Children have an elementary need for motor activity

The children's perceptual and motor experience not only determines their physical and motor development but also decisively influences their emotional, psycho-social, and cognitive development.

Deficiency in this field might affect the children's entire personal development in a negative way.

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Physical inactivity in childhood is abnormal!

- regardless of whether it is due to physical, emotional, psycho-social, or cognitive factors

Reduced physical activity leads to:
- Reduced radius of action
- Impaired perception of and motor development
- Impaired psycho-social development
  - Social behavior, self-concept, motivation, and others

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Physical activity patterns of children after neonatal arterial switch operation.

**Group A:** 52 children and adolescents (aged 7-14 years) after neonatal arterial switch operation
**Group B:** 35 children with repaired atrial or ventricular septal defect
**Group C:** 124 age-matched healthy children

Assessment: 24-hour continuous heart rate monitoring using the percentage of heart rate reserve to measure the amount of physical activity.

**Results:**
The CHD group was significantly less physically active than healthy peers

- 19% (Group A) and 31% (Group B) of the CHD patients engaged in more than 30 minutes a day of moderate activity compared to 57% of the healthy peers (Group C) (p<0.004)
- 27% (Group A) and 34% (Group B) of the CHD patients engaged in more than 20 minutes a day of vigorous activity compared to 47% of the healthy peers (Group C) (p<0.003)

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147 patients, mean age 11.6 years (7-18 years) at a median of 8.1 years after the Fontan procedure
Assessment: A questionnaire of self-reported physical activity, measurement of habitual physical activity using universal accelerometer and others

**Results:**
- 80% participated in gym class at school
- 33% reported they were less active than their friends

The measured time spent in moderate and vigorous activity was markedly below normal at all ages
- 38% of the patients achieved the current physical activity recommendations for children and adolescents

Objectively measured physical activity levels was not significantly related to self-reported activity levels.
Children should do at least 60 minutes of physical activity daily. (http://www.cdc.gov/physicalactivity/everyone/guidelines/children.html)

Moderate to vigorous physical activity ≥ 90 min/d are recommended for optimal health.

Sedentary lifestyles immediately impact peer socialization and hinder motor skill development, which may lead to decreased activity self-efficacy and increase the risk of sedentary lifestyle morbidities (obesity, diabetes and atherosclerosis).

Exercise-intolerant and activity restricted children experienced larger increases in the absolute body mass index (BMI) and the BMI percentile than children with neither exercise intolerance nor activity restrictions

110 CHD patients - follow up for 8.4 years (aged 3.9 ± 2.5 baseline and 12.7 ± 3.1 at follow up)

activity restriction was the strongest predictor of the risk of being overweight (RR, 2.60; 95% CI, 1.34-3.54) and obese (RR, 4.08; 95% CI, 1.42-7.38) at follow up

Factors associated with the physical activity level of children who have the Fontan procedure

Longmuir et al. Am Heart J 161(2); 2011:411-417

Children with complex heart defects are sedentary, with activity level unrelated to exercise capacity.

Aim: to identify factors associated with physical activity level for children who have the Fontan procedure

Subjects: 64 children (25 female, 5-11 years) after Fontan.

Measurements: weekly minutes of moderate-to-vigorous physical activity, cardiac status, resting/exercise cardiopulmonary capacity, gross motor skills, health related endurance/strength/body composition and parent/child activity perception.

Main results:
Participants performed 361 ± 137 min/week of moderate-to-vigorous physical activity
Increased activity was related to:
- antithrombotic medication use (86 min/week),
- higher weekly outdoor time (0.7 minute per outside minute)
- lower family income ($3/week per $10,000),
- higher parent rating of child’s activity relative to peers
Decreased activity was related to:
- winter season (-44 min/week)
- history of arrhythmia (-96 min/week)
- greater child’s confidence in own ability to be active (-113 min/week)

Development of motor abilities in children with congenital heart disease compared to healthy peers

Impaired motor competence in school-aged children with complex congenital heart disease.

Motor Development in Children with Congenital Heart Diseases Compared to Healthy Peers
Study Group
120 children (aged 7 to 12 years) who had undergone a surgical repair with multiple and complex correction within the first year of life were compared with 387 healthy school children at same age.

Assessment: The Movement ABC for testing motor skills, isokinetic strength measurement for knee extension and flexion and hand dynamometer for isometric grip strength

Results:
Children with CHD scored significantly worse for manual dexterity, ball skills, static and dynamic balance, grip strength and quadriceps muscle strength.

Compared with the healthy peers, children with complex congenital heart diseases had 5.8-fold (95% confidence interval, 3.8-8.8) risk of having any degree of impaired motor competence.

The risk to have severe motor disturbances was 11-fold (95% confidence interval, 5.4-22.5).

Survey of children with congenital heart diseases
Children and adolescents with congenital heart diseases:
- n = 194
  - 106 boys,
  - 88 girls,
  - mean age 10.0 ± 2.7 years,
  - (Median: 10; Range: 5 to <15 years)

Control group (healthy schoolchildren):
- n = 455
  - 220 boys,
  - 235 girls,
  - mean age 9.6 ± 2.17 years,
  - (Median: 9; Range: 7 to <15 years)

Motor Development in Children with Congenital Heart Diseases
Compared to Healthy Peers

Cardiac diagnosis present in the CHD (* also in combination with other diagnosis)

<table>
<thead>
<tr>
<th>Cardiac diagnosis</th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>ventricular septal defect (VSD)</td>
<td>47</td>
<td>24.2</td>
</tr>
<tr>
<td>tetralogy of Fallot (ToF)</td>
<td>28</td>
<td>14.4</td>
</tr>
<tr>
<td>coarctation of the aorta (CoA)</td>
<td>23</td>
<td>11.9</td>
</tr>
<tr>
<td>atrial septal defect (ASD II)</td>
<td>15</td>
<td>8.2</td>
</tr>
<tr>
<td>aortic stenosis (AS)</td>
<td>14</td>
<td>7.2</td>
</tr>
<tr>
<td>transposition of the great arteries (TGA)</td>
<td>14</td>
<td>7.2</td>
</tr>
<tr>
<td>pulmonary stenosis (PS)</td>
<td>12</td>
<td>6.2</td>
</tr>
<tr>
<td>complex lesions / single ventricle physiology</td>
<td>10</td>
<td>5.1</td>
</tr>
<tr>
<td>arrhythmia</td>
<td>9</td>
<td>4.6</td>
</tr>
<tr>
<td>patent ductus arteriosus (PDA)</td>
<td>8</td>
<td>4.1</td>
</tr>
<tr>
<td>aortic insufficiency (AI)</td>
<td>7</td>
<td>3.6</td>
</tr>
<tr>
<td>mitral insufficiency (MI)</td>
<td>7</td>
<td>3.6</td>
</tr>
<tr>
<td>persistent foramen ovale (PFO)</td>
<td>3</td>
<td>1.5</td>
</tr>
<tr>
<td>Ebstein’s anomaly</td>
<td>3</td>
<td>1.5</td>
</tr>
<tr>
<td>transposition of pulmonary veins</td>
<td>2</td>
<td>1.0</td>
</tr>
<tr>
<td>long QT syndrome (LQTS)</td>
<td>2</td>
<td>1.0</td>
</tr>
<tr>
<td>other diagnosis</td>
<td>8</td>
<td>4.1</td>
</tr>
</tbody>
</table>

The primary cardiac diagnosis present in the CHD (* also in combination with other diagnosis)

The body-coordination-test for children (KTK)
The body-coordination-test for children (KTK)

Motor Quotient (MQ) Classification

131-145 high motor development
116-130 good motor development
86-115 normal motor development
71-85 moderate motor disturbances
56-70 severe motor disturbances
< 56 below classification level

Classification according to current cardiac situation and postoperative clinical findings.

