
<td>Weight</td>
<td>↓</td>
<td>=</td>
</tr>
<tr>
<td>BMI</td>
<td>↓</td>
<td>=</td>
</tr>
</tbody>
</table>

BMI; body mass index.
## RESULT

Table 3. Prevalence of underweight (BMI <18.5) and obesity (BMI>30) in adult men and women with congenital heart disease.

<table>
<thead>
<tr>
<th></th>
<th>Complex lesions 18-40 years</th>
<th>Simple lesions 18-50 years</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Men</td>
<td>Women</td>
</tr>
<tr>
<td>Underweight (BMI&lt;18.5)</td>
<td>↑</td>
<td>=</td>
</tr>
<tr>
<td>Obesity (BMI &gt;30)</td>
<td>=</td>
<td>=</td>
</tr>
</tbody>
</table>

BMI; body mass index.
Lean mass deficits, vitamin D status and exercise capacity in children and young adults after Fontan palliation

- Body composition dual energy X-ray absorptiometry
- 50 patients Fontan circulation
- Median age 11.5 (range 5.1–33.5) years

- Results:
- Poor growth and marked lean mass deficits
  - Avitabile et al. Heart. 2014 November ; 100(21): 1702–1707
• 3069 ACHD patients (median age 32.6 years)
• Higher BMI was associated with lower mortality
• Symptomatic patients with complex cardiac defects
• Weight loss even higher risk of mortality.

TAKE HOME MESSAGES

• Impaired aerobic capacity
• Multiple underlying factors
• Exercise training is safe and have positive effects
• Exercise training – prescribed individually
• Higher prevalence of lower BMI
• Low BMI associated with worse prognosis
THANK YOU FOR YOUR ATTENTION!