Exercise Prescription using a Group Normalized Rating of Perceived Exertion (RPE) in Adolescents and Adults with Spina Bifida (SB)

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Title: Exercise Prescription Using a Group Normalized Rating of Perceived Exertion in Adolescents and Adults with Spina Bifida

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Disclosures:

• Does not intend to discuss commercial products or services.
• Does not intend to discuss non-FDA approved uses of products/providers of services.
• Received the Spina Bifida Young Investigators Award from the Spina Bifida Association/Ashley Rose Foundation
Background

Morbidity and mortality in SB due to preventable comorbidities

Higher than average rates obesity, metabolic syndrome, cardiovascular disease risk, hypertension and lymphedema (Dosa et al. 2009; Nelson et al. 2007; Stepanczuk et al. 2014; Garcia et al. 2014)

Poor health related aerobic fitness common (Buffart et al. 2008)

> 20% of hospital admissions of adults over 65 with SB or spinal anomalies were due to cardiac and pulmonary complications (Dicianno and Wilson 2010)
Co-morbidities are treatable/preventable with healthy lifestyle in non-disabled adults

In non-disabled populations, exercising at target rating of perceived exertion (RPE) equivalent to the ventilatory breakpoint (Vpt) provides training stimulus to improve cardiopulmonary fitness (Robertson et al., 2001; Goss et al. 2011)

Lack of evidence-based exercise prescription information for individuals with SB.
Background

In non-disabled adults, a group normalized RPE range of 5-7 on OMNI Scale (Robertson) and 12-14 on Borg 6-20 Scale (Borg) is congruent with the Vpt (i.e., anaerobic threshold) (Irving et al. 2006)

WHEEL Scale validated in adolescents and adults with SB (Crytzer et al. 2015)

The perceptual-physiologic link between RPE and Vpt (Group Normalized Perceptual Response) not yet determined for people with SB who are wheelchair users
Aims/Hypotheses

AIM 1: Determine the group normalized RPE equivalent to the Vpt based on Borg 6-20 Scale and WHEEL Scale responses

AIM 2: Develop exercise prediction equation to estimate the Borg 6-20 Scale RPE (dependent/conditional metric) from WHEEL Scale RPE (independent/criterion metric)

AIM 3: Create table of interchangeable values between WHEEL Scale and Borg Scale RPE over range of wheelchair power outputs from lowest to highest intensities for people with SB performing a load incremented test.
Methods

Cross-sectional observational study

Inclusion criteria:

- age 13 – 80 years
- diagnosed with spina bifida, except the common occult subtype resulting in no neurological impairments
- scoliosis
- unable to pedal a standard (two-wheel) bicycle
Methods

Exclusion Criteria

• History of coronary artery disease, coronary bypass surgery or other cardio-respiratory clinical disorders

• Upper extremity injury or loss of shoulder, elbow, and/or wrist range of motion that would prevent performing arm ergometry exercise testing

• Upper extremity or thoracic surgery in the last six months that would contraindicate performing arm ergometer exercise testing

• Any other medical condition for which the participant’s primary care physician determined was a contraindication to arm ergometer exercise testing or pulmonary function testing
Symptom limited exercise stress test on electronically braked arm ergometer

- 1 min. warm-up then 10 watt increase each min.
- Visual/auditory/verbal cues to maintain 70 RPM
- Borg and WHEEL Scale RPE recorded last 15 seconds of each min.
- Volitional endpoint of test owing to fatigue or crank rate not maintained
- Metabolic cart measures oxygen uptake (VO₂), carbon dioxide production (VCO₂), heart rate, respiratory exchange rate
• Alpha was set *a priori* to 0.05.
• Mean, standard deviation, range for BMI, PASIPD, and %VO2 peak were calculated for Group A (achieved Vpt) and Group NA (did not achieve Vpt).
• Vpt was determined as the point at which VCO2 exceeded VO2 on plots where VO2 and VCO2 expressed as function of time for each participant.
• Calculated %VO2peak equivalent to the time point and that value was used to define the Vpt for each participant.
• Mean, SD, range calculated for %VO2peak for Group A; these values and Borg Scale and WHEEL Scale ratings at Vpt used to create plots to indicate the %VO2peak and Borg and WHEEL Scale RPE for Group A.
• Linear regression analysis conducted with Borg 6-20 RPE rating as conditional variable and WHEEL RPE rating as criterion variable.
• The derived linear regression equation used develop a conversion table to predict RPE values for the Borg Scale from WHEEL Scale RPE.
Outcomes

Sociodemographics

Body composition

Physical Activities Scale for Individuals with Physical Disabilities (PASIPD)

History of Chiari II malformation

Metabolic Variables
Results

- N = 29 (15 female; age, 30.48 ± 12.51 years, range 17-71 years)
- N = 19 in Group A and N = 10 in Group B
Table 1. Selected Baseline Characteristics for Groups A (Demonstrated Vpt) and NA (Did not demonstrate Vpt)