Group I: patients after heart surgical and/or interventional operations
1. no residual sequelae (complete correction)
2. with mild residual sequelae
3. with significant residual sequelae
4. patients with complex heart defects after palliative interventions
5. patients with heart defects not requiring operation

Group II: patients in whom the two circulatory systems have not been separated (e.g. systemic and pulmonary circulation has been achieved)
6. aortopulmonary shunt operation
7. patients in whom the two circulatory systems have been separated (e.g. systemic and pulmonary circulation has been achieved a) such as the Fontan operation or the Mustard operation for TGA, where separation of systemic and pulmonary circulation has been achieved b) patients in whom the two circulatory systems have not been separated (e.g. anteroventricular shunt operation)

Group III: patients with with heart defects not requiring operation
1. shunt lesions with insignificant left to right-shunt such as small atrial or ventricular septal defect
2. patients with complex heart defects after palliative interventions
3. insignificant arrhythmia/ECG-abnormality
4. insignificant valvular defects/anomalies such as congenital bicuspid aortic valve
5. insignificant myocardial changes

Group IV: patients with complex arrhythmia
6. patients with complex arrhythmia
7. with mild residual sequelae
8. with significant residual sequelae
9. patients with complex heart defects after palliative interventions
10. patients with heart defects not requiring operation

Group V: patients with complex arrhythmia
11. patients with complex arrhythmia
12. with mild residual sequelae
13. with significant residual sequelae
14. patients with complex heart defects after palliative interventions
15. patients with heart defects not requiring operation

A comparison of VO2peak (peak) between patients with congenital heart disease and healthy subjects, all aged 8-17 years.

Bjarnason-Wehrens et al. Cardiology in the Young (2007); 17 (5): 487-498
Aerobic capacity in adults with various congenital heart diseases.
Fredriksen et al. Am J Cardiol 2001;87:310-304

Study population: 335 adult patients (mean age 33 ±13 years) 55% males, with wide spectrum of congenital heart diseases
Assessment: cardiopulmonary exercise testing
Follow up: median follow-up time 304 days; (range 17-580 days)
- cardiopulmonary exercise capacity (peak VO2 ml/kg/min)
- prognostic value of cardiopulmonary exercise capacity (peak VO2 ml/kg/min)

Exercise intolerance in adult congenital heart disease: comparative severity, correlates, and prognostic implication.

Study group: 335 adult patients (mean age 33 ±13 years) with wide spectrum of congenital heart diseases
Exercise capacity was diminished in all patients, even in asymptomatic patients (NYHA-class I) (VO2peak 26.1 ± 8.2 ml/kg/min)

Study group: 99 adults with wide spectrum of congenital heart diseases (57 male, mean age 25.6 years)
Assessment: anonymous self assessment questionnaire
In adult patients with CHD safety, efficiency as well as potential health benefits of physical activity and exercise training are usually not addressed by the physicians
- 71% reported this topic had never been raised spontaneously by their physicians
- 19% reported they had been encouraged to be more physically active
- 11% stated that they had been told to have no exercise limitation due to the cardiac disease – but more commonly patients were told which kind of exercises were prohibited
Physical activity levels in adults with congenital heart disease.

Study group: 61 adults with wide spectrum of congenital heart diseases (36 male, 35.7 ± 10.9 years).

Physical activity level assessed using accelerometer over one week.

Results:
The range of physical activity was seen between normal and severely limited, declining with increasing severity of the disease. Only 23% of the asymptomatic patients (NYHA-class I) engaged in more than 30 minutes a day of moderate activity. NYHA-class II 15% (p=0.005) NYHA-class III 0% (p=0.001).

Most of the patients were willing to participate in physical activity and exercise but were unsure about the safety and the benefits of such activities.

Advises on physical activity and sports should be included in clinical consultations.

These results emphasise the importance of encouraging children and adolescents and adults with congenital heart diseases to engage more in physical activity and exercise training in order to avoid sedentary behaviour in adulthood and prevent atherosclerotic cardiovascular disease.

Recommendations for physical activity in congenital heart disease

In general, children with CHD should be advised to comply with public health recommendations of daily participation in 60 min or more of moderate-to vigorous physical activity that is developmentally appropriate and enjoyable and involves a variety of activities.

In keeping with these recommendations, all youth with CHD who fulfil the necessary requirements should have the opportunity to participate in physical activity and, if needed, take part in specially adapted programs of physical education.

In general, children with CHD should be advised to comply with public health recommendations of daily participation in 60 min or more of moderate-to vigorous physical activity that is developmentally appropriate and enjoyable and involves a variety of activities.

In keeping with these recommendations, all youth with CHD who fulfil the necessary requirements should have the opportunity to participate in physical activity and, if needed, take part in specially adapted programs of physical education.
Participation in specific supervised programs for the promotion of motor abilities can help to limit motor deficits and prepare and support the integration of children into their peer group.

The participation in such groups is especially **but not only** recommended for patients with significant findings and complex heart defects.

A diversified perceptual and motor learning program - which motivate children and satisfy their need for movement, play and demand their creativity.

Study group 38 children and adolescents aged 7-14 with diverse CHD

Intervention: 8 months (75-minute once a week) specific psychomotor training program

Figure 2: Compensation of Negative Consequences of Congenital Heart Disease by Means of Goal-oriented Improvement of Motor Development

**Figure 2:** Compensation of Negative Consequences of Congenital Heart Disease by Means of Goal-oriented Improvement of Motor Development

Physical activity and sport participation in CHD-children

1. as soon as possible
2. beginning already in babyhood and pre-school-age
3. as normal as possible
4. participation in peers normal indoor and outdoor activities - in kindergarten - in school etc.
5. as much as possible
6. the children’s elementary and natural need for motor-activities should not be interrupted unless necessary because of danger of physical overload

In preschool children, the development of skills and even difficult coordinative tasks is of utmost importance.

A diversified perceptual and motor learning program - which motivate children and satisfy their need for movement, play and demand their creativity.
In prepubertal children

A playful mixture of different age appropriate activity tasks focusing mainly on skills/coordination, but also carefully on flexibility and strength and endurance. During this period physical activity habits for later life are established.

Aerobic exercise in children with CHD

- the activity/exercise must be fun and interesting for the child.
  - jogging, or using stationary cycle is boring and children quickly lose interest.
- the program should include variety of aerobic activities focused on “modified” peers present leisure time activities like swimming, biking, inlineskating, kickbording scooter riding etc., as well as outdoor and indoor games with aerobic component
- the goal in such programs is not necessarily physical training but rather improvement in physical activity and movement.
- a successful program is aerobic in its nature as well as interesting to the child and based on perceptual and motor learning.

Improving strength performance in children with CHD

climbing, pulling, pushing, swinging, jumping, bouncing etc.

integrated in a diversified perceptual and motor learning program - which motivate children and satisfy their need for movement, play and demand their creativity

Exercise Training in pubertal children and after puberty

For pubertal children, other components of exercise play a more important role.

Social components like integration into a team or compliance to fixed rules are important.

After puberty, training can be similar to adults’, focusing especially on strength and endurance

For all age groups, the most essential tasks to avoid a sedentary life style during childhood and to convince the child that participation in physical activity is fun.

Recommendations for clinical practice

- Clinicians should be aware of the detrimental effects of inactivity and sedentary behaviour and should promote physical activity in children with CHD.
- Advice regarding appropriate levels of physical activity should be implemented in clinical consultations.
- Children with CHD should comply with public health recommendations for daily participation in "60 min of moderate-to-vigorous physical activity that is developmentally appropriate and enjoyable, and involves a variety of activities."
- Moreover, they should perform <2 h/day of sedentary activities such as watching TV, using a computer, and playing video games.

Takken et al. EJPC 19;2011;1034-65
Physical activity counselling should be a priority during every visit with a healthcare professional. The importance of daily activity should be emphasized and encouraged at all clinic visits.

Healthcare professionals should encourage the patient (and their caregivers) to ask questions about their physical activity levels and should provide specific counselling to encourage physical activity …

Clinicians should provide written recommendations (including restrictions and permissions) to both primary care providers as well as parents and patients regarding appropriate levels of physical activity and exercise.

Objective measurements of the patient’s daily physical activity (versus self-report or proxy-report) should be considered and patients who do not achieve the recommended level of daily moderate-to-vigorous activity should be offered additional counselling or training interventions until an adequate level of physical activity is achieved and maintained.

Recommendations for clinical practice

Takken et al. EJPC 19;2011;1034-65

Thank you for your attention

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