Development of physical fitness in children with intellectual disabilities

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Abstract

Background Few studies examined the development of physical fitness in children and youth with intellectual disabilities (ID), but the developmental patterns of physical fitness are largely unknown. The first aim was to examine physical fitness of primary school children with ID, aged 8–12, and compare the results with typically developing children in order to determine the performance level of children with ID. The second aim was to investigate the developmental trajectory of physical fitness in children with ID and the possible influence of gender and severity of cognitive impairment in a 4-year during longitudinal study.

Method Seventy-three children with borderline or mild ID (51 boys, 22 girls; age range 8–11 in the year of enrolment) were measured annually on running speed, aerobic endurance (cardiovascular endurance), explosive strength, handgrip strength and trunk strength. Physical fitness scores of 515 typically developing children (266 boys, 249 girls; age range 8–12) were collected for reference values.

Results The results indicated statistically significant differences (with moderate to large Effect Sizes) between children with ID and typically developing children in all ages, favouring the typically developing children, and showed that the gap remained stable across the ages or decreased with increasing age. Multilevel models showed that the children with ID developed statistically significant on all items of physical fitness between age 8 and age 12. There was no statistically significant effect of gender on physical fitness, and the developmental trajectories were similar for boys and girls. For children with borderline and mild ID the developmental trajectories were parallel, but children with mild ID scored statistically significant worse on running speed, explosive strength and handgrip strength.

Conclusions Despite statistically significant development of physical fitness in children with ID, their physical fitness levels should be stimulated. This should start already in young children (<8 years) and the children with the most severe cognitive impairments need special attention.

Keywords development, longitudinal, physical fitness, primary school

Introduction

Physical fitness is associated with a reduced chance of metabolic risk factors (Jago et al. 2010), a lower risk of becoming overweight in adolescence (Moreira et al. 2011; Ortega et al. 2011), a lower risk for clustering of cardiovascular disease risks.
(Andersen et al. 2008) and aerobic physical fitness seems also to be related to cognitive functioning (Hillman et al. 2009; Pontifex et al. 2011). Some studies have shown that children and youth with intellectual disabilities (ID) have lower aerobic fitness and muscular strength (Mac Donncha et al. 1999; Gillespie 2003; Golubovic et al. 2012) then their typically developing counterparts, which might negatively influence children’s physical and cognitive development.

Few studies have examined the development of physical fitness in children and youth with ID. The peak aerobic fitness of 180 individuals with ID (mental retardation without Down syndrome) increased between age group 9–15 years and age group 16–21 years after which it plateaued (Baynard et al. 2008). Furthermore, an increase of abdominal strength/endurance has been seen in a study among 77 individuals with ID (IQ range 30–70) from age group 11–16 years to age group 17–22 years (Lahtinen et al. 2007). As far as we know, the developmental trajectory of aerobic fitness as well as strength in children with ID of primary school age is unknown. In typically developing children it has been shown in a recent large cross-sectional study among 735 children that fitness levels increased statistically significant with increasing age in children aged 6–12 (Fransen et al. 2012). Studying changes in physical fitness over time in children with ID will give insight in possible accelerations or stabilisation and the peak height velocity of aerobic fitness and strength with age as well as possible differences in the developmental trajectories between boys and girls. In addition, it gives insight whether or not the severity of cognitive impairment influences the trajectory of physical fitness. In other studies it has been found that children with mild ID (50 < IQ < 70) had lower scores on motor skills and physical fitness compared with children with borderline ID (71 < IQ < 79; Hartman et al. 2010; Vuijk et al. 2010; Golubovic et al. 2012), which could be partly related to a negative influence of impaired cognitive functioning on participation in physical activity and sports. Children with ID may have lack of opportunities for sport and physical activity (Baynard et al. 2008), which results in low physical activity levels or sedentary behaviour which may, in turn, lead to low physical fitness (Lotan et al. 2004; Santos et al. 2013).

Insight into the developmental trajectory of physical fitness highlights the necessity of interventions aimed at improving physical fitness in this vulnerable population as well as possible subgroups regarding age, gender and severity of cognitive impairment that possibly need special attention. Furthermore, it provides knowledge on the windows of opportunity for stimulating physical fitness in children with ID.

Accordingly, the first aim of the present study was to examine physical fitness of primary school children with ID, aged 8–12, and compare the results with typically developing children in order to determine the performance level of children with ID. The second aim was to investigate the developmental trajectory of physical fitness in children with ID and the possible influence of gender and severity of cognitive impairment in a 4-year during longitudinal study.

**Method**

**Participants**

Seventy-three children with ID (51 boys, 22 girls; age range 8–11 in the year of enrolment; IQ range = 56–79) from primary special-needs schools located in the northern regions of the Netherlands participated in a longitudinal study. Over a period of 4 years, the children’s physical fitness was measured annually in January. Not all 73 children participated in all three measurements, as some children enrolled in the school during the 4-year period and some others left school. Ten children enrolled in the school at the second measurement and 1 child enrolled at the fourth measurement. Table 1 shows the characteristics of the study population in the year of enrolment. Forty-five children were classified as borderline ID (31 boys and 14 girls; mean age = 9.00, SD = 0.93; IQ range = 71–79) and 28 children with mild ID (20 boys and 8 girls; mean age = 9.32, SD = 0.91; IQ range = 54–70). IQ was determined on the basis of results of individual intelligence testing obtained from school records. It has been measured by school psychologists as part of the regular diagnosis process. The two groups did not differ statistically significant with regard to age (Mann–Whitney test, \( P = 0.096 \)) and gender (\( \chi^2 \)-test, \( P = 0.818 \)). The children were...
included if they were healthy and they were not diagnosed with attention-deficit hyperactivity disorder or autism spectrum disorders.

To determine the performance level of physical fitness in children with ID in comparison with typically developing children, 515 children (266 boys and 249 girls) from six mainstream primary schools in the same region were selected for participation. The children ranged in age from 8 to 12 years (mean age = 9.63, SD = 1.31) and their age was appropriate to their grade level. Measurements took place in the period January to April.

Informed consent was obtained for all children and all procedures were approved by the institutional Ethics Committee of the Center of Human Movement Sciences, University Medical Center Groningen, University of Groningen.

### Assessment of physical fitness

Physical fitness was measured with four items of the Eurofit physical fitness test battery (Adam et al. 1988). The standardised and validated Eurofit test battery is designed for assessment of health-related fitness in children and adults (Adam et al. 1988). To measure aerobic components of physical fitness, the test items 20-m endurance shuttle run (20MSR) and 10 × 5 m shuttle run (SR) were administered. For measuring strength, the items standing broad jump (SBJ), handgrip (HG) and sit-ups (SUP) were used. Before each test item was administered, the skill being assessed was demonstrated and instructions were provided. The tests were completed as part of three lessons of physical education at the gym of the school in a fixed sequence. A protocol was used in which the children proceeded in groups of two to three children through the fixed sequence. In the 20MSR (aerobic endurance) test children run back and forth between two lines 20 m apart, pacing their run to audio signals that progressively increase in difficulty. The test ended when a child failed to reach the end lines prior to the beep on two successive occasions. The performance was expressed as the number of stages completed. In the SR (running speed) test children were asked to run 5 m 10 times, covering a distance of 50 m in total. The performance was expressed as the time in seconds, and the best score of two trials was recorded. In the SBJ (explosive strength) test children were asked to jump as far as possible with two feet from a standing position. The performance was expressed as the distance jumped in centimetres. The best score of two trials was recorded. In the HG (handgrip strength) test the children were measured with a handgrip dynamometer with the preferred hand. The children were asked to hold the dynamometer to the side of their body, arm fully extended and palm facing inward. The performance was expressed as strength in kilograms. The best score of two trials was recorded. In the SUP test (trunk strength) the children had to perform as many SUP as possible and the performance was expressed as the number of SUP completed within 30 s. The reliability and validity of the Eurofit for children is adequate (Adam et al. 1988), and adequate reliability was obtained in boys with ID (Intra class correlations varied from 0.94 to 0.99; Mac Donncha et al. 1999).