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Group A Mean ± SD (range); N=19</th>
<th>Group NA Mean ± SD (range); N=10</th>
<th>pvalue</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>28.53 ± 13.08 (17-71)</td>
<td>34.20 ± 11.00 (19-50)</td>
<td>0.13</td>
</tr>
<tr>
<td>BMI using arm span (kg/m²)</td>
<td>23.34 ± 7.16 (12.09-38.73)</td>
<td>26.17 ± 8.34 (12.09-40.81)</td>
<td>0.43</td>
</tr>
<tr>
<td>PASIPD (METS/day)</td>
<td>13.46 ± 12.41 (1.54-54.81)</td>
<td>17.32 ± 7.83 (6.38-29.81)</td>
<td>0.12</td>
</tr>
<tr>
<td>Vpt (%VO$_2$peak)</td>
<td>61.76 ± 16.26 (36.60-97.70)</td>
<td></td>
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<tr>
<td>Race (Caucasian)</td>
<td>n (%)</td>
<td>n (%)</td>
<td></td>
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<tr>
<td>Wheelchair use</td>
<td>17 (89.5)</td>
<td>9 (90)</td>
<td>0.99</td>
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<tr>
<td>History Chiari II Malformation</td>
<td>16 (84.2)</td>
<td>9 (90)</td>
<td>0.99</td>
</tr>
<tr>
<td>Restricted pulmonary status</td>
<td>8 (42.1)</td>
<td>4 (40)</td>
<td>0.99</td>
</tr>
</tbody>
</table>

*Note: Chi-square test was used for categorical variables.
Figure 1: Box Plots of $\%\text{VO}_{2\text{peak}}$ at the Ventilatory Breakpoint (Vpt) for Borg Scale Rating of Perceived Exertion (RPE) and WHEEL Scale RPE for Group A
Figure 2: Line of best fit using WHEEL Scale RPE as criterion variable and the Borg RPE as conditional variable in the regression analysis.
### Table 2: Results of Linear Regression Analysis

<table>
<thead>
<tr>
<th></th>
<th>Adjusted R²</th>
<th>p value for model</th>
<th>Predictors: Conditional Metric</th>
<th>p value of predictors</th>
<th>Standard Error</th>
<th>t</th>
<th>df</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Primary MODEL</strong></td>
<td>R² = 0.80</td>
<td>Adjusted R² = 0.79</td>
<td>Average Borg Score</td>
<td>p&lt;0.0001*</td>
<td>0.64</td>
<td>11.08</td>
<td>18</td>
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<td></td>
<td></td>
<td></td>
<td>Average WHEEL Score</td>
<td>p&lt;0.0001*</td>
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<tr>
<td><strong>Reciprocal MODEL</strong></td>
<td>R² = 0.80</td>
<td>Adjusted R² = 0.79</td>
<td>Average WHEEL Score</td>
<td>p&lt;0.0007*</td>
<td>0.96</td>
<td>-4.13</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Average Borg Score</td>
<td>p&lt;0.0001*</td>
<td>0.07</td>
<td>8.42</td>
<td></td>
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</tbody>
</table>

**Borg Scale Rating = (1.22 x WHEEL Scale Rating) + 7.14**

**WHEEL Scale Rating = (0.66 x Borg Scale Rating) – 3.97**
<table>
<thead>
<tr>
<th>WHEEL Scale RPE</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Borg Scale RPE</td>
<td>6-8</td>
<td>9-10</td>
<td>11</td>
<td>12</td>
<td>13</td>
<td>14</td>
<td>15-16</td>
<td>17</td>
<td>18</td>
<td>19-20</td>
</tr>
</tbody>
</table>

Table 3: Wheel Scale RPE to Borg Scale RPE Conversion for Individuals with Spina Bifida who achieved Vpt
Initial Exercise Prescription Intensity Based on Group Normalized RPE–Vpt

0 not tired at all
1 a little tired
2 getting more tired
3 really tired
4 very, very tired

Crytzer et al. 2015
Based on classification of participants from the parent study (Crytzer et al 2015), we found that Group NA contained a significantly greater percentage of individuals with restrictive lung disease \((p = 0.044)\).

Restrictive lung disease may limit attainment of exercise intensity levels sufficient to trigger the onset of anaerobic glycolytic metabolism.
Conclusions

This is the first study to identify a group normalized RPE equivalent to the Vpt for exercise prescription in the SB subpopulation.

For people with SB whose Vpt is approximately 61% \%VO_2 peak a WHEEL scale RPE of 5.74 ± 2.58 and a Borg scale RPE of 13.95 ± 3.50 can be used to prescribe exercise intensity equivalent to the Vpt.

When necessary, WHEEL scale RPE can be converted to Borg Scale RPE using the equation

\[
\text{Borg scale RPE} = (1.22 \times \text{WHEEL Scale RPE}) + 7.14
\]

Pulmonary restriction may be a limitation to high intensity exercise in people with SB who do not achieve peak exercise during stress testing.
Acknowledgments

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• Exercise Physiology Lab in the Endocrinology and Metabolism Research Center
• Department of Health and Physical Activity

UPMC Mercy Hospital Adult Spina Bifida Clinic

UPMC Children’s Hospital Spina Bifida Clinic
Bibliography


Discussion

- Group Normalized WHEEL Scale RPE equivalent to individualized Vpt proves a prescriptive reference to develop exercise program that provides aerobic overload stimulus
  - In non-disabled adults the targeted training zone: between 50 to 85% of VO2max (ACSM's Guidelines for Exercise Testing and Prescription 2010, Roberton et al 2001)
- Exercise prediction equation developed sets the framework for future investigations that use the WHEEL Scale as the criterion metric to establish construct validity of other RPE scales for individuals with SB
- Used the regression equation derived in AIM 2 to develop a conversion table that was valid for interchanging RPE between each numerical category on both metrics, i.e., WHEEL and Borg Scales. Physical therapists and exercise physiologists can prescribe a target RPE that can be used by individuals with SB to self-regulate exercise intensity using either scale.