Effect of Equine-assisted Activities and Therapies on Cardiorespiratory fitness in children with Cerebral Palsy: A Randomized Controlled Trial

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Cerebral Palsy

+ Cerebral palsy (CP) is defined as a group of permanent disorders of the development of movement and posture, causing activity limitation.
+ The main impairments include reduced muscle strength and cardiorespiratory fitness (CRF), resulting in difficulties performing activities of daily living.

Cardiorespiratory fitness (CRF)

+ Cardiorespiratory fitness (CRF) refers to the ability of the circulatory and respiratory systems to supply oxygen to skeletal muscles during sustained physical activity.

  A strong independent predictor of all-cause mortality.

+ Early childhood (0–6 years) is a critical age for children with CP to adopt either an active or sedentary lifestyle.

+ Therefore, an early intervention to increase habitual physical activities and CRF is important to maintain a healthy lifestyle and quality of life in people with CP.
Equine-assisted activities and therapies (EAAT) on CRF

- Eight-week hippotherapy (16 sessions) significantly decreased energy expenditure in children with ambulatory spastic CP, aged 9 to 11 years (McGibbon et al).

- EAAT will less likely improve CRF in children with CP, considering the short duration of maintaining moderate to vigorous exercise activity during the lesson combined with the low training frequency (Bongers and Takken).
Purpose

+ This study aimed to evaluate the effects of a 16-week EAAT program (40 minutes per session, twice a week, 32 sessions) on CRF in children with CP.
Assessed for eligibility (n=47)

Excluded (n=1)
- Not meeting inclusion criteria (n=0)
- Declined to participate (n=1)
- Other reasons (n=0)

Randomized (n=46)

Allocated to intervention (n=23)
- Received allocated intervention (n=23)
- Did not receive allocated intervention (n=0)

Lost to follow-up (n=0)
Discontinued intervention (n=0)

Allocated to intervention (n=23)
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Lost to follow-up (n=0)
Discontinued intervention (n=0)

Analysed (n=23)
- Excluded from analysis (n=0)

Analyse (n=23)
- Excluded from analysis (n=0)
Participants

**INCLUSION**

+ CP diagnosis
+ Children classified as having Gross Motor Function Classification System (GMFCS) level I, II, or III CP
+ Aged 6–12 years
+ Body weight <35 kg.

**EXCLUSION**

+ Injection of botulinum toxin within 3 months
+ Selective dorsal rhizotomy or orthopedic surgery within 1 year
+ Poor visual acuity
+ Hearing impairment
+ Severe intellectual disability
+ Uncontrolled seizures
+ hip dislocation
+ Scoliosis Cobb angle >30°
+ Unhealed fracture.
Intervention

+ The lesson was semi-private: the ratio between the instructor and participants was 1:2 or 1:3.

+ Four well-trained ponies (average height, 135 cm; average weight, 294 kg)

+ 32 sessions (40 minutes per session) twice a week for 16 week

+ After the 1 or 2-week adaptation period, repetitions of trot and normal walk were progressively increased to facilitate CRF according to the individual’s riding ability
Outcome Measures

+ **Motor capacity**
  - Gross Motor Function Measure (GMFM), GMFM88 & GMFM66
  - Pediatric Balance Scale (PBS)
  - Timed Up and Go test (TUG)
  - 6-minute walk test (6MWT)

+ **Symptom-limited cardiopulmonary exercise test (CPX) using a treadmill** (TrueOne 2400, ParvoMedics, Inc., Salt Lake City, UT)
  - Modified Naughton protocol

+ **Habitual physical activity**
  - Triaxial accelerometer (model GT3X, ActiGraph, LLC, Pensacola, FL)
Statistical analysis

+ The differences in values pre- and post-intervention between the groups
  : independent t-test or Mann-Whitney test

+ The training effect between each group
  : The paired t-test or Wilcoxon rank sum test

+ Linear regression analysis was performed to determine the factors affecting the amount of HRrest change
Result
### Demographics & clinical Characteristics

<table>
<thead>
<tr>
<th></th>
<th>EAAT (N=23)</th>
<th>Control (N=23)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (y)</td>
<td>7.74±1.63</td>
<td>7.22±1.48</td>
<td>0.261</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>123.37±8.83</td>
<td>123.91±11.49</td>
<td>0.858</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>24.82±5.04</td>
<td>24.60±5.78</td>
<td>0.893</td>
</tr>
<tr>
<td>Sex (male/female)</td>
<td>12/11</td>
<td>12/11</td>
<td>0.429</td>
</tr>
<tr>
<td>GMFCS level (I/II/III)</td>
<td>10/9/4</td>
<td>11/10/2</td>
<td>0.882</td>
</tr>
<tr>
<td>Bilateral/unilateral cerebral palsy</td>
<td>13/10</td>
<td>14/9</td>
<td>0.470</td>
</tr>
</tbody>
</table>
## Change of motor capacity after the intervention

<table>
<thead>
<tr>
<th></th>
<th>EAAT (N=23)</th>
<th>Control (N=23)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre-intervention</td>
<td>Post-intervention</td>
<td>Difference</td>
</tr>
<tr>
<td><strong>GMFM66</strong></td>
<td>77.91±11.96</td>
<td>80.15±12.68</td>
<td>2.24±2.32a</td>
</tr>
<tr>
<td><strong>PBS</strong></td>
<td>46.61±13.00</td>
<td>49.09±11.80</td>
<td>2.48±2.00a</td>
</tr>
<tr>
<td><strong>TUG (sec)</strong></td>
<td>8.82±3.52</td>
<td>7.26±2.59</td>
<td>-1.55±1.19a</td>
</tr>
<tr>
<td><strong>6MWT (m)</strong></td>
<td>349.83±92.78</td>
<td>387.04±110.75</td>
<td>37.22±49.52a</td>
</tr>
</tbody>
</table>