### Data analysis

To determine the performance level of physical fitness in children with ID in comparison with typically developing children, ANCOVAs were performed per age group (i.e. 8, 9, 10, 11 and 12 years), with gender as covariate, for all variables of physical fitness. To determine the meaningfulness of group effects, correlational Effect Sizes (ES) were calculated for each dependent variable in accordance with Rosnow et al. (2000). The ES can be considered small, $r = 0.10$ to $0.29$, medium, $r = 0.30$ to $0.49$, and large, $r ≥ 0.50$ (Field 2005).

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**Table 1** Main characteristics of the children with intellectual disabilities (ID)

<table>
<thead>
<tr>
<th>Age in the year of enrolment (years)</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>22</td>
</tr>
<tr>
<td>9</td>
<td>20</td>
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<tr>
<td>10</td>
<td>21</td>
</tr>
<tr>
<td>11</td>
<td>10</td>
</tr>
<tr>
<td>12</td>
<td>0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Gender (n)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Boys</td>
<td>51</td>
</tr>
<tr>
<td>Girls</td>
<td>22</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Severity of ID</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Borderline</td>
<td>45</td>
</tr>
<tr>
<td>Mild</td>
<td>28</td>
</tr>
</tbody>
</table>
Multilevel modelling (MLwin 2.23) was used to investigate the development of physical fitness in the children with ID. In multilevel models longitudinal data, which are not independent, can be analysed. In addition, the amount of measurements may vary per child, as MLwin assumes missing at random (Snijders & Bosker 2011). Five multilevel models (two for aerobic fitness and three for strength) were constructed with age, age$^2$, gender and severity of ID as possible predictors and the measures of aerobic fitness and strength as dependent variables. Both age and age$^2$ were entered in the model in order to examine if the best model fit was a linear or quadratic curve, or a combination of both. The possible predictors were entered separately into the initial model. During each step, goodness of fit was evaluated by comparing the $-2$ Log Likelihood of the previous model with the most recent model. Variables that did not contribute statistically significant to the model were removed from further analysis. Random intercepts were considered allowing a unique intercept for each individual child (Snijders & Bosker 2011). To investigate whether or not the developmental trajectories of physical fitness were influenced by gender or severity of ID, interactions of these variables with age were entered into the model. In case of statistically significant interaction effects, these were added to the final models. In order to examine possible accelerations, decelerations or stabilisations in the development of aerobic fitness and strength, for each final model Z-scores per age group were calculated. First it was tested whether the physical fitness measure changed statistically significant from the reference age (age $= 8$ years) to older ages (9, 10, 11 and 12 years). The Z-scores were considered to be statistically significant when they exceeded 1.96 ($P < 0.05$) or 2.58 ($P < 0.01$). Second, the Z-scores of each age were tested against the preceding age (which was then taken as reference group). For all analyses the significance level was set at 0.05.

**Results**

Physical fitness of children with ID compared with typically developing children

In Tables 2 and 3 results of the physical fitness measures per age group are shown for the children with ID and the typically developing children. The

### Table 2  Estimated means (SE) of aerobic fitness (aerobic endurance and running speed) of children with intellectual disabilities (ID) and typically developing children (TD) by age

