Improvements in Aerobic Capacity in Women with Cardiac Rehabilitation

Exercise Training

Jason Rengo MS, FAACVPR
Patrick Savage MS, FAACVPR
Sherrie Khadanga, MD
Phil Ades MD, MAACVPR

University of Vermont Medical Center
Burlington, VT
October 6th, 2017
Conflicts of Interest

None
Background

- Peak aerobic capacity ($\text{VO}_2^{\text{peak}}$) is associated with improved cardiovascular prognosis at entry and following cardiac rehabilitation (CR)

- Using TM time improvements in estimated aerobic capacity are similar between females and males
  - Gassner et al. Heart Lung 2003;32:258-265

- Directly measured $\text{VO}_2^{\text{peak}}$ differences observed
  - Females improve 11% vs 17% in males
Background


Image: Bar chart showing Age-Adjusted Deaths per 10,000 person-years for different VO2 quartiles. WOMEN

- VO2 Quartiles:
  - 1: <11.9
  - 2: 11.9 - 14.1
  - 3: 14.2 - 16.5
  - 4: ≥15.6

- Deaths (n):
  - 1: 40
  - 2: 16
  - 3: 15
  - 4: 7

- Crude Annual Mortality (%):
  - 1: 3.9
  - 2: 1.8
  - 3: 1.5
  - 4: 0.7

- Hazard Ratio:
  - 1: 5.67
  - 2: 2.74
  - 3: 2.18
  - 4: 1.00

- Probability for Cardiovascular Mortality (%)

1 % ↑ peak VO2
2 % ↓ Mortality
Purpose

• Describe baseline $VO_{2peak}$ and training response in female CR participants

• Secondary outcome:
  • Compare female training response with male counterparts
Methods

• Prospective data on 3,925 consecutive patients enrolling in CR (clinical database)
  • 940 females, 2985 males
  • Study period 1996-2015

• VO$_{2\text{peak}}$ was directly measured at baseline and exit from CR

• Demographic data included:
  • age
  • weight
  • handgrip strength
  • self-reported physical function (MