Methods for Determining Exercise Intensity

1. **METs or VO₂Reserve**
   - Target VO₂ = (exer intensity) (VO₂ - VO₂rest) + VO₂rest
   - So: calculate work rate using metabolic calculations or use a MET table

1. **METs or VO₂Reserve**
   - Initial Stage: 40/50% - 60% VO₂R
   - Improvement Stage: 60-85% VO₂R
     - (most 60-80%)
   - Maintenance Stage: 70-85% VO₂R

1. **Example:** VO₂max = 38 ml/kg/min
   - Target VO₂ = .5 X (38-3.5) + 3.5
   - Target VO₂ = .5 X (34.5) + 3.5 = 20.8 ml/kg/min
   - 20.8/3.5 = 5.9 METs
   - Target VO₂ = .85 X (38-3.5) + 3.5
   - Target VO₂ = .85 X (34.5) + 3.5 = 32.8 ml/kg/min
   - 32.8/3.5 = 9.4 METs
   - Goal for intensity: 5.9 - 9.4 METs
     - use MET Table
     - or 20.8 – 32.8 ml/kg/min
   - Use metcalc to solve for speed, resistance, etc.

Limitations For The Use Of VO₂ In Prescribing Exercise (p 146 G)

- The caloric cost for activities in groups 2 and 3 (see box 7-1) are quite variable and depend on the skill of the participant and/or the level of competition.
- The caloric cost of activities can provide a starting point for prescribing exercise intensity for individuals with cardiac and/or pulmonary disease, and for individuals with low functional capacities, but the load should be titrated depending on the physiologic responses, perceived exertion, and signs and symptoms.
Limitations For The Use Of VO₂ In Prescribing Exercise

- The caloric cost of an activity does not take into consideration the effect of the environment (e.g., heat, humidity, altitude, pollution), level of hydration, and other variables that can alter the HR and RPE responses to exercise. The ability of individuals to undertake exercise successfully at a given absolute intensity is directly related to their relative effort as reflected by HR and RPE.

2. HR vs VO₂ - direct method

- Graded exercise test required; plot VO₂ against HR, take percentage of VO₂max, determine HR at that VO₂.
- Note, you cannot use a resting and maximal VO₂ and heart rate for the plot, must use more points.

2. HR vs VO₂ - direct method

- Heart Rate vs VO₂ - 40/50 - 85% VO₂ₘₐₓ
- Initial Stage: 40/50% - 60% VO₂ₘₐₓ
- Improvement Stage: 60-85% VO₂ₘₐₓ
- Maintenance Stage: 70-85% VO₂ₘₐₓ

Example: VO₂ₘₐₓ = 38 ml/kg/min
- 38 x .5 = 19 ml/kg/min, HR at VO₂ = 130 bpm
- 38 x .85 = 32 ml/kg/min, HR at VO₂ = 168 bpm

3. Heart Rate Reserve Method (HRR) - Karvonen

- THR = ([HRmax - HRrest] X %) + HRrest

p 148G
3. Heart Rate Reserve Method (HRR) - Karvonen

Example: 40 year old
If HR max is not known must estimate, never estimate if it is known.

MPHR: 220-40 = 180
Resting HR = 80 bpm
HRR: 180 - 80 = 100
100 X .5 = 50 + 80 = 130 bpm
100 X .85 = 85 + 80 = 165 bpm
THR: 130 - 165 bpm
Do not use this method if an accurate RHR is not available.

4. % HR (HR\text{max}) - Percent of maximal HR

Example: 40 year old, maximal HR is not known, use if available
220-40 = 180 bpm
180 X 0.65= 117 bpm
180 X 0.9 = 162 bpm
THR zone = 117-162
Estimates THR 10-15% low so %ages are higher

4. % HR (HR\text{max}) - Percent of maximal HR

MHR X (% intensity) = THR
55/65 - 90% HR\text{max}
Initial Stage: 55/65% - 70% HR\text{max}
Improvement Stage: 70-90% HR\text{max}
Maintenance Stage: 75-90% HR\text{max}

5. Rating of Perceived Exertion

**RPE during GXT may not consistently translate to same intensity during exercise session for different modes of exercise.**

When to use?
- Difficulty with palpation
- HR response to exercise altered due to medications with no GXT available
- Assist in fine tuning or titrating the exercise prescription