<table>
<thead>
<tr>
<th>Age</th>
<th>ID</th>
<th>TD</th>
<th>ID</th>
<th>TD</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Aerobic endurance (20MSR$^\dagger$)</td>
<td>Running speed (SR$^\dagger$)</td>
<td>Aerobic endurance (20MSR$^\dagger$)</td>
<td>Running speed (SR$^\dagger$)</td>
</tr>
<tr>
<td></td>
<td>M number of stages (SE)</td>
<td>M number of stages (SE)</td>
<td>M time in seconds (SE)</td>
<td>M time in seconds (SE)</td>
</tr>
<tr>
<td>8</td>
<td>2.70 (0.33)</td>
<td>4.37 (0.14)$^{**}$</td>
<td>0.35</td>
<td>29.91 (0.46)</td>
</tr>
<tr>
<td></td>
<td>n = 22</td>
<td>n = 123</td>
<td></td>
<td>n = 22</td>
</tr>
<tr>
<td>9</td>
<td>3.01 (0.32)</td>
<td>4.82 (0.17)$^{**}$</td>
<td>0.38</td>
<td>27.92 (0.38)</td>
</tr>
<tr>
<td></td>
<td>n = 35</td>
<td>n = 125</td>
<td></td>
<td>n = 39</td>
</tr>
<tr>
<td>10</td>
<td>3.57 (0.29)</td>
<td>5.76 (0.27)$^{**}$</td>
<td>0.42</td>
<td>26.12 (0.31)</td>
</tr>
<tr>
<td></td>
<td>n = 55</td>
<td>n = 105</td>
<td></td>
<td>n = 63</td>
</tr>
<tr>
<td>11</td>
<td>4.15 (0.32)</td>
<td>6.24 (0.25)$^{**}$</td>
<td>0.39</td>
<td>25.77 (0.34)</td>
</tr>
<tr>
<td></td>
<td>n = 48</td>
<td>n = 99</td>
<td></td>
<td>n = 53</td>
</tr>
<tr>
<td>12</td>
<td>4.39 (0.34)</td>
<td>6.50 (0.37)$^{**}$</td>
<td>0.32</td>
<td>24.39 (0.28)</td>
</tr>
<tr>
<td></td>
<td>n = 50</td>
<td>n = 50</td>
<td></td>
<td>n = 50</td>
</tr>
</tbody>
</table>

$^{* *}$ ANCOVA, controlled for gender, $P < 0.001$.

$^\dagger$ A higher score indicates a better performance.

$^\dagger$ A lower score indicates a better performance.

20MSR: 20 m endurance shuttle run (missing values: ID: 38 of 248 measurements; TD: $n = 18$); SR: 10 × 5 m shuttle run (missing values: ID: 21 of 248 measurements; TD: $n = 6$).

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<table>
<thead>
<tr>
<th>Age</th>
<th>Explosive strength (SBJ†)</th>
<th>Handgrip strength (HG†)</th>
<th>Trunk strength (SUP†)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M distance in cm (SE)</td>
<td>M distance in cm (SE)</td>
<td>ES</td>
</tr>
<tr>
<td></td>
<td>ID</td>
<td>TD</td>
<td>ID</td>
</tr>
<tr>
<td>8</td>
<td>115.73 (4.16)</td>
<td>131.87 (1.67)**</td>
<td>0.27</td>
</tr>
<tr>
<td></td>
<td>n = 22</td>
<td>n = 125</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>110.66 (3.20)</td>
<td>138.50 (1.60)**</td>
<td>0.59</td>
</tr>
<tr>
<td></td>
<td>n = 40</td>
<td>n = 125</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>118.36 (2.79)</td>
<td>147.04 (2.11)**</td>
<td>0.62</td>
</tr>
<tr>
<td></td>
<td>n = 63</td>
<td>n = 105</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>123.81 (3.48)</td>
<td>152.57 (2.47)**</td>
<td>0.51</td>
</tr>
<tr>
<td></td>
<td>n = 53</td>
<td>n = 99</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>128.54 (3.18)</td>
<td>160.19 (3.15)**</td>
<td>0.54</td>
</tr>
<tr>
<td></td>
<td>n = 50</td>
<td>n = 50</td>
<td></td>
</tr>
</tbody>
</table>

** ANCOVA, controlled for gender, \( P < 0.001 \).
† A higher score indicates a better performance.
SBJ: standing broad jump (missing values ID: 20 of 248 measurements; TD: \( n = 11 \)); HG: handgrip (missing values ID: 20 of 248 measurements; TD: \( n = 25 \)); SUP: sit-ups (missing values ID: 22 of 248 measurements; TD: \( n = 15 \)).
children with ID were statistically significant less physical fit than the typically developing children on all measures of aerobic endurance and strength in all age groups. For aerobic endurance, a medium ES was found, which was relatively stable across the ages. For running speed, a large ES was found in all ages, but it decreased with increasing age. For all measures of strength mainly moderate to large ES were found in all ages. For explosive strength, the ES was relatively stable across the ages, whereas for handgrip strength and trunk strength the ES decreased with increasing age.