The PBS, TUG, and 6MWT results improved only in the EAAT group, and the difference between the two groups was statistically significant (p<.05)
## Change of cardiorespiratory fitness after the intervention

<table>
<thead>
<tr>
<th></th>
<th>EAAT (N=20)</th>
<th>CONTROL (N=21)</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre-intervention</td>
<td>Post-intervention</td>
<td>Difference</td>
<td>Pre-intervention</td>
<td>Post-intervention</td>
</tr>
<tr>
<td></td>
<td>(N=20)</td>
<td>(N=20)</td>
<td>(N=20)</td>
<td>(N=21)</td>
<td>(N=21)</td>
</tr>
<tr>
<td>Exercise time (min)</td>
<td>11.49±2.21</td>
<td>12.94±2.20</td>
<td>1.45±1.42(^a)</td>
<td>11.17±4.35</td>
<td>12.15±4.95</td>
</tr>
<tr>
<td>VO(_2)peak (mL/kg/min)</td>
<td>24.74±2.66</td>
<td>26.58±3.91</td>
<td>1.84±4.33</td>
<td>26.31±4.19</td>
<td>26.18±4.23</td>
</tr>
<tr>
<td>VE(L/min)</td>
<td>21.79±6.22</td>
<td>23.69±7.51</td>
<td>1.90±4.99</td>
<td>21.38±6.97</td>
<td>21.20±5.16</td>
</tr>
<tr>
<td>RER</td>
<td>.98±.04</td>
<td>1.01±.06</td>
<td>0.04±0.05(^a)</td>
<td>.98±.05</td>
<td>.98±.06</td>
</tr>
<tr>
<td>HRrest (beat/min)</td>
<td>92.20±14.65</td>
<td>79.80±7.45</td>
<td>-12.40±11.980(^a)</td>
<td>92.00±15.36</td>
<td>90.95±12.93</td>
</tr>
<tr>
<td>HRmax (beat/min)</td>
<td>169.10±13.99</td>
<td>170.05±12.61</td>
<td>0.95±13.15</td>
<td>168.62±16.30</td>
<td>167.64±15.27</td>
</tr>
<tr>
<td>SBP rest (mmHg)</td>
<td>102.80±8.63</td>
<td>101.50±6.55</td>
<td>-1.30±7.03</td>
<td>102.45±11.07</td>
<td>101.50±9.34</td>
</tr>
<tr>
<td>DBP rest (mmHg)</td>
<td>69.65±8.04</td>
<td>68.10±7.64</td>
<td>-1.55±8.22</td>
<td>66.40±8.56</td>
<td>66.18±8.55</td>
</tr>
</tbody>
</table>

\(^a\) Significant difference compared to baseline.
## Change of physical activity after the intervention

<table>
<thead>
<tr>
<th></th>
<th>EAAT (N=23)</th>
<th>Control (N=23)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre-intervention</td>
<td>Post-intervention</td>
<td>Difference</td>
</tr>
<tr>
<td>%SPA</td>
<td>73.13±6.30</td>
<td>74.99±6.66</td>
<td>1.86±5.07</td>
</tr>
<tr>
<td>%LPA</td>
<td>22.41±5.18</td>
<td>20.84±5.49</td>
<td>-1.58±4.41</td>
</tr>
<tr>
<td>%MPA</td>
<td>3.10±1.19</td>
<td>2.81±1.01</td>
<td>-0.28±0.67</td>
</tr>
<tr>
<td>%VPA</td>
<td>1.34±1.08</td>
<td>1.35±0.95</td>
<td>0.00±0.53</td>
</tr>
<tr>
<td>Activity</td>
<td>809.58±253.82</td>
<td>771.61±250.36</td>
<td>-37.97±147.50</td>
</tr>
<tr>
<td>(counts/min)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Outcome of linear regression analysis

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Reference</th>
<th>Estimate</th>
<th>Standard Error</th>
<th>t-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>746.75</td>
<td>128.90</td>
<td>5.79</td>
<td>&lt;0.0001</td>
<td></td>
</tr>
<tr>
<td>Group 2 (1)</td>
<td>194.09</td>
<td>42.84</td>
<td>4.53</td>
<td>&lt;0.0001</td>
<td></td>
</tr>
<tr>
<td>GMFM66 score</td>
<td>12.88</td>
<td>9.66</td>
<td>1.33</td>
<td>0.1914</td>
<td></td>
</tr>
<tr>
<td>PBS score</td>
<td>12.24</td>
<td>13.08</td>
<td>0.94</td>
<td>0.3561</td>
<td></td>
</tr>
<tr>
<td>TUG result</td>
<td>-9.28</td>
<td>6.60</td>
<td>-1.41</td>
<td>0.1689</td>
<td></td>
</tr>
<tr>
<td>HRrest</td>
<td>-5.82</td>
<td>1.24</td>
<td>-4.71</td>
<td>&lt;0.0001</td>
<td></td>
</tr>
</tbody>
</table>
Conclusion

EAAT Effect on HRrest

- HRrest was decreased at the end of the 16-week EAAT program in children with CP.
- This decrease was not explained by the improvement of motor capacity (GMFM, PBS, and TUG results) but by the intervention (EAAT or control).

Effort to CRF improvement

- The increased risk of cardiometabolic diseases in people with CP is associated with low CRF. EAAT may be among the endurance training programs that can be provided to children with CP to improve their CRF.
Thank you,
Any questions?