Table 4-6. Category Scale for Ratings of Perceived Exertion (RPE) (p 79)

| 6 | 14 |
| 7 | Very, very light | 15 | Hard |
| 8 | 16 |
| 9 | Very light | 17 | Very hard |
| 10 | 18 |
| 11 | Fairly light | 19 | Very, very hard |
| 12 | 20 |
| 13 | Somewhat hard |

Table 4-6. Category-Ration Scales for Ratings of Perceived Exertion (RPE) (p 79)

| 0 | Nothing at all | 5 | Strong |
| 1 | Very weak | 6 |
| 2 | Weak | 7 | Very strong |
| 3 | Moderate | 8 |
| 4 | 10 | Extremely strong |
RPE

Target RPE: 12-16/15 3-6/10
Initial Stage: 12-13/15 3-4/10
Improvement Stage: 14-16/15 4-6/10
Maintenance Stage: 15-16/15 5-6/10

7. Talk test

Is the client able to answer without struggling to breathe between words?
Is the client working above their anaerobic threshold?

Which method is best? The facts!

- Ideal – based on oxygen consumption – VO₂R or work rate (calculate or measure – mph or Watts)
- Many factors affect HR – temperature, humidity, terrain and surface

TABLE 7-2. Classification of Physical Activity Intensity Based on Physical Activity Lasting up to 60 Minutes

<table>
<thead>
<tr>
<th>Intensity</th>
<th>%HRR</th>
<th>%HR&lt;sub&gt;max&lt;/sub&gt;</th>
<th>RPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very light</td>
<td>&lt;20%</td>
<td>&lt;35%</td>
<td>&lt;10</td>
</tr>
<tr>
<td>Light</td>
<td>20–39</td>
<td>35–54</td>
<td>10–11</td>
</tr>
<tr>
<td>Moderate</td>
<td>40–59</td>
<td>55–69</td>
<td>12–13</td>
</tr>
<tr>
<td>Hard</td>
<td>60–84</td>
<td>70–89</td>
<td>14–16</td>
</tr>
<tr>
<td>Very hard</td>
<td>≥85</td>
<td>≥90</td>
<td>17–19</td>
</tr>
<tr>
<td>Maximal</td>
<td>100</td>
<td>100</td>
<td>10</td>
</tr>
</tbody>
</table>


%VO₂R vs % VO₂max

- Problem - %VO₂R does not = % VO₂max
- Error –
  - Rest = 0% of HRR but not 0% (dead) of VO₂max (3.5/35 ml/kg/min = 10% VO₂max)
  - Amount of error depends on fitness level – more error less fit clients
  - Error is smaller as exercise intensity increases

%VO₂R vs % HRR

- No error between
  - Rest – 0% of VO₂R and 0% HRR
  - Not affected by fitness level
  - No error for younger, older, healthy, and cardiac
Example

- 57 year-old female
- VO₂ max is 17.5 ml/kgmin
- BMI = 31 kg/m²

% VO₂ R

- Start 40-50%
  Target VO₂ = (.4) (17.5 – 3.5) + 3.5
  = .4 (14) + 3.5
  = 5.6 + 3.5
  = 9.1 ml/kgmin

What walking speed is that?
2.1 mph

% VO₂ max

- Target VO₂ = 17.5 (.4) = 7.0 ml/kgmin
  What speed is that?
  1.3 mph (very, very slow – large error)
Which method is best?
- Often do not have laboratory data for VO2
- Next best choice is HRR – If accurate RHR
  - 5 min of seated rest if seated exercise
  - 2-3 min of standing if walking or running
Why?
  Takes RHR into account

Problem with HR methods
- Estimation of HRmax
- Never use estimated max HR if have a measured value
  - Why??
    - ± 10 bpm (2 SD) – 2/3 of population
    - > 10 bpm - 1/3 of population

HRR vs % HRmax
- Example:
  - 50 yr old male, RHR = 90 bpm, sedentary
  - % HRmax method
    - \(220 - 50 = 170\) X .65 = 111 bpm
    - Reasonable – when stand RHR increases 10-15 bpm
      without exercise – NOT REASONABLE!!!!!!!!!!
    - Intensity is too low!

Bottom Line – Best Method?
- Is person on a medication that affects HR?
  - Yes
- Do have GXT data?
  - Yes - use \(V0\_R\) (1st choice) or HRR (2nd choice)
  - No – use RPE

RPE
- Must use with medications that affect HR when no measured maximal HR
- Use if no HR monitor and cannot palpate pulse
- Use to titrate all other methods of exercise prescription
Bottom Line – Best Method?

- If no medications that affect HR?
  - Have GXT data
    - VO_{2R} or work rate (speed or Watts, etc.), if not
    - HRR if accurate resting HR
    - %HR_{max} if no accurate RHR

FYI

- Next Table – more research – more accurate than guidelines book when comparing methods for exercise prescription
- Probably be used in 7th edition
- Use current guidelines for ACSM exam

Table 3.1

<table>
<thead>
<tr>
<th>VO_{2R} (%)</th>
<th>HRR (%)</th>
<th>HR_{max} (%)</th>
<th>RPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>40</td>
<td>40</td>
<td>64</td>
<td>12</td>
</tr>
<tr>
<td>50</td>
<td>50</td>
<td>71</td>
<td>13</td>
</tr>
<tr>
<td>60</td>
<td>60</td>
<td>77</td>
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</tr>
<tr>
<td>70</td>
<td>70</td>
<td>84</td>
<td>15</td>
</tr>
<tr>
<td>80</td>
<td>80</td>
<td>91</td>
<td>16</td>
</tr>
<tr>
<td>85</td>
<td>85</td>
<td>96</td>
<td>17</td>
</tr>
</tbody>
</table>

Cardiopulmonary exercise intensity may be prescribed as a workload (based on a desired percentage of VO_{2R} reserve), as a target heart rate (calculated by the HR_{max} method or the %HR_{max} method), or as a rating of perceived exertion. Percent HR units provide equivalent intensities to VO_{2R} units, while %HR_{max} units must be adjusted upward to provide the same intensities. (*) Equivalent values for %HR_{max} are from notes, in print.

Specificity

- Measured maximal HR varies with mode of activity
- RPE varies with mode of activity at same HR
  - Swimming – subtract 12 bpm from MPHR or from maximal land HR
  - Water aerobics – subtract 10 bpm from MPHR or maximal HR on land

Exercise Progression

<table>
<thead>
<tr>
<th>Program Stage</th>
<th>Exercise Frequency (Sessions/wk)</th>
<th>Exercise Intensity (%HRmax)</th>
<th>Exercise Duration (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial stage</td>
<td>1</td>
<td>3</td>
<td>40–50</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>3–4</td>
<td>40–50</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>3–4</td>
<td>50–60</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>3–4</td>
<td>50–60</td>
</tr>
<tr>
<td>Improvement</td>
<td>5–7</td>
<td>3–4</td>
<td>60–70</td>
</tr>
<tr>
<td></td>
<td>8–10</td>
<td>3–4</td>
<td>60–70</td>
</tr>
<tr>
<td></td>
<td>11–13</td>
<td>3–4</td>
<td>65–75</td>
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<td>14–16</td>
<td>3–5</td>
<td>65–75</td>
</tr>
<tr>
<td></td>
<td>17–20</td>
<td>3–5</td>
<td>70–85</td>
</tr>
<tr>
<td>Maintenance</td>
<td>21–24</td>
<td>3–5</td>
<td>70–85</td>
</tr>
<tr>
<td></td>
<td>24+</td>
<td>3–5</td>
<td>70–85</td>
</tr>
</tbody>
</table>
Initial Stage

- Goal – light muscular endurance exercise
  - Minimal soreness
  - Minimal discomfort
  - Injury prevention
- ≤ 4 weeks
- 15-20 min progressing to 30 min
- 3-4 d/wk

Improvement Stage

- Progress at a more rapid rate
- 4-5 months depending on goals
- May or may not progress to upper end of range by end of stage
- Rate of progression depends on age, conditioning, ability to adapt

Initial Stage

- Set realistic goals
- Establish adherence
- Rewards – intrinsic vs extrinsic

Maintenance Stage

- Long term maintenance of fitness and/or weight
- After 5-6 months or sooner
- Set new goals
- Include recreational/enjoyable activities
- Check caloric expenditure