In summary, the results indicated moderate to large differences between the groups in all ages, favouring the typically developing children. The gaps remained stable across the ages or decreased with increasing age.

Development of aerobic fitness in children with ID

The models of the longitudinal changes in aerobic fitness are shown in Fig. 1. The running speed model showed a statistically significant increase of fitness with increasing age. Compared with the performance of 8-year-old children, statistically significant improvements in running speed were found for the 9-year-old ($P < 0.01$), 10-year-old ($P < 0.01$), 11-year-old ($P < 0.01$) and 12-year-old ($P < 0.01$) children. In addition, the children were estimated to improve statistically significant from the age of 8 to 9 years ($-1.99 \text{s}$), from 9 to 10 years ($-2.01 \text{s}$), from 10 to 11 years ($-0.54 \text{s}$) and from 11 to 12 ($-1.48 \text{s}$). The children were estimated to improve the most from age 8 to age 10 ($2 \text{ s per year on average}$), thereafter their running speed gradually increased in a linear way ($1 \text{ s per year on average}$). The children with borderline ID were estimated to perform statistically significant better than the children with mild ID ($\text{Beta} = 1.10, \text{SE} = 0.56, P < 0.001, 1.1 \text{ s}$). The models were not influenced by age$^2$ and gender, so these variables were not included in the final models. No statistically significant interaction effects (i.e. gender $\times$ age and severity of ID $\times$ age) were found, indicating parallel developmental trajectories for boys and girls and for children with borderline ID and mild ID. Details of the model can be listed as follows: Level 2 intercept variance: $\text{Beta} = 4.03; \text{SE} = 0.89$; Level 1 residual variance: $\text{Beta} = 3.73; \text{SE} = 0.43$; Deviance: 1034.26; Deviance empty model, $P < 0.05$: 1164.04.

In the model of aerobic endurance, a statistically significant linear increase of fitness was found with increasing age. Compared with the performance of 8-year-old children, statistically significant improvements in aerobic endurance were found for the 10-year-old ($P < 0.01$), 11-year-old ($P < 0.01$) and 12-year-old ($P < 0.01$) children. The children were estimated to improve the most from 10 to 11 years, which can be characterised by an acceleration in the development ($0.7 \text{ stages, } P < 0.01$). There was no effect of severity of ID, age$^2$ and gender, and no

![Figure 1](multilevel-models.png)
Development of strength in children with ID

The model of explosive strength showed that the 10-, 11- and 12-year-old children performed better compared with the 8-year-old children (all $P$-values < 0.01). The children were estimated to improve the most from the age of 10 to 11, which can be characterised by an acceleration in the development (7.27 cm, $P < 0.01$). Children with borderline ID were estimated to perform statistically significant better than the children with mild ID (Beta = 10.41, SE = 4.15, $P < 0.001$, 10.41 cm). No statistically significant interaction effects of gender and severity of ID with age were found. Details of the model are: Level 2 intercept variance: Beta = 268.10; SE:52.4; Level 1 residual variance: Beta = 128.33; SE = 14.6; Deviance: 1889.34; Deviance empty model, $P < 0.05$: 2037.34.

In the model of handgrip strength, a statistically significant linear increase of strength was found with increasing age. Compared with the performance of 8-year-old children, the 9-year-old, 10-year-old, 11-year-old and 12-year-old children were estimated to perform statistically significant better (all $P$-values <0.01). Furthermore, in each year the children performed statistically significant better than in the preceding year: from 8 to 9 (2.72 kg), from 9 to 10 (2.36 kg), from 10 to 11 (2.01 kg) and from 11 to 12 (3.60 kg). The children were estimated to improve the most from 11 to 12 year. Before 11 years, their handgrip strength gradually increased in a linear way (2.4 kg per year on average). Children with borderline ID performed statistically significant better than children with mild ID (Beta = 1.85, SE = 0.80, $P < 0.001$, 1.85 kg). Details of the model are: Level 2 intercept variance: Beta = 6.85; SE:1.84; Level 1 residual variance: Beta = 11.61; SE = 1.32; Deviance: 1269.37; Deviance empty model, $P < 0.05$: 1396.76.

