Appendix A
Selected OMNI Scales

Fig. A.1  Children’s OMNI-walk/run RPE scale (Robertson 2004)
Fig. A.2  Adult OMNI-walk/run RPE scale (Robertson 2004)

Fig. A.3  Children’s OMNI-resistance exercise RPE scale, female (Robertson 2004)
Fig. A.4  Children’s OMNI-resistance exercise RPE scale, male (Robertson 2004)

Fig. A.5  Adult OMNI-resistance exercise RPE scale, male (Robertson 2004)
Fig. A.6  Children’s OMNI-step RPE scale, female (Robertson 2004)

Fig. A.7  Children’s OMNI-step RPE scale, male (Robertson 2004)
Fig. A.8  Adult OMNI-step RPE scale, female (Robertson 2004)

Fig. A.9  Adult OMNI-elliptical RPE scale (Mays et al. 2010)
Appendix B
RPE Scale Instructions

Adult OMNI-Walk/Run RPE Scale Instructions
for RPE-O Only

This perceived exertion scale includes numerical categories from 0 to 10. You will use it to assess your perceptions of exertion while you exercise. The numbers on the scale represent a range of exertion levels from 0, “extremely easy,” to 10, “extremely hard.” To help you select a number that represents your level of exertion, consider the following. When the exercise exertion you are experiencing is “extremely easy,” respond with a 0. Think about a time when you exercised and the level of exertion was “extremely easy” and most likely equivalent to a rating of 0. As an example, you should respond with a 0 when you are walking very slowly on the treadmill. When the exertion you are experiencing is “extremely hard,” respond with a 10. Think about a time when you exercised and the perception of exertion was “extremely hard,” likely attained at your maximal performance level. Most likely the exertional level would be equivalent to a rating of 10. As an example, you should respond with a 10 when you are running up a steep incline on the treadmill and you may not be able to exercise much longer owing to fatigue. Please rate your level of exertion for your overall body, taking into consideration the exertion experienced in your legs and your chest/breathing. When asked, use both the pictures and words to help you select one rating number that represents the level of exertion your body is experiencing. Each number response is called a rating of perceived exertion, or RPE. Please point to the number that best represents your RPE at the moment you are asked.
**Adult OMNI-Walk/Run RPE Scale Instructions for Undifferentiated and Differentiated RPE**

This perceived exertion scale includes numerical categories from 0 to 10. You will use it to assess your perceptions of exertion while you exercise. The numbers on the scale represent a range of exertion levels from 0, ‘extremely easy,’ to 10, ‘extremely hard.’ To help you select a number that represents your level of exertion, consider the following. When the exercise exertion you are experiencing is ‘extremely easy,’ respond with a 0. Think about a time when you exercised and the level of exertion was ‘extremely easy’ and most likely equivalent to a rating of 0. As an example, you should respond with a 0 when you are walking very slowly on the treadmill. When the exertion you are experiencing is ‘extremely hard,’ respond with a 10. Think about a time when you exercised and the perception of exertion was ‘extremely hard,’ likely attained at your maximal performance level. Most likely the exertional level would be equivalent to a rating of 10. As an example, you should respond with a 10 when you are running up a steep incline on the treadmill and you may not be able to exercise much longer owing to fatigue. You will be asked to rate your level of exertion for your overall body, your legs and your chest/breathing. When asked, use both the pictures and words to help you select one rating number that represents the level of exertion your overall body, legs, or chest/breathing are experiencing. Each number response is called a rating of perceived exertion, or RPE. Please point to the number that best represents your RPE at the moment you are asked.

**Borg (6–20) Scale Instructions for RPE-O Only During Treadmill Exercise**

This perceived exertion scale includes numerical categories from 6 to 20. You will use it to assess your perceptions of exertion while you exercise. The numbers on the scale represent a range of exertion levels from 6, “no exertion at all,” to 20, “maximal exertion.” To help you select a number that represents your level of exertion, consider the following. When the exercise exertion you are experiencing is “no exertion at all,” respond with a 6. Think about a time when you exercised and the level of exertion was “no exertion at all” and most likely equivalent to a rating of 6. As an example, you should respond with a 6 when you are walking very slowly on the treadmill. When the exertion you are experiencing is “maximal exertion,” respond with a 20. Think about a time when you exercised and the perception of exertion was “maximal exertion,” likely attained at your maximal performance level. Most likely the exertional level would be equivalent to a rating of 20. As an example, you should respond with a 20 when you are running up a steep incline on the treadmill and you may not be able to exercise much longer owing to fatigue. Please rate your level of exertion for your overall body, taking into consideration the exertion experienced in your legs and your chest/breathing. When asked, use the
words to help you select one rating number that represents the level of exertion your body is experiencing. Each number response is called a rating of perceived exertion, or RPE. Please point to the number that best represents your RPE at the moment you are asked.

**Adult OMNI-Cycle RPE Scale Instructions for RPE-L Only**

This perceived exertion scale includes numerical categories from 0 to 10. You will use it to assess your perceptions of exertion while you exercise. The numbers on the scale represent a range of exertion levels from 0, “extremely easy,” to 10, “extremely hard.” To help you select a number that represents your level of exertion, consider the following. When the exercise exertion you are experiencing is “extremely easy,” respond with a 0. Think about a time when you exercised and the level of exertion was “extremely easy” and most likely equivalent to a rating of 0. As an example, you should respond with a 0 when you are pedaling against no resistance on the cycle. When the exertion you are experiencing is “extremely hard,” respond with a 10. Think about a time when you exercised and the perception of exertion was “extremely hard,” likely attained at your maximal performance level. Most likely the exertional level would be equivalent to a rating of 10. As an example, you should respond with a 10 when you are pedaling against a very heavy resistance on the cycle and may not be able to exercise any longer owing to fatigue. You will be asked to rate the level of exertion of your legs only, not for your chest/breathing or your overall body. When asked, use both the pictures and words to help you select one rating number that represents the level of exertion your body is experiencing. Each number response is called a rating of perceived exertion, or RPE. Please point to the number that best represents your RPE at the moment you are asked.

**Adult OMNI-Cycle RPE Scale Instructions for Undifferentiated and Differentiated RPE**

This perceived exertion scale includes numerical categories from 0 to 10. You will use it to assess your perceptions of exertion while you exercise. The numbers on the scale represent a range of exertion levels from 0, “extremely easy,” to 10, “extremely hard.” To help you select a number that represents your level of exertion, consider the following. When the exercise exertion you are experiencing is “extremely easy,” respond with a 0. Think about a time when you exercised and the level of exertion was “extremely easy” and most likely equivalent to a rating of 0. As an example, you should respond with a 0 when you are pedaling against no resistance on the cycle. When the exertion you are experiencing is “extremely hard,” respond with a 10. Think about a time when you exercised and the perception of exertion was “extremely hard,” likely attained at your maximal performance level.
Most likely the exertional level would be equivalent to a rating of 10. As an example, you should respond with a 10 when you are pedaling against a very heavy resistance on the cycle and may not be able to exercise any longer owing to fatigue. You will be asked to rate your level of exertion for your overall body, your legs and your chest/breathing. When asked, use both the pictures and words to help you select one rating number that represents the level of exertion your overall body, legs, or chest/breathing are experiencing. Each number response is called a rating of perceived exertion, or RPE. Please point to the number that best represents your RPE at the moment you are asked.

**Borg (6–20) Scale Instructions for RPE-L**

**Only During Cycle Exercise**

This perceived exertion scale includes numerical categories from 6 to 20. You will use it to assess your perceptions of exertion while you exercise. The numbers on the scale represent a range of exertion levels from 6, “no exertion at all,” to 20, “maximal exertion.” To help you select a number that represents your level of exertion, consider the following. When the exercise exertion you are experiencing is “no exertion at all,” respond with a 6. Think about a time when you exercised and the level of exertion was “no exertion at all” and most likely equivalent to a rating of 6. As an example, you should respond with a 6 when you are pedaling against no resistance on the cycle. When the exertion you are experiencing is “maximal exertion,” respond with a 20. Think about a time when you exercised and the perception of exertion was “maximal exertion,” likely attained at your maximal performance level. Most likely the exertional level would be equivalent to a rating of 20. As an example, you should respond with a 20 when you are pedaling against a very heavy resistance on the cycle and may not be able to exercise any longer owing to fatigue. Please rate your level of exertion for your legs only, not for your chest/breathing or your overall body. When asked, use the words to help you select one rating number that represents the level of exertion your legs are experiencing. Each number response is called a rating of perceived exertion, or RPE. Please point to the number that best represents your RPE at the moment you are asked.

**Adult OMNI-Resistance Exercise RPE**

**Scale for RPE-AM Only**

This perceived exertion scale includes numerical categories from 0 to 10. You will use it to assess your perceptions of exertion while you perform resistance exercise. The numbers on the scale represent a range of exertion levels from 0, “extremely easy,” to 10, “extremely hard.” To help you select a number that represents your
level of exertion, consider the following. When the resistance exercise exertion you are experiencing is “extremely easy,” respond with a 0. Think about a time when you exercised and the level of exertion was “extremely easy” and most likely equivalent to a rating of 0. As an example, you should respond with a 0 when you are lifting a very light weight that is extremely easy to lift. When the exertion you are experiencing is “extremely hard,” respond with a 10. Think about a time when you performed resistance exercise and the perception of exertion was “extremely hard,” likely attained at your maximal performance level. Most likely the exertional level would be equivalent to a rating of 10. As an example, you should respond with a 10 when you are lifting the heaviest weight you can lift and may not be able to lift for one more repetition owing to fatigue. You will be asked to rate the level of exertion of your active muscles only, not for your chest/breathing or your overall body. When asked, use both the pictures and words to help you select one rating number that represents the level of exertion your active muscles are experiencing. Each number response is called a rating of perceived exertion, or RPE. Please point to the number that best represents your RPE at the moment you are asked.

**Adult OMNI-Resistance Exercise RPE Scale for Undifferentiated and Differentiated RPE**

This perceived exertion scale includes numerical categories from 0 to 10. You will use it to assess your perceptions of exertion while you perform resistance exercise. The numbers on the scale represent a range of exertion levels from 0, “extremely easy,” to 10, “extremely hard.” To help you select a number that represents your level of exertion, consider the following. When the resistance exercise exertion you are experiencing is “extremely easy,” respond with a 0. Think about a time when you exercised and the level of exertion was “extremely easy” and most likely equivalent to a rating of 0. As an example, you should respond with a 0 when you are lifting a very light weight that is extremely easy to lift. When the exertion you are experiencing is “extremely hard,” respond with a 10. Think about a time when you performed resistance exercise and the perception of exertion was “extremely hard,” likely attained at your maximal performance level. Most likely the exertional level would be equivalent to a rating of 10. As an example, you should respond with a 10 when you are lifting the heaviest weight you can lift and may not be able to lift for one more repetition owing to fatigue. You will be asked to rate your level of exertion for your overall body, your active muscles and your chest/breathing. When asked, use both the pictures and words to help you select one rating number that represents the level of exertion your overall body, active muscles, or chest/breathing are experiencing. Each number response is called a rating of perceived exertion, or RPE. Please point to the number that best represents your RPE at the moment you are asked.
Borg (6–20) Scale Instructions for RPE-AM Only During Resistance Exercise

This perceived exertion scale includes numerical categories from 6 to 20. You will use it to assess your perceptions of exertion while you perform resistance exercise. The numbers on the scale represent a range of exertion levels from 6, “no exertion at all,” to 20, “maximal exertion.” To help you select a number that represents your level of exertion, consider the following. When the resistance exercise exertion you are experiencing is “no exertion at all,” respond with a 6. Think about a time when you exercised and the level of exertion was “no exertion at all” and most likely equivalent to a rating of 6. As an example, you should respond with a 6 when you are lifting a very light weight that is extremely easy to lift. When the exertion you are experiencing is “maximal exertion,” respond with a 20. Think about a time when you performed resistance exercise and the perception of exertion was “maximal exertion,” likely attained at your maximal performance level. Most likely the exertional level would be equivalent to a rating of 20. As an example, you should respond with a 20 when you are lifting the heaviest weight you can lift and may not be able to lift for one more repetition owing to fatigue. You will be asked to rate the level of exertion of your active muscles only, not for your chest/breathing or your overall body. When asked, use the words to help you select one rating number that represents the level of exertion your active muscles are experiencing. Each number response is called a rating of perceived exertion, or RPE. Please point to the number that best represents your RPE at the moment you are asked.
Appendix C
Determination of Validity Coefficients: An Example Using Cycle Ergometry Graded Exercise Test Results

1. In a Microsoft Excel spreadsheet, label columns of data as shown in Fig. A.10.
   (a) For resistance exercise, Exercise Stage may be replaced with %1RM and Weight Lifted may take the place of physiological variables such as VO$_2$ and HR.
   (b) For treadmill exercise, VO$_2$ may be expressed in ml·kg·min$^{-1}$.
   (c) RPE-O and other differentiated RPE’s such as RPE-C or RPE-AM may be used in your experiment.

![Excel Spreadsheet](image-url)
2. Plot of VO\textsubscript{2} and Borg RPE-L for determination of concurrent validity:

(a) Click on the **INSERT** tab and in the **CHARTS** section click on **SCATTER**. Select the first available chart option. A blank or example scatter plot will appear on your screen (Fig. A.11).

![Figure A.11](image)

(b) Click on the **SELECT DATA** tab (Fig. A.12).
Fig. A.12

(c) Remove any entries found in the **LEGEND ENTRIES** text box then click **ADD** (Figs. A.13 and A.14).
<table>
<thead>
<tr>
<th>Exercise Stage</th>
<th>VO₂ (l·min⁻¹)</th>
<th>Borg RPE-L</th>
<th>OMNI RPE-L</th>
<th>HR (beats·min⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.41</td>
<td>7</td>
<td>1</td>
<td>94</td>
</tr>
<tr>
<td>2</td>
<td>2.16</td>
<td>9</td>
<td>2</td>
<td>113</td>
</tr>
<tr>
<td>3</td>
<td>2.92</td>
<td>12</td>
<td>4</td>
<td>132</td>
</tr>
<tr>
<td>4</td>
<td>3.68</td>
<td>15</td>
<td>6</td>
<td>150</td>
</tr>
<tr>
<td>5</td>
<td>4.19</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>4.53</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
(d) Under **SERIES NAME**, enter VO$_2$ and Borg RPE-L. Then click on the icon to the right of the **SERIES X VALUES** text box and highlight the VO$_2$ values. After the values are highlighted click the icon on the box that appeared (Fig. A.15).
(e) Then click on the icon to the right of the **SERIES Y VALUES** text box and highlight the Borg RPE-L values. After the values are highlighted click the icon on the box that appeared (Fig. A.16).

![Fig. A.16](image-url)
(f) Click **OK** on the next two screens. You should now have a scatter plot with Borg RPE-L on the y-axis and VO$_2$ on the x-axis (Fig. A.17).

![Excel spreadsheet and scatter plot](image-url)
(g) Create a title for the plot and enter the appropriate axis labels and units of measure (Fig. A.18).

### Fig. A.18

<table>
<thead>
<tr>
<th>Exercise Stage</th>
<th>VO₂ (l·min⁻¹)</th>
<th>Borg RPE-L</th>
<th>OMNI RPE-L</th>
<th>HR (beats·min⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.41</td>
<td>7</td>
<td>1</td>
<td>94</td>
</tr>
<tr>
<td>2</td>
<td>2.16</td>
<td>9</td>
<td>2</td>
<td>113</td>
</tr>
<tr>
<td>3</td>
<td>2.92</td>
<td>12</td>
<td>4</td>
<td>132</td>
</tr>
<tr>
<td>4</td>
<td>3.68</td>
<td>15</td>
<td>6</td>
<td>150</td>
</tr>
<tr>
<td>5</td>
<td>4.40</td>
<td>10</td>
<td>10</td>
<td>169</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td>186</td>
</tr>
</tbody>
</table>
(h) To determine the validity coefficient, click on one of the data points to highlight the entire data series. Right click on one of the data points and a menu will appear. Click **ADD TRENDLINE** and the **FORMAT TRENDLINE** menu will appear. Select **LINEAR**, **DISPLAY EQUATION ON CHART**, and **DISPLAY R-SQUARED VALUE ON CHART** then click **CLOSE**. The trendline and equation will be displayed on the chart. Take the square root of the $R^2$ value to determine the Pearson correlation coefficient (Fig. A.19).

Fig. A.19
Appendix D
Determination of VT and RPE-VT

Calculation of $V_E \cdot VO_2^{-1}$ and $V_E \cdot VCO_2^{-1}$

1. Obtain a printout containing the 15-s exercise $VO_2$, $VCO_2$, and $V_E$ values in l·min$^{-1}$ from the respiratory-metabolic measurement system. In a Microsoft Excel spreadsheet, label columns for $VO_2$, $VCO_2$, $V_E$ (each in l·min$^{-1}$), $V_E \cdot VO_2^{-1}$ and $V_E \cdot VCO_2^{-1}$.

