Quantifying Children’s Active Play

An Experiment on Accelerometry of Self-Paced Children’s Games During Guided Active Play

Moghadasazadeh A., Jamnik V., and Belcastro A.N.

Pediatric Exercise Physiology Laboratory, School of Kinesiology and Health Science, York University (Toronto, ON, Canada)

Background

- The most widely used methods of quantifying physical activity (PA) throughout literature are: heart rate (HR), pedometry, and accelerometry (ACC). Evidence exists for strong linear relationships among ACC-PA (uni-axial-vertical axis, triaxial-vector magnitude) and oxygen consumption (VO2) energy expenditure (EE), and metabolic equivalents (METs) using standardized or regularized PA protocols using a motorized treadmill (TM); i) ACC cut-off points (low/moderate/vigorous); and ii) Linear regression equations to estimate EE and/or MET (1, 2).

- Literature reports that the estimates of EE and METs for unregulated children’s PA (games, daily living) are significantly underestimated when using linear regression equations from ACC calibrated against regulated TM activity (2, 3).

- Purpose: to determine: a) the nature of the relationships between counts from individual axes and vector magnitude (VM) for self-paced/unregulated children’s games; and b) assess what impact a dominant axis may have on these relationships

- Hypothesis: in a field setting where a free range of movement is allowed, children’s self-paced PA does not follow a linear model and has different axis characteristics than TM activity

- Objective: to measure and analyze energy expenditure of children between the ages of 8 to 12 years of age during active play in a gymnasium setting using VM.

Methodology

- Children (n=15; Table 1) were recruited from an active play community program. All procedures were approved by York’s Human Participant Ethics Committee with child assent and written consent received from parents/guardians.

- Treadmill: following pre-screening (2013 PARQ+) and a 10 min resting VO2 children walked/jogged on a TM (4, 6 and 8km/h and 0% grade) for 5 minutes at each pace. VO2 (COSMED2) and HR (using a Polar Heart Rate Monitor) were determined over 10sec intervals. Accelerometers (ActiGraph GT3X+ - right hip) were used to quantify physical activity (PA) (10sec epoch).

- A prediction equation (linear regression) for VO2 using PA (vertical-axis and/or VM) were determined with and without resting values. Active Play: six cooperative games (~6 min each focused on running/jumping) were conducted in a supervised camp format (30 children; 1 hr duration; indoor gym). VO2, HR and PA (as above) were collected continuously for each game.

- Statistical Analysis: Linear regression estimates of VO2 (TM and 6 games) using PA (vertical and VM) versus actual VO2 measurements were compared by Bland-Altman Plots. Intercept values for TM and games were assessed using ANOVA and Tukey Post-Hoc test at a p<0.05.

Results

- Linear regressions for each game resulted in a range of intercepts, for VM and time, from 520±198 counts/10sec to 1200±619 counts/10sec (p<0.05) compared to treadmill values of 193±95 counts/10sec (p<0.05). Unregulated self-paced children’s games can take on any shape and the relationship between treadmill and the games are different. The range of activity between the lowest TM speed and the highest TM speed is similar to the range of lower intensity and higher intensity games that were played.

- Hypothetical calculation with standardized activity counts and varying axis contribution (Fig. 4) showed that VM counts varies with axis difference, showing that a dominant axis affects the VM max. The percent difference in axis contribution to VM between the dominant and lowest axis (Table 2) was 40±13% and 3±1.6% for treadmill activity and self-paced games, respectively (p<0.05). The contribution of axis during children’s games were similar, unlike the TM activity in which there was a high percent axis difference indicating the presence of a dominant axis (vertical).

Discussion & Conclusions

- TM activity is associated with increased PA (vertical and VM-Fig 1.) resulting in a significant contribution of a dominant axis (Table 2).

- The lack of a dominant axis reported for regulated PA (Table 2) may underlie the poor estimate of VO2 for games (fig. 2).

- The variety of movement in children’s self-paced PA (Fig. 3) may explain the greater mean squared error for non-TM activity (1) when using either vertical and/or vector magnitude generated equations from TM activity.

- The suggestion that axes dominance may underestimate VM may require ACC measurements of unregulated active play to use a correction factor.

References


Table 1. Characteristics chart of children in KIN KIDS Guided Active Play Program

<table>
<thead>
<tr>
<th>Age</th>
<th>Height</th>
<th>Mass</th>
<th>BMI</th>
<th>Age[yr]</th>
<th>Gender [%]</th>
<th>Race [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>8-12</td>
<td>4-6</td>
<td>8</td>
<td>10</td>
<td>1.6</td>
<td>0.3</td>
<td>0.7</td>
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</tbody>
</table>

Table 2. Axes dominance as a function of TM and games

<table>
<thead>
<tr>
<th>Physical Activity</th>
<th>VO2 (%)</th>
<th>Accelerometry</th>
<th>R²</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>TM</td>
<td>40±13%</td>
<td>0.3</td>
<td>0.5</td>
<td>0.01</td>
</tr>
<tr>
<td>Games</td>
<td>3±1.6%</td>
<td>0.7</td>
<td>0.01</td>
<td>0.05</td>
</tr>
</tbody>
</table>

Table 3. Linear regression of accelerometer counts/10sec

<table>
<thead>
<tr>
<th>Activity</th>
<th>VO2 (counts/10sec)</th>
<th>R²</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>TM</td>
<td>520±198</td>
<td>0.5</td>
<td>0.01</td>
</tr>
<tr>
<td>Games</td>
<td>1200±619</td>
<td>0.01</td>
<td>0.05</td>
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