The model of trunk strength showed a statistically significant linear increase with increasing age. Compared with the performance of 8-year-old children, statistically significant improvements in trunk strength were found for the 9-year old ($P < 0.01$), 10-year-old ($P < 0.01$), 11-year-old ($P < 0.01$) and 12-year-old ($P < 0.01$) children. In each year, the children performed statistically significant better than in the preceding year: from 8 to 9 years (2.22 SUP), from 9 to 10 years (1.84 SUP), from 10 to 11 years (2.17 SUP) and from 11 to 12 years (1.67 SUP). There was no statistically significant effect of severity of ID and no interaction effects of gender and severity of ID with age were found. Details of the model are: Level 2 intercept variance: Beta = 7.69; SE: 1.90; Level 1 residual variance: Beta = 10.19; SE = 1.17.
Deviance: 1240.85; Deviance empty model, P < 0.05: 1331.08.

Discussion

The present study showed substantial differences in aerobic and muscular fitness between children with ID and typically developing children between 8 and 12 years. From 8 years on, the gap was moderate for aerobic fitness and large for muscular strength and the gaps remained relatively stable or decreased with increasing age. These results regarding physical fitness do not confirm the developmental skill-learning hypothesis, which states that the developmental skill-learning gap widens for children with less physical skill as their age-group peers, on average, gain expertise and start to participate in more demanding physical activities (Wall 2004).

Evidence favouring the developmental skill-learning hypothesis has been found regarding motor skills in children with ID. The low performance on motor skills in children with ID (Hartman et al. 2010; Vuijk et al. 2010; Rintala & Loovis 2013) may have resulted in low participation in culturally normative activities like sports (Bouffard et al. 1996; Wall 2004). The relationship between low motor skill performance and low sports participation has already been demonstrated in children with ID (Westendorp et al. 2011). In addition, several studies have shown that individuals with ID experience barriers for physical activity, such as lack of motivation to participate (Temple & Walkley 2007), immobility and illness (Finlayson et al. 2009), inadequate support and opportunities, problems with transport (Caton et al. 2012) or financial constraints (Hawkins & Look 2006). The low fitness levels of the children with ID might result in a higher risk for fitness related health risks in adolescence and adulthood. It is well known that fitness levels of typically developing children are relatively stable and track from childhood to adolescence (Janz et al. 2006; Kristensen et al. 2006). Studies have shown that aerobic endurance in childhood was related to lower body mass index and blood pressure in early adulthood (Kvaavik et al. 2009), and aerobic endurance in adolescence was associated with a low cardiovascular risk profile (low sum of four skinfolds, waist circumference and total serum cholesterol) in adulthood (Twisk et al. 2002). In addition, strength in general is important for athletic performance, execution of daily life activities and fall prevention (Taeymans et al. 2009). Trunk strength showed limited tracking from childhood to adulthood (Trudeau et al. 2003), but handgrip strength appeared to be a fair predictor of adult strength in women (Taeymans et al. 2009). The present study underlines the importance of improving the physical fitness levels of children with ID already at young ages (<8 years) in order to prevent health risks in the long term.