2. In the columns for $VO_2$, $VCO_2$, and $V_E$, enter each 15-s value measured during exercise as listed in the printout (Fig. A.20).

![Excel spreadsheet with columns for VO2, VCO2, VE, VE·VO2⁻¹, and VE·VCO2⁻¹](image)
3. Calculate $V_E \cdot VO_2^{-1}$ by dividing $V_E (l \cdot min^{-1})$ by $VO_2 (l \cdot min^{-1})$ for each row and enter the value in the appropriate cell. This can be completed by typing the equation seen in Fig. A.21 in the first cell available under $V_E \cdot VO_2^{-1}$ then hitting the ENTER key on the keyboard. This equation can be copied into the remaining cells below $V_E \cdot VO_2^{-1}$ to complete the calculation for each 15-s interval.

Fig. A.21
4. Calculate $V_E \cdot VCO_2^{-1}$ by dividing $V_E (l \cdot min^{-1})$ by $VCO_2 (l \cdot min^{-1})$ for each row and enter the value in the appropriate cell. This can be completed by typing the equation seen in Fig. A.22 in the first cell available under $V_E \cdot VO_2^{-1}$ then hitting the ENTER key on the keyboard. This equation can be copied into the remaining cells below $V_E \cdot VCO_2^{-1}$ to complete the calculation for each 15-s interval.
Plot of $V_E \cdot VO_2^{-1}$ and $V_E \cdot VCO_2^{-1}$ for Determination of VT

1. Obtain a printout from the respiratory-metabolic measurement system containing the 15-s exercise values of $VO_2$ (l·min$^{-1}$) and the ventilatory equivalents ($V_E \cdot VO_2^{-1}$ and $V_E \cdot VCO_2^{-1}$). These variables have no units of measure because they are a ratio between two variables with the same units of measure.

2. In a Microsoft Excel spreadsheet, label columns for $VO_2$ (l·min$^{-1}$), $V_E \cdot VO_2^{-1}$ and $V_E \cdot VCO_2^{-1}$. Enter each 15-s value measured during exercise as listed in the printout. If $V_E \cdot VO_2^{-1}$ and $V_E \cdot VCO_2^{-1}$ were calculated using a Microsoft Excel spreadsheet as described above, you may continue to use that spreadsheet (Fig. A.23).

![Excel Spreadsheet](image-url)
3. Create a line graph with $V_E \cdot VO_2^{-1}$ and $V_E \cdot VCO_2^{-1}$ on the $y$-axis and $VO_2$ (L·min$^{-1}$) on the $x$-axis.

(a) Click on the **INSERT** tab then click on the **INSERT LINE CHART** icon. Select the first option for a basic 2D line chart (Fig. A.24).
(b) A blank chart will appear on the spreadsheet. Right click on the chart and click **SELECT DATA** (Fig. A.25).

Fig. A.25
(c) The **SELECT DATA SOURCE** box will appear (Fig. A.26).
(d) Click **ADD** under **LEGEND ENTRIES** and the **EDIT SERIES** box will appear (Fig. A.27).

![Excel spreadsheet screenshot with data and chart](image_url)

**Fig. A.27**
(e) Click on the icon to the right of the **SERIES NAME** text box then click on the cell in the spreadsheet containing $V_E \cdot VO_2^{-1}$. Click the icon on the right side of the box that appeared to return to the **EDIT SERIES** box (Fig. A.28).

![Fig. A.28](image-url)
(f) Click on the icon to the right of the **SERIES VALUES** text box then highlight all the cells in the spreadsheet containing data under $V_E \cdot VO_2^{-1}$. Click the icon on the right side of the box that appeared to return to the **EDIT SERIES** box. Click **OK** to return to the **SELECT DATA SOURCE BOX** (Fig. A.29).

![Spreadsheet screenshot](image-url)
(g) Click **ADD** under **LEGEND ENTRIES** and the **EDIT SERIES** box will appear.

(h) Click on the icon to the right of the **SERIES NAME** text box then click on the cell in the spreadsheet containing $V_E \cdot \text{VCO}_2^{-1}$. Click the icon on the right side of the box that appeared to return to the **EDIT SERIES** box.

(i) Click on the icon to the right of the **SERIES VALUES** text box then highlight all the cells in the spreadsheet containing data under $V_E \cdot \text{VCO}_2^{-1}$. Click the icon on the right side of the box that appeared to return to the **EDIT SERIES** box. Click **OK** to return to the **SELECT DATA SOURCE BOX**.

(j) Click **EDIT** under **HORIZONTAL (CATEGORY) AXIS LABELS** (Fig. A.30).

![Fig. A.30](image-url)
(k) Highlight all the cells containing data under VO$_2$ then click **OK** (Fig. A.31).

![Fig. A.31](image-url)

<table>
<thead>
<tr>
<th>VO$_2$</th>
<th>VCO$_2$</th>
<th>V$_E$</th>
<th>VE/VO$_2$</th>
<th>VE/VCO$_2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.98</td>
<td>0.80</td>
<td>24.66</td>
<td>25.16</td>
<td>30.83</td>
</tr>
<tr>
<td>0.96</td>
<td>0.81</td>
<td>24.72</td>
<td>25.75</td>
<td>30.52</td>
</tr>
<tr>
<td>1.60</td>
<td>1.29</td>
<td>38.96</td>
<td>24.35</td>
<td>30.20</td>
</tr>
<tr>
<td>0.80</td>
<td>0.75</td>
<td>22.76</td>
<td>28.45</td>
<td>30.13</td>
</tr>
<tr>
<td>1.53</td>
<td>1.31</td>
<td>34.99</td>
<td>22.87</td>
<td>30.82</td>
</tr>
<tr>
<td>1.73</td>
<td>1.42</td>
<td>38.34</td>
<td>22.16</td>
<td>30.34</td>
</tr>
<tr>
<td>1.37</td>
<td>1.26</td>
<td>34.52</td>
<td>25.20</td>
<td>31.15</td>
</tr>
<tr>
<td>1.75</td>
<td>1.65</td>
<td>45.17</td>
<td>25.81</td>
<td>30.42</td>
</tr>
<tr>
<td>1.46</td>
<td>1.44</td>
<td>40.28</td>
<td>27.59</td>
<td>30.07</td>
</tr>
<tr>
<td>1.42</td>
<td>1.39</td>
<td>38.67</td>
<td>27.23</td>
<td>29.86</td>
</tr>
<tr>
<td>1.79</td>
<td>1.74</td>
<td>49.02</td>
<td>27.39</td>
<td>30.03</td>
</tr>
<tr>
<td>1.22</td>
<td>1.28</td>
<td>36.65</td>
<td>30.04</td>
<td>28.63</td>
</tr>
<tr>
<td>1.57</td>
<td>1.53</td>
<td>41.76</td>
<td>26.60</td>
<td>27.29</td>
</tr>
<tr>
<td>1.42</td>
<td>1.40</td>
<td>37.54</td>
<td>26.44</td>
<td>26.81</td>
</tr>
<tr>
<td>2.23</td>
<td>2.12</td>
<td>55.03</td>
<td>24.68</td>
<td>25.96</td>
</tr>
<tr>
<td>1.41</td>
<td>1.47</td>
<td>40.65</td>
<td>28.83</td>
<td>27.65</td>
</tr>
</tbody>
</table>
(1) Click **OK** on the **SELECT DATA SOURCE** box and the plot will appear. It may be beneficial to enlarge the plot so the labels on the x-axis are easily viewable. Locate the point on the graph where $V_E \cdot VO_2^{-1}$ begins to increase without an increase in $V_E \cdot VCO_2^{-1}$. Draw a vertical line from that point down to the x-axis and identify the VO$_2$ equivalent to this divergent point. Convert the units of this VO$_2$ value from l·min$^{-1}$ to %VO$_2$max/peak (Fig. A.32).

![Fig. A.32](image_url)
Adjustment of Automatic VT Calculation in a Respiratory Metabolic Measurement System

1. Focus your attention on the figure showing $V_E \cdot VO_2^{-1}$ and $V_E \cdot VCO_2^{-1}$ on the y-axis and Time on the x-axis. There will be a vertical line indicating the position of the VT on this figure.
2. If the vertical line is not located over the point where $V_E \cdot VO_2^{-1}$ begins to increase without an increase in $V_E \cdot VCO_2^{-1}$, adjust the vertical line until it is located directly over this point.
3. If the vertical line is located over the point where $V_E \cdot VO_2^{-1}$ begins to increase without an increase in $V_E \cdot VCO_2^{-1}$, do not adjust it.
4. The computer program will automatically provide the $VO_2$ value (l · min$^{-1}$) and %$VO_2$max/peak associated with the VT.

