Active Video Game Play in Children with Cerebral Palsy: Potential for Physical Activity Promotion and Rehabilitation Therapies

Howcroft, Klejman, Fehlings, Wright, Zabjek, Andrysek, Biddiss, 2012
Key Terms

Gaming:
- Active Video Game (AVG)

Energy Measures:
- Energy Expenditure (EE)
- V02: Oxygen consumption
- VC02: Expired carbon dioxide
- Metabolic Equivalent for Task (MET)

Anatomy:
- Flexi Carpi Radials (FCR)
- Wrist Extensor Bundle (WE)
Introduction

- Ambulatory children with CP are less physically active than TD peers
- Host of health problems:
  - Obesity, diabetes, cardiovascular disease, cancer, joint disease
- But... children value screen-time activities
- AVGs could promote physical activity
  - replace sedentary screen time with active screen time
  - Potential for motor learning
Active Video Games

Popular Titles
- Wii Bowling, Wii Tennis, Wii Boxing, DDR Disney Dance Grooves
- Selected to include upper and lower limb movements
Why AVGs?

Why should we care?

- Low-cost technology that is more accessible than proprietary technology
- Easy to incorporate into pre-existing activities
- Intrinsically adaptive:
  - experimenter can manipulate difficulty
  - challenging to child
- Rewarding
Study Aims

● Evaluate AVG play for physical activity promotion and rehabilitation therapies in children CP

● Assess energy expenditure, muscle activation, and quality of movement
Subjects

- Children with CP (N = 17; 10 boys & 7 girls)
- I and II Gross Motor Function Classification System
  - Ability to play AVGs in standing position
Methods

Energy Expenditure:
- Heartrate
- Oxygen consumption (VO2); expired carbon-dioxide (VCO2)
- EE = relationship between VO2 and VCO2

Muscle Activity:
- Surface electromyography
- Upper trapezius, triceps, biceps, FCR, WE dominant limb

Quality of Movement:
- 7-camera Vicon MX motion capture system

Surveys:
- OMNI Scale of Perceived Exertion
- Physical Activity Enjoyment Scale (PACES)
Protocol

Phase 1: Maximum voluntary exertions
Phase 2: 5-minute free-play period
Phase 3: Played each game in randomized order for 8 minutes on beginner level; rest period of 5 minutes between each game
## Results: Energy Measures

### Table 2: Energy Measures at Rest and During AVG Play

<table>
<thead>
<tr>
<th>Energy Measures</th>
<th>Baseline State</th>
<th>Wii Bowling</th>
<th>Wii Tennis</th>
<th>DDR Disney Dance Grooves</th>
<th>Wii Boxing</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\dot{V}_{O_2}$ (mL/min)</td>
<td>170.91±36.13</td>
<td>351.88±131.50</td>
<td>405.23±144.15</td>
<td>535.88±212.30</td>
<td>542.66±193.10</td>
</tr>
<tr>
<td>MET</td>
<td>1.00±0.00</td>
<td>2.14±0.68</td>
<td>2.60±0.78</td>
<td>3.20±1.04</td>
<td>3.36±1.50</td>
</tr>
<tr>
<td>EE (kJ/min)</td>
<td>3.01±0.62</td>
<td>6.40±2.21</td>
<td>7.82±2.25</td>
<td>9.71±3.64</td>
<td>10.08±3.74</td>
</tr>
<tr>
<td>% increase in EE from rest</td>
<td>NA</td>
<td>114.00±69.00</td>
<td>163.00±79.00</td>
<td>222.00±107.00</td>
<td>243.00±155.00</td>
</tr>
<tr>
<td>Heart rate (bpm)</td>
<td>88.35±10.37</td>
<td>112.54±17.61</td>
<td>120.05±17.75</td>
<td>127.47±16.71</td>
<td>137.12±19.11</td>
</tr>
<tr>
<td>% increase in heart rate from rest</td>
<td>NA</td>
<td>28.00±16.00</td>
<td>24.0±42.00</td>
<td>45.00±20.00</td>
<td>57.00±31.00</td>
</tr>
<tr>
<td>OMNI</td>
<td>1 (0)</td>
<td>2 (1)</td>
<td>3 (2.5)</td>
<td>4 (1.5)</td>
<td>4 (5)</td>
</tr>
</tbody>
</table>

**NOTE.** Values are mean ± 1SD or median (interquartile range). Abbreviations: bpm, beats per minute; NA, not applicable.
Results: Muscle, Movement & More

WE was the most activated muscle. Energy measure significantly higher for games involving the lower body (e.g., DDR).

Perceived exertions mirrored EE data: Wii bowling to DDR & Wii Boxing.

Title-Specific Findings:
- Wii Boxing elicited higher angular activity.
- Wii Boxing consistently elicited the highest activation levels for all muscle groups.

Playing styles:
- About half of children used idiosyncratic gestures.
- FCR activation levels were higher.
Clinical Implications

Moderate levels of physical activity were achieved for dance and boxing games:
- Wii Boxing elicited 3.36 METs; DDR elicited 3.20 METs
- "Similar" to clinical interventions (3.2-4.2 METs)

Potential to induce neuromuscular reeducation:
- Range of mean muscle activation 7% - 18%

Children enjoyed playing the games:
- High-level enjoyment of enjoyment!
- Average PACES scores were 4.5 out of 5
Discussion

This study is just a stepping stone. No big claims.

- Need to study clinical outcomes
- *Not* a replacement for structured physical therapy

*However...* AVGs are an enjoyable activity with potential to achieve clinically valuable levels of physical activity.