The present study showed that the gap between children with ID and typically developing children for aerobic fitness and muscular strength remained relatively stable or decreased with increasing age. A close look at the developmental trajectories of physical fitness demonstrated that the children with ID showed an acceleration in the development of running speed at early age (8–10 years), then an acceleration in aerobic endurance and explosive strength (10–11 years) and then an acceleration in handgrip strength (11–12 years). Although no quadratic age effects were observed (indicating no accelerated development in the whole age range from 8 to 12 years), the presence of accelerations between 2 or 3 consecutive years might reveal critical periods in the development of physical fitness, which seem to vary from item to item. A possible explanation for the accelerations might be the influence of maturation and aerobic or resistance training. In typically developing children of primary school age, aerobic fitness, measured by maximum oxygen uptake and strength increase as a result of maturation (growth of musculature, lungs and heart) (Haywood & Getchell 2009). In addition, aerobic training and resistance training result respectively in an increase of maximum oxygen uptake and strength in children of primary school age (Haywood & Getchell 2009). In this period, many typically developing children start to participate in organised sports, which might be an important contributing factor for children’s increase of aerobic fitness and strength. In contrast, children with ID are at risk for a sedentary lifestyle and low sports participation (Lotan et al. 2004; Westendorp et al. 2011). In a large cross-sectional study among Flemish typically developing children the number of hours per week spent in sports were related to...
higher scores on running speed and aerobic endurance (only in the age group 8–10 years), and explosive strength (8–12 years), whereas no effect of sports participation was found for handgrip strength (Fransen et al. 2012). It is likely that a combination of maturation and physical activity, and the fact that part of the children participated in organised sports, played a role in the developmental trajectories of the children with ID in the current study.

The developmental trajectories of physical fitness in the children with ID were not influenced by gender, which indicates that the development of physical fitness is similar for boys and girls. This was an unexpected finding because a study in a large sample of typically developing children, 6–17 years of age ($n = 10,464$), showed that boys outperformed girls on most physical fitness items (Sauka et al. 2011). In typically developing children, boys had better cardiorespiratory endurance compared with girls from the age of 9 years, and better speed-agility from the age of 7 years. In addition, sex differences, favouring boys, were found for explosive strength, and hand grip in all age groups and for trunk strength from 8 to 17 year (Sauka et al. 2011). There is no clear explanation for the fact that we did not find effects of gender in our study sample. However, it should be noticed that the low sample size of girls ($n = 22$) may have prevented us from demonstrating differences between boys and girls.

For both children with borderline and mild ID the developmental trajectories of physical fitness were parallel. However, children with mild ID scored statistically significant worse than children with borderline ID on running speed, explosive strength and handgrip strength. So the severity of ID was related with physical fitness, favouring the children with less severe cognitive impairments. A possible explanation for this result is that children with mild ID participate less in organised sports than their peers because of their cognitive problems. Although Westendorp et al. (2011) showed that sports participation did not differ statistically significant between children with borderline or mild ID, 8% of the children with mild ID participated in at least two sports versus 20% of the children with borderline ID. It is possible that the intensity of physical activity during sports participation is lower in children with mild ID. A practical implication is that interventions aimed at improving physical fitness in children with ID should pay special attention to the children with the most severe cognitive impairments.

Strengths of this study include the longitudinal design, which offered the possibility to understand better changes in physical fitness over time. In addition, the use of multilevel analysis was a method which could deal with differences in the amount of measurements between children. Finally, it appeared that the measurements could be taken successfully in this study population of children with ID. Although the children had cognitive impairments, we believe that using demonstrations, clear instructions and measuring small groups of children per test resulted in valid data. A limitation of the current study was the relatively low sample of girls that was included. In general, more boys than girls are diagnosed with ID (Lai et al. 2012). A study with larger sample sizes could have revealed differences in physical fitness between boys and girls. Furthermore, it should be noted that the sample size of the children with ID was smaller than that of the typically developing children, so caution should be paid to the scores per age category in the children with ID. However, at all ages relatively low fitness levels demonstrated in the children with ID compared with the typically developing children. Finally, the children were recruited from primary schools in the northern Netherlands, which resulted in study samples of children with IQ scores above 50. The study cannot be generalised to children with more severe cognitive impairments (IQ levels below 50) and children from other regions of the Netherlands.

**Conclusion**

The present study showed lower aerobic and muscular fitness in children with ID compared with typically developing children between 8 and 12 years. The longitudinal developmental trajectories of the children with ID showed statistically significant improvements of physical fitness with increasing age, with no differences between boys and girls. The children with mild ID showed similar developmental trajectories compared with the children with borderline ID, but they had relatively low scores on
running speed, explosive strength and handgrip strength. The current study suggests that physical fitness in children with ID can be maintained or improved, but stimulating physical fitness should start already in young children (<8 years) and special attention should be paid to the children with the most severe cognitive impairments.

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References


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