Determination of RPE-VT: An Example Using Cycle Ergometry Graded Exercise Test Results

1. In a Microsoft Excel spreadsheet, label columns of data as shown in Fig. A.33.

![Excel Spreadsheet](image-url)
(a) For treadmill exercise, \( \text{VO}_2 \) may be expressed in \( \text{ml} \cdot \text{kg} \cdot \text{min}^{-1} \).
(b) RPE-O and differentiated RPE such as RPE-C may be used in your experiment.

2. Plot of \( \text{VO}_2 \) as a function of Borg RPE-L for determination of RPE-VT.

(a) Click on the **INSERT** tab and in the **CHARTS** section click on **SCATTER**. Select the first available chart option. A blank or example scatter plot will appear on your screen (Fig. A.34).

![Chart Example](image-url)

**Fig. A.34**
(b) Click on the **SELECT DATA** tab (Fig. A.35).

![Excel Sheet with Data](image)

**Fig. A.35**
(c) Remove any entries found in the **LEGEND ENTRIES** text box then click **ADD** (Fig. A.36).

![Excel spreadsheet](image)

**Fig. A.36**
(d) Under **SERIES NAME**, enter VO\textsubscript{2} and Borg RPE-L. Then click on the icon to the right of the **SERIES X VALUES** text box and highlight the VO\textsubscript{2} values. After the values are highlighted click the icon on the box that appeared (Fig. A.37).

Fig. A.37
(e) Then click on the icon to the right of the **SERIES Y VALUES** text box and highlight the Borg RPE-L values. After the values are highlighted click the icon on the box that appeared (Fig. A.38).

![Excel sheet with columns for Exercise Stage, VO2 (l.min^-1), Borg RPE-L, OMNI RPE-L, and HR (beats.min^-1)]

**Fig. A.38**
(f) Click **OK** on the next two screens. You should now have a scatter plot with Borg RPE-L on the y-axis and VO₂ on the x-axis (Fig. A.39).
(g) To determine the Borg RPE-VT, click on one of the data points to highlight the entire data series. Right click on one of the data points and a menu will appear. Click ADD TRENDLINE and the FORMAT TRENDLINE menu will appear. Select LINEAR and DISPLAY EQUATION ON CHART then click CLOSE. The trendline and its linear equation will be displayed on the chart. Use this linear equation to calculate RPE-VT. Use \( \text{VO}_2 \ (\text{l} \cdot \text{min}^{-1}) \) corresponding to the VT as the “x” value in the equation and solve for “y.” The calculated “y” value is the Borg RPE-VT (Fig. A.40).

![Image of Excel spreadsheet showing trendline and linear equation](image-url)
Appendix E
Prediction of VO\textsubscript{2} peak: An Example Using Cycle Ergometry Graded Exercise Test Results

1. In a Microsoft Excel spreadsheet, label columns of data as shown in Fig. A.41.
   (a) For treadmill exercise, VO\textsubscript{2} may be expressed in ml·kg·min\(^{-1}\).
   (b) RPE-O and differentiated RPE such as RPE-C may be used in your experiment.

Fig. A.41

<table>
<thead>
<tr>
<th>Exercise Intensity</th>
<th>VO\textsubscript{2} (l·min(^{-1}))</th>
<th>OMNI RPE-L</th>
<th>HR (beats·min(^{-1}))</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1.41</td>
<td>1</td>
<td>94</td>
</tr>
<tr>
<td>B</td>
<td>2.16</td>
<td>2</td>
<td>113</td>
</tr>
<tr>
<td>C</td>
<td>2.92</td>
<td>4</td>
<td>132</td>
</tr>
</tbody>
</table>
2. Plot of VO$_2$ and OMNI RPE-L for prediction of VO$_2$ peak.

(a) Click on the **INSERT** tab and in the **CHARTS** section click on **SCATTER**. Select the first available chart option. A blank or example scatter plot will appear on your screen (Fig. A.42).

![Fig. A.42](image_url)
(b) Click on the **SELECT DATA** tab (Fig. A.43).
(c) Remove any entries found in the **LEGEND ENTRIES** text box then click **ADD** (Fig. A.44).

![Excel spreadsheet with data]

**Fig. A.44**
(d) Under **SERIES NAME**, enter VO$_2$ and OMNI RPE-L. Then click on the icon to the right of the **SERIES X VALUES** text box and highlight the OMNI RPE-L values. After the values are highlighted click the icon on the box that appeared (Fig. A.45).

![Excel spreadsheet showing exercise intensity, VO$_2$, OMNI RPE-L, and HR values.](image)

**Fig. A.45**
(e) Then click on the icon to the right of the **SERIES Y VALUES** text box and highlight the VO\(_2\) values. After the values are highlighted click the icon on the box that appeared (Fig. A.46).

**Fig. A.46**
(f) Click **OK** on the next two screens. You should now have a scatter plot with VO$_2$ on the y-axis and OMNI RPE-L on the x-axis (Fig. A.47).

![Scatter plot with VO$_2$ and OMNI RPE-L](image)

**Fig. A.47**
(g) To determine the equation from which VO$_2$ peak will be predicted, click on one of the data points to highlight the entire data series. Right click on one of the data points and a menu will appear. Click **ADD TRENDLINE** and the **FORMAT TRENDLINE** menu will appear. Select **LINEAR** and **DISPLAY EQUATION ON CHART** then click **CLOSE**. The trendline and its linear equation will be displayed on the chart. Use this linear equation to calculate RPE-VT. Use VO$_2$ (l·min$^{-1}$) corresponding to the VT as the “x” value in the equation and solve for “y.” The calculated “y” value is the Borg RPE-VT (Fig. A.48).

Fig. A.48
Appendix F
Advanced Perceived Exertion Scaling
Procedure for Use Prior to an RPE-Based, Interval Exercise Program

For cycle exercise, the low intensity bout begins with unloaded pedaling and subsequently increases in power output every 15 or 30 s. The client provides RPE just prior to each power output increase until moderate intensity is reached, identified by a rating of 5–6 on the OMNI Scale or 11–13 on the Borg Scale. If the client shows physiological signs of moderate to high intensity exercise, such as increased rate of breathing or heart rate, yet continues to rate exertion levels as low, further discussion about the link between RPE and physiological intensity may be necessary. Then, to further test the subject’s understanding, he/she is asked to produce a specific level of perceived exertion on the cycle. The test administrator decides on a specific target RPE, from two to four on the OMNI Scale, and then instructs the client to adjust the power output until the intensity of cycling produces an exertion level equal to that specific RPE. The subject should be allowed to adjust the intensity for 1 or 2 min before the power output is checked for accuracy. If the intensity chosen does not match the intensity at which the client previously rated that particular RPE, additional practice and feedback may be necessary. However, if the intensity chosen matches the intensity at which the client previously reported that particular RPE, provide him/her with positive reinforcement and continue with the next phase.

For the moderate intensity phase, begin the load-incremented bout at the low intensity that the client previously produced and increase power output every 15 or 30 s. The client provides RPE just prior to each power output increase until high intensity is reached, identified by a rating of 8 on the OMNI Scale or 17–18 on the Borg Scale. If the client terminates exercise due to fatigue yet rates exertion levels as moderate, further discussion about RPE and maximal physiological intensity may be necessary. For some clients, especially those who may not have performed maximal exercise previously, the experience of maximal exercise facilitates their ability to rate exertion levels at moderate intensities of exercise. For the production bout at moderate intensity, RPE’s from 5 to 7 on the OMNI Scale are appropriate. This bout is important to determine if additional practice and feedback may be necessary to rate exertion accurately at moderate exercise intensity.
For the high/maximal intensity phase, begin the load-incremented bout at the intensity the client previously produced in the moderate phase and subsequently increase power output every 15 or 30 s until volitional termination owing to fatigue. Similar to the standard exercise anchoring procedure, instruct the subject to assign a maximal RPE value (10 on the OMNI Scale, 20 on the Borg Scale) to that intensity. Minimal rest (approximately 2 min) is necessary between phases and between load-incremented and production bouts within phases. However, ample rest sufficient for complete or near complete recovery is advised between advanced exercise anchoring and subsequent administration of aerobic fitness testing. For unfit and/or sedentary individuals, advanced exercise anchoring and aerobic fitness testing may need to be performed on separate days.
Glossary

Cardiorespiratory fitness  The ability to perform dynamic exercise of a moderate to vigorous intensity using large muscle groups for a prolonged period; this fitness measurement is dependent upon the functional capacity of the cardiovascular and respiratory systems and the oxidative capacity of skeletal muscle.

Differentiated RPE  RPE used to estimate the level of exertion for a specific anatomical region of the body, such as the chest/breathing (RPE-C), arms (RPE-A), legs (RPE-L), or active muscle mass (RPE-AM).

Estimation–production paradigm  A perceptually based exercise prescription procedure whereby both the estimation and production test protocols are used to prescribe and self-regulate exercise intensity according to a target RPE or RPE zone.

Estimation protocol  A research procedure used in perceived exertion scale validation studies involving a graded exercise test during which RPE and physiological responses are measured for each progressive exercise test stage, with intensity ranging from very low through maximal.

Exercise anchoring  A procedure whereby the individual links the perception of exertion experienced while actually performing a very low exercise intensity and when performing a very high exercise intensity with the low and high anchor points on the perceived exertion scale, respectively.

Exercise intensity self-regulation error  When an individual is not accurately self-regulating exercise intensity at a target RPE such that the physiological responses (VO$_2$, HR) during the production trial are different from those that were observed at the same target RPE during the estimation trial.

Exertional recall  An estimate of the RPE for a bout of exercise or physical activity performed at least 1 week prior; may be included as part of a physical activity questionnaire.

Group-normalized perceptual response  A range of RPE’s that corresponds to a target physiological outcome during exercise and that is common to a specified group of individuals.
Imposed exercise intensity When an individual performs a prescribed exercise intensity based on physical units (W), ergometer settings (speed/grade, intensity settings) or physiological measures (HR, VO₂) which has been determined by the health-fitness professional or exercise test administrator.

Intensity discrimination The ability to perceptually differentiate between separate target RPE’s such that physiological responses are different between different self-regulated conditions.

Just noticeable difference in perceived exertion (perceived exertion JND) The smallest amount of change in a stimulus (exercise intensity), expressed in physiological (VO₂) or physical (PO) units, necessary to elicit a change in sensation (perception of physical exertion).

Maximal Aerobic Power (VO₂max/peak) The maximum amount of oxygen that can be consumed while breathing ambient air during load-incremented aerobic exercise at sea level; the terms maximal aerobic power and maximal or peak oxygen uptake (VO₂max/peak) can be used interchangeably.

Memory anchoring A procedure used to acquaint the user with the level of exertion perceived at the low and high anchor points of a category RPE scale.

Momentary RPE The acute level of perceived exertion rated at the moment the individual is asked during exercise or PA; also referred to as in-task or on-stimulus RPE.

Muscular strength, dynamic The ability of a muscle or muscle group to exert force using concentric or eccentric muscular action resulting in the movement of a resistance.

One-repetition maximum (1RM) The maximal amount of force that can be produced during a single contraction of a muscle or muscle group through the full range of motion.

Pacing Strategy The self-selected exercise pace or tactic that an athlete adopts, usually at the beginning of an event or competition, to ensure optimal metabolic requirements and performance outcomes.

Perceived exertion The subjective intensity of effort, strain, discomfort, and/or fatigue that is experienced during exercise and physical activity.

Perceptual augmenter A perceptual outlier who provides RPE values greater than what is appropriate based on a given physiological and/or physical marker of exercise intensity and may assign a maximal or near-maximal RPE to submaximal exercise intensity.

Perceptual outlier An individual who provides inappropriate RPE values that do not conform to the predictions of Borg’s Range Model.

Perceptual reducer A perceptual outlier who provides RPE values less than what is appropriate based on a given physiological and/or physical marker of exercise intensity and may assign a submaximal RPE to maximal exercise intensity.

Prescription congruence When physiological responses (VO₂, HR) corresponding to a specific target RPE are similar between the estimation trial and production trial at a given submaximal intensity.

Predicted RPE A global estimate of the expected RPE for an entire bout of exercise or PA rated prior to performance of that activity.
Production protocol  An exercise bout during which an individual self-regulates exercise intensity to produce a specific target RPE.

RPE warning zone  A range of RPE’s that indicate impending graded exercise test termination and, as such, the initiation of preliminary procedures to safely end the exercise test.

Segmented session RPE  A global estimate of the average RPE experienced for a specific segment (time-period) of a bout of exercise or PA but rated after performance of that activity.

Self-selected exercise intensity  When an individual performs exercise at a preferred intensity during which self-adjustment of ergometer settings are allowed.

Session RPE  A global estimate of the average RPE experienced for an entire bout of exercise or PA but rated after performance of that activity.

Target RPE or target RPE range  One RPE or a range of RPE’s that indicate the level(s) of exertion to be achieved by self-regulating exercise intensity using a production perceptual protocol.

Teleoanticipation  A sensory nervous system comprised of both feed-forward and feedback perceptual-cognitive information regarding muscle fiber recruitment and firing frequency during exercise performance; in this system the magnitude and frequency of efferent (i.e., descending) motor signals associated with previous exercise performance are stored in the sensory cortex; this information is further augmented by afferent signals reflecting the metabolic and biomechanical limits of muscular performance; subsequently, the stored perceptual-cognitive information is recalled to shape the upper limits of exercise performance as set by peak tolerable perceptual limits of heavy muscular exercise.

Undifferentiated RPE  RPE used to estimate the level of exertion for the overall body, often referred to as RPE-O.

Validity  The degree to which a test or test item measures the construct it is intended to measure.

Validity, concurrent (general definition)  The extent to which test scores are associated with those of other accepted tests when both measures are obtained along a common stimulus range.

Validity, concurrent, of a perceived exertion scale  The extent to which RPE are associated with accepted physical and physiological markers of exercise intensity across an individual’s full physiological range.

Validity, construct (general definition)  The ability of a test to represent the underlying construct.

Validity, construct, of a perceived exertion scale  The extent to which RPE from a newly developed perceived exertion scale are associated with RPE derived from a perceived exertion scale for which concurrent validity has been previously established.

Ventilatory threshold (VT)  Also known as the ventilatory breakpoint, can be defined as the point during exercise of increasing intensity when pulmonary ventilation begins to increase at a rate disproportionately faster than that of oxygen consumption; the respiratory analog to the lactate threshold (both commonly called the anaerobic threshold).
Adenosine antagonism, 221
  classification, 221
  dopamine secretion, 221, 222
  nociceptors activation, 222
  PE and muscle pain, 222
Adherence
  characteristics, 5
  exercise prescription, 5
  to exercise program, 166
  health care and fitness professional, 4
  intervention programs, 4
  low, 164
Adult OMNI-Cycle RPE Scale, 45
Aerobic interval exercise
  in coronary artery disease patients, 134
  in diabetic patients, 134
  effect on AR and PAE, 210–212
  estimation–production paradigm, 137
  improved VO\textsubscript{2}max, 134
  intensity discrimination, AR, 209–210
  intensity discrimination using AR, 209–210
  maximal cardiac output, 134
  moderate-intensity continuous exercise, 134
  rate-limiting physiological factors, 133
  target exercise-induced pain ratings, 209
Affective response (AR). See also Music
  circumplex model, 30–31
  cognitive appraisal process, 29–30
  description, 29
  diverse environments, 31
  dual-mode model, 33–34
  FS (see Feeling Scale (FS))
  PA–AR relation, 31
  PAE (see Physical activity enjoyment (PAE))
  rating scale, 32
  significance, to exercise, 30
Alberton, C.L., 78
Albertus, Y., 149–150
American College of Sports Medicine (ACSM)
  aerobic PA, 3
  assessment of RPE throughout graded exercise testing, 64–65
  and CDC, 2
  Exercise is Medicine® , 4
  guidelines, cardiorespiratory fitness, 213
  health-fitness benefits, 163, 206
  initiatives, partnership with the US Surgeon General, 4
  metabolic equations, 209–210
Anaerobic threshold (AT)
  acute AR to exercise, 34
  exercise intensities, 34
  ventilatory (VT)/lactate threshold (LT), 33–34
Anchoring procedures
  AR to exercise, 200–201
  exercise-induced pain, 200
  exercise procedures, 45–48
  memory procedures, 45–46
AR. See Affective response (AR)
Astorino, T.A., 220, 225
Asynchronous vs. synchronous music, 248
AT. See Anaerobic threshold (AT)
Atkinson, G., 245
Backhouse, S.H., 225, 236
Baden, D.A., 149, 150
Baechle, T.R., 105
Balasekaran, G., 60, 61
Bartlett, J.D., 35, 211
Behavior change
PA adherence, 4
perceptual and psychosocial needs, 5
Borg (0-10) Category-Ratio (CR) Scale (CR10 Scale)
and children’s OMNI-Hurt Scale, 25–26
perceived exertion and pain, 23
rate pain sensation, 24
Borg, G., 24, 30
Borg, G.A., 43
Borg Scale, RPE measurement, 15, 16
Caffeine. See also Ergogenic effect
description, 219
ergogenic aid, 219
RPE (see Rating of perceived exertion (RPE))
Carbohydrate ingestion. See also Ergogenic effect
description, 233
endurance exercise performance, 233
glucose receptors, stimulation, 234
Carbohydrate mouth rinse
on RPE and mood, 236–237
short-term exercise, 235
Carbohydrate supercompensation/loading, 234
Cardiorespiratory fitness
AR and PAE, 37–38
assessment, 65
cardiovascular and respiratory systems, functional capacity, 90
estimation protocol, 112
maximal exercise testing, 90
pulmonary ventilation, 90
treadmill protocol, 90
VO₂ and VCO₂, expired concentrations, 90
VO₂max, 90
CDC. See Centers for Disease Control and Prevention (CDC)
Ceci, R., 132
Centers for Disease Control and Prevention (CDC), 2
CERT. See Children’s Effort Rating Table (CERT)
Chernoweth, D., 3
Children’s Effort Rating Table (CERT)
10-category scale, 59
semantic limitations, children, 16
upper HR range, dynamic exercise, 17
verbal descriptors, 16
Children’s OMNI Muscle Hurt Scale
description, 25
muscle hurt during resistance exercise, 25
and Pain Intensity Scale, 21
verbal and pictorial descriptors, 26
Children’s OMNI-Step RPE Scale, 62
Circumplex model
eyearly monopolar scales, 30
facial and vocal expressions, 30–31
Coefficients, validity
Microsoft Excel spreadsheet, 267
VO₂ and Borg RPE-L
axis labels and units, measure, 274
LEGEND ENTRIES text box, 268, 270
Pearson correlation coefficient, 275
scatter plot, 273
SELECT DATA tab, 268
SERIES NAME, 271
SERIES Y VALUES, 272
Cole, K.J., 223
Comparative stimulus/stimuli, 151
Concurrent validity
CR10 Scale, 202
definition, 56
Pain Intensity Scale, 202
undifferentiated RPE, evidence
CERT, 59
HR and VO₂, 59
OMNI Perceived Exertion Scale, 58, 60, 61
validity coefficients, 58–59
Constant workload exercise. See Rating of perceived exertion (RPE)
Construct validity
Children’s OMNI-Step RPE Scale, 62
definition, 57
Feeling Scale (FS) Scale, 203
Pain Intensity Scale, 203
undifferentiated RPE, evidence, 60, 62
Continuous exercise
aerobic interval exercise, 133–134
in coronary artery disease patients, 134
interval exercise bout, duration, 135
moderate-intensity, 134
RPE-based interval exercise and, 133
self-regulating, 227, 250
training, 134
Cook, D.B., 24, 25, 200, 202, 204, 205, 207, 214
Cooper, D.M., 35
Crisp, N.A., 35, 211
Cross-validation, RPE-based prediction models, 95–96
CR10 Scale. See Borg (0-10) Category-Ratio (CR) Scale (CR10 Scale)
Cycle ergometry graded Borg RPE-L for determination INSERT tab, 291
LEGEND ENTRIES text box, 293 scatter plot, 296
SELECT DATA tab, 292 SERIES NAME, 294 SERIES Y VALUES text box, 295 trendline and linear equation, 297
Microsoft Excel spreadsheet, 290 VO₂ peak prediction (see Prediction, VO₂peak)
Dynamic muscular strength. See also Aerobic interval exercise assessment, 91 multiple-RM test, 91 1RM, 91
Elsangedy, H.M., 78 Enjoyment. See Physical activity enjoyment (PAE)
Ergogenic effect caffeine adenosine antagonism, 221–222 endurance exercise, 220 glycogen sparing, 220–221 placebo control design, 219 reliability, time and distance protocols, 220 carbohydrate ingestion during exercise, 234–235 and mouth rinses (see Carbohydrate mouth rinse) supercompensation protocols/loading, 234
Estimation protocol/trial Borg’s Range Model, 111 exercise intensity self-regulation, 119, 238, 250 individual aerobic fitness level, 112
Da Silva, S.G., 205 Daussin, F.N., 133–134

D Demand artifact, 24 Demura, S., 223

Differentiated RPE, 46–47 vs. undifferentiated exertional ratings, 58
in validity experiment, 62–63
Distress management training (DMT) program, 203
DMT. See Distress management training (DMT) program Doherty, M., 219, 222, 223, 228
Dopamine caffeine, 221, 227 central fatigue, exercise, 222 exercise performance, 221, 222 motivation and reward, 225

Dual-mode model anaerobic threshold (AT), 33–34 description, 33 interindividual variability, AR, 201, 206 Dunbar, C.C., 115–117

Index 315
Estimation protocol/trial (cont.)
perceived exertion scaling procedures, 57–58
physiological monitoring, 112
regular aerobic exercise, 112
RPE Scale, 112
RPE-VT, 112
Eston, R. G., 96
Exercise anchoring procedure
category pain scales, 200
cycle ergometer procedures, 51–52
resistance exercise procedures, 52–53
RPE scale anchoring, 45–46
treadmill procedures, 49
trial exercise test, 201
Exercise discomfort index (EDI), 216
Exercise enjoyment, regular PA participation, 30
Exercise-induced feeling inventory (EFI), 248
Exercise-induced muscle pain
applications, 26
children’s OMNI-Hurt Scale, 25–26
and clinical conditions, 22–23
CR10 Scale, 23–24
demographic characteristics, 26
description, 21
healthy individuals, 23
leg aches and leg cramps, 23
mechanoreceptors and chemoreceptors, 22
noxious sensations, 22
pain intensity scale, 24
perceived exertion, 22
threshold, tolerance and affective components, 21
Exercise intensity self-regulation.
  See also Estimation–production paradigm
caffeine, 227
carbohydrate ingestion, 237
differentiated RPE, 117–118
error
assessments, outcomes and analysis, 154
cycle ergometer procedures, 154–160
exercise testing, 153
JND (see Just noticeable difference (JND))
pacing strategy and teleoanticipation, 148
perceived exertion, 150
perceptual acuity, 152
standard stimulus, 150–151
exercise-induced pain, 207–208
exercise intensity self-regulation, 208–209
music, 250
perceptual methodology, 238, 250
RPE vs. HR, 118–119
Exercise is Medicine®, 4
Exercise prescription
  Exercise is Medicine®, 4
  health-fitness promotion, 5
Exercise template, 149–150, 153
Exertional symptoms, perceived, 14
Exertion scaling procedures
cycle ergometer procedures, 50–52
dominant signal, 46
effort continua, 44
exercise anchoring procedures, 46–48
high/maximal intensity phase, 307–308
memory, 45–46
moderate intensity phase, 307
perceptual outliers, 47–48
Range Models, 44–45
resistance exercise procedures, 52–53
test administrator, 307
treadmill procedures, 48–50
undifferentiated vs. differentiated RPE, 46–47
F
Feeling Scale (FS)
circumplex model, 33
construct validity evidence, 203
description, 32
face, content and construct validity, 33
verbal descriptors, 29, 32–33
FS. See Feeling Scale (FS)
G
Glycogen sparing
endurance exercise performance, 220
plasma epinephrine, 220–221
responders and non-responders, 221
Goss, F., 77
Goss, F.L., 64–65
Green, J.M., 182, 224
Grieser, M., 35
Group-normalized perceptual response
assessments, 80
client information, 79
outcomes and analysis, 80

GXT. See Graded exercise test (GXT)

H
Hadjicharalambous, M., 223
Hagen, J., 246
Haile, A.M., 36, 204
Haile, L., 182, 183, 214, 215
Hardy, C.J., 30, 203, 215
Hassmen, P., 132
Heart rate (HR) range
and VO₂ monitoring, 78
at VT (HR-VT)
calculation, 77
OMNI scales, 75
variability, 77
Helgerud, J., 134
Higgins, L.W., 115–116, 133, 135
Hudson, G.M., 225
Hunt, S.E., 214, 215

I
Imposed exercise. See also Self-selected exercise
vs. self-selected intensity
exercise programs, 213
FS ratings, 213
lactate threshold (LT), sedentary males, 213
VT, 214
Intensity discrimination. See also Aerobic interval exercise
assessment, 133
cycle ergometry, 132
estimation–production paradigm, 132–133
self-regulate exercise intensity, 132
separate production trials, 132
test protocol, 132
Intermodal, prescription congruence, 113–116
Interval exercise
advanced perceived exertion scaling procedures, 136
advantages, health–fitness and performance outcomes, 133–134
appropriate intensity, 135
assessments, results and analysis, 137
client information, 136–137
cycle ergometer procedures, 140–143
duration, 135

J
Jenkins, N.T., 224
Just noticeable difference (JND)
exercise-induced muscle pain and AR, 212
exercise intensity self-regulation error
(see Exercise intensity self-regulation)
psychophysical methods, 151
sensations, 151
teleoanticipation and perceived exertion,
227, 238–239, 250

K
Kalinski, M.I., 117
Kane, I., 180, 215, 216
Kang, J., 114
Kenney, E., 203
Kilpatrick, M.W., 182
Kirkcaldy, B.C., 201
Krause, M.P., 60

L
Lactate threshold (LT)
definition, 76
in sedentary males, 213
self-selected intensity, FS ratings, 213
Lagally, K.M., 72
Lambert, E.V., 150, 160
Laurence, G., 223, 224
Leutzinger, J., 3
Lima-Silva, A.E., 245
Lim, H.B., 245
Lim, H.B.T., 248, 251
Lind, E., 214
Lin, J., 247
Ljunggren, G., 24
Lloyd, A.J., 23
Load-incremented exercise, 46, 48
LT. See Lactate threshold (LT)
Lu, F.J., 247

M
MAAC. See Multiple Affective Adjective Checklist (MAAC)
Matsuo, T., 134, 135
Index

Muscle hurt. See Children’s OMNI Muscle Hurt Scale

Music
asynchronous vs. synchronous, 248
modern fitness facilities, 243
optimal pacing strategy (see Optimal pacing strategy)
preferred vs. nonpreferred
external auditory stimuli comparison, 247
lower undifferentiated and differentiated
RPE responses, 246–247
song categories, 247
trials, 247
research, 243
RPE (see Rating of perceived exertion (RPE))
in trained athletes, 246

N
Nakamura, P.M., 247
Nethery, V.M., 243
Noble, B.J., 64

O
O’Connor, P.J., 204, 207, 209, 224
OMNI Perceived Exertion Scale, 58, 60, 61
OMNI-Resistance Exercise Scale, 46, 48
OMNI Scale. See also Children’s OMNI Muscle Hurt Scale
adult, 17, 18
children’s, 17
elliptical RPE scale, 259
exercise science research, 16
resistance exercise RPE scale
adult male, 257
female childrens, 256
male childrens, 257
RPE scale
adult female, 259
female childrens, 258
male childrens, 258
verbal and pictorial descriptors, 17, 18
walk/run RPE scale
adult, 256
children, 255
Oncurrent validity, evidence for
undifferentiated RPE, 58–60
O’Neal, E.K., 236
One-repetition maximum (1RM)
definition, 46
high anchor point using 1RM procedure, 53
resistance exercise prediction procedures

Maximal aerobic power and muscular strength accuracy, age predicted maximal HR (APMHR) equations, 92
aerobic exercise, 92–93
beta-blocker medication, 92
chronic obstructive pulmonary disease (COPD), 92
health-fitness setting, 92
maximal GXT, 93
peripheral artery disease (PAD), 93
predictor variables, 91
resistance training program, 93
submaximal tests, training-induced fitness changes, 96–97
VO₂max and 1RM prediction, 91
VO₂max/peak, 92, 96
Maximal exercise testing
for achievement of VO₂max, 65–66
to predict impending graded exercise test termination, 64–65
Maximal HR (HRmax)
accurate prediction, 92
aerobic exercise, clinics and fitness facilities, 92
APMHR equation, men and women, 92
graphic determination, 92
GXT, 90
prediction models, 92
VO₂max, 93
Maximal oxygen consumption (VO₂max), 57, 58, 65
cycle ergometer procedures, 101–104
perceptually regulated exercise test, 96
RPE-based models, 93–94
specific resistance settings, 4
treadmill procedures prediction, 98–101
Mays, R.J., 60, 61
Mechanoreceptors, nociceptive pathway, 22
Memory anchoring procedure
cycle ergometer procedures, 50–51
resistance exercise procedures, 52
RPE scale anchoring, 45–46
treadmill procedures, 49
Metabolic equivalent task (MET), 192
Mitranum, W., 134
Moderate-intensity exercise, 134
Momentary RPE, 182–184
Morgan, O., 5
Morgan, W.P., 13
Moses, J., 201
Mullen, S.P., 35
Multiple Affective Adjective Checklist (MAAC), 203
Murgatroyd, S., 33

Muscle hurt. See Children’s OMNI Muscle Hurt Scale

Music
asynchronous vs. synchronous, 248
modern fitness facilities, 243
optimal pacing strategy (see Optimal pacing strategy)
preferred vs. nonpreferred
external auditory stimuli comparison, 247
lower undifferentiated and differentiated
RPE responses, 246–247
song categories, 247
trials, 247
research, 243
RPE (see Rating of perceived exertion (RPE))
in trained athletes, 246

N
Nakamura, P.M., 247
Nethery, V.M., 243
Noble, B.J., 64

O
O’Connor, P.J., 204, 207, 209, 224
OMNI Perceived Exertion Scale, 58, 60, 61
OMNI-Resistance Exercise Scale, 46, 48
OMNI Scale. See also Children’s OMNI Muscle Hurt Scale
adult, 17, 18
children’s, 17
eelliptical RPE scale, 259
exercise science research, 16
resistance exercise RPE scale
adult male, 257
female childrens, 256
male childrens, 257
RPE scale
adult female, 259
female childrens, 258
male childrens, 258
verbal and pictorial descriptors, 17, 18
walk/run RPE scale
adult, 256
children, 255
Oncurrent validity, evidence for
undifferentiated RPE, 58–60
O’Neal, E.K., 236
One-repetition maximum (1RM)
definition, 46
high anchor point using 1RM procedure, 53
resistance exercise prediction procedures
data organization and analysis, 106
equipment, 104
maximum strength test, 105
pre-exercise procedures, 104
submaximal protocol, 105–106
RPE-based models, 93–94
Optimal pacing strategy
male recreational runners, 245
maximal RPE, 245–246
music conditions, 245
time trial exercise performance, 245
Overtraining, 181

P
PA. See Physical activity (PA)
PACER. See Progressive Aerobic Cardiovascular Endurance Run (PACER)
Pacing strategy. See also Optimal pacing strategy
mechanisms, 148–149
and RPE, 149–150
and teleoanticipation, 148
PAE. See Physical activity enjoyment (PAE)
Pain Intensity Scale
Borg CR10 Scale, 202
children’s OMNI Muscle Hurt Scale, 21, 209
description, 24
load-incremented cycle exercise, 203
self-regulate exercise intensity, 207–208
Pain threshold. See Exercise-induced muscle pain
Parfit, G., 33, 34, 112, 165, 206, 213, 214
Pearson correlation, 56
Perceived exertion
Borg and OMNI RPE Scales, 11
definition, 11
global explanatory model, 11, 12
OMNI scale, 17–18
in PA, 13
perceptual-cognitive reference filter, 14–15
performance-related mediators, 14
physiological mediators, 13
psychophysics, 15–16
psychosocial mediators, 13–14
RPE scales, 19
scales for children, 16–17
scale validation
application, 63
concurrent validity, 56, 58–60
construct validity, 57, 60, 62
cycle ergometer procedures, 68–70
differentiated RPE in validity experiment, 62–63
differentiated vs. undifferentiated exertional ratings, 58
estimation protocol, 57–58
maximal exercise testing, RPE, 64–66
resistance exercise procedures, 70–72
treadmill procedures, 66–68
undifferentiated RPE, 58–60, 62
validity, 55–57
symptoms, 14
Perceptual acuity, 152
Perceptual-cognitive reference filter, 14–15
Perceptually-regulated exercise test, VO_{2}peak prediction, 96
Perceptual methodology
carbohydrate ingestion, 237
ergogenic effects, 249
estimation–production paradigms, 227, 237, 250
external environment control, 251
perceived exertion scale validation, 226, 237, 249
predicted, momentary and session RPE, 228, 239, 251
public health implications, 226
self-selected vs. imposed exercise intensities, 227–228, 239, 250–251
target RPE at VT, 226, 238, 249
teleoanticipation and perceived exertion
JND, 227, 238–239, 250
VO_{2}max and 1RM prediction, RPE, 227, 238, 250
Perceptual outliers, 47
Performance-related mediators, perceived exertion, 14
Pfeiffer, K.A., 60
Physical activity (PA). See also Physical inactivity
ACSM and CDC, 2
adherence, 4–5
high associations with diseases, 1
laboratory manual of, 5–6
lower mortality rate and longer life expectancy, 1–2
overall healthfitness promotion, 1
psychological effects, 2
Physical activity enjoyment (PAE)
and AR, aerobic interval exercise, 200, 210–212
assessment methodology, 35
definition, 34, 37–38
FS responses, 203–204
limitations, 36
Physical activity enjoyment (PAE) (cont.)
  questionnaire methodology, 35
  single-item metrics, 36–37
Physical inactivity
  economic cost, 3
  epidemic, 2–3
Physiological mediators, perceived exertion, 13
Potteiger, J.A., 244
Poulton, R., 179–180
Predicted RPE
  assessments, results and analysis, 184
  cycle ergometer procedures
    equipment, 187
    graded exercise test, 188
    pre-exercise procedures, 188
    submaximal exercise intensity trial, 189–191
  EDI, 216
  PACER, 180
  RPE prior, 179–180
  and session AR, 215–216
  and session exercise-induced pain, 214–215
  treadmill procedures
    equipment, 184
    graded exercise test, 185–186
    pre-exercise procedures, 185
    submaximal exercise intensity trial, 186–187
Prediction model, RPE-based
  accuracy evaluation, 94–95
  cross-validation, 95–96
Prediction, \( \text{VO}_2 \text{peak} \)
  Borg RPE-VT, 306
 LEGEND ENTRIES text box, 302
  Microsoft Excel spreadsheet, 299
  OMNI RPE-L, 300, 305
  SELECT DATA tab, 301
  SERIES NAME, 303
  SERIES Y VALUES text box, 304
Preferred exercise
  assessments, results and analysis, 166–167
  client information, 166
  cycle ergometer procedures
    data organization and analysis, 172–173
    equipment, 171
    graded exercise test, 171–172
    imposed exercise intensity trial, 173–175
    organization and analysis, 175–176
    pre-exercise procedures, 171
    self-selected exercise intensity trial, 174–175
treadmill procedures
  data organization and analysis, 168–169, 171
  equipment, 167
  graded exercise test, 167–168
  imposed exercise intensity trial, 169–170
  pre-exercise procedures, 167
  self-selected exercise intensity trial, 170
Prescribed exercise, 164
Prescription congruence
  intramodal vs. intermodal
    in active college-aged men, 115
    cross-modal, 114
    cycle ergometer estimation protocols, 113
    cystic fibrosis, 115–116
    estimation and production protocols, 113
    OMNI Cycle RPE Scale, 116
    self-regulate exercise intensity, 115
    target RPE (Borg Scale), 115
  treadmill and cycle ergometer exercise, 114
  production protocol/trial, 113
  resistance exercise, 126–128
Production protocol/trial
  adults with cardiovascular disease, 113
  Borg Scale RPE, 113
  children with cystic fibrosis, 113
  cycle ergometer procedures, 125–126
  definition, 111
  ergometer exercise, 113
  exercise intensity self-regulation error, 113
  prescription congruence, 113
  target RPE production, 112–113
  treadmill procedure, 122–123
Progressive Aerobic Cardiovascular Endurance Run (PACER), 180
Psychophysics, perceived exertion
  Borg Scale RPE, 15–16
  definition, 15
  HR from RPE responses, 16
  Psychosocial mediators, perceived exertion, 13–14

R
  Range Models, 44–45
Rating of perceived exertion (RPE)
  adult OMNI-cycle instructions
    RPE-L only, 263
    undifferentiated and differentiated RPE, 263–264
  adult OMNI-resistance exercise
    RPE-AM only, 264–265
Index

undifferentiated and differentiated RPE, 265
adult OMNI-walk/run, 262
Borg (6–20) scale instructions
cycle exercise and RPE-O, 264
only RPE-O, 262–263
RPE-AM only, 266
caffeine
during exercise, 222–224
on mood, 225
and pain, 224–225
predicted, momentary and session, 228
target RPE at VT, 226
VO2max and 1RM prediction, 227
chest/breathing, 261
estimation and production trials, 152
exercise adherence, 244
JND, 153
and mood, 236–237
pacing strategies, 149–150
perceived exertion responses, reduction, 243
perception of exertion, 261
predicted, momentary and session, 239, 251
predicted RPE (see Predicted RPE)
scales, perceived exertion, 19
segmented session RPE (see Segmented session RPE)
session RPE (see Session RPE)
target RPE at VT, 238, 249
undifferentiated and differentiated, 244
VO2max prediction, 238, 250
at VT (RPE-VT)
in children, 78
evidence, 78
and OMNI Scale, 78–79
workload conditions, 243–244
Rejeski, W.J., 30, 32, 203
Resistance exercise
and aerobic, 21
children’s OMNI-Hurt Scale, 25
isotonic, 25
procedures
data organization and analysis, 72
equipment, 52, 70
exercise procedure, 52–53
exercise protocols, 71–72
memory procedure, 52
pre-exercise procedures, 71
Respiratory exchange ratio (RER), 59
Respiratory exertion, 46
Respiratory rate (RR), 59
Roberson, D.W., 220
Robertson, R.J., 17, 25, 60–64, 72, 78, 113, 127, 132, 203
Rognmo, O., 134
Rollo, I., 236
Rose, E.A., 206, 208–210, 213
RPE. See Rating of perceived exertion (RPE)
RPE-VT and VT determination
automatic VT calculation, 290
calculation, 277–279
RPE-VT determination (see Cycle ergometry graded)
VBE, VO2-1 and VE VCO2-1
blank chart, 282
line graph, 281
SELECT DATA SOURCE box, 283
SERIES NAME, 285
SERIES VALUES text box, 286–288
ventilatory equivalents, 280
vertical line, 289
RPE warning zone, 64
Russell, J.A., 32
S
Scaling procedures
anchoring procedures (see Anchoring procedures)
perceptual and affective variables, 201–202
Schafer, M.A., 192–193
Schneider, M., 35
Segmented session RPE
definition, 183
estimation, 186–187, 190–191
rating, 183
resistance exercise, 191–192
Self-efficacy, 5, 14, 34
Self-selected exercise. See also Imposed exercise
affective responses (AR), 164
health-fitness domain, 163–164
imposed exercise intensity, 164
prescribed exercise intensity, 164
RPE, 165–166
VT/LT, 165
Self-selected vs. imposed exercise intensities, 227–228, 239, 250–251
Session RPE. See also Predicted RPE
description, 180–181
exercise intensity, 182–183
segmented, 183
validity, 181–182
Shephard, R.J., 201
Sheppard, K.E., 214
Short-term exercise, 235
Smith, P.M., 219, 222, 228
Standard stimulus, 150–151, 155, 157, 158
Stanley, D.M., 36, 204
Suminski, R.R., 60
Svebak, S., 33

T
Target AR
- exercise intensity prescription, 205–206
- physiological and psychological, 210
Target pain ratings, exercise prescription, 204–205, 212
Teleoanticipation
- individual’s cognitive ability, 148
- pacing strategy and, 148
- perceived exertion JND, 227, 238–239, 250
- prescription congruence improvement, 116–117
Teleoanticipation and perceived exertion JND, 227, 238–239, 250
Tenenbaum, G., 244
Treadmill procedures
- data organization and analysis, 67–68, 82–83
- equipment, 48, 66, 80
- exercise procedure, 49
- graded exercise test, 66–67, 81
- memory procedure, 49
- pre-exercise procedures, 66, 80–81

U
Undifferentiated RPE, 46, 149
- concurrent validity evidence, 58–60
- construct validity evidence, 60, 62
Utter, A.C., 60

V
Validity
- coefficients, 56 (see also Coefficients, validity)
- concurrent (see Concurrent validity)
- construct (see Construct validity)
- definition, 55–56
- enjoyment measures, exercise, 203–204
- exercise-induced pain scales, 202–203
- Feeling Scale (FS), 203
- test protocols, 57
Van Lunduyst, L.M., 201
Ventilatory threshold (VT)
- cycle ergometer procedures
- data organization and analysis, 84–85
- equipment, 83
- graded exercise test, 83–84
- pre-exercise procedures, 83
- direct assessment, 76
- elite endurance athletes, 76
- FS ratings, exercise, 206
- health-fitness setting, 78
- HR-VT, 77
- and LT, 76
- OMNI scale, 78–79
- pain threshold, 212
- RPE, 205
- RPE-VT, 77, 78
- in sedentary, 205
- surrogate measure, 75
- treadmill procedures, 80–83
- VT. See Ventilatory threshold (VT)

W
Weiser, P.C., 23, 113, 132
Winnick, J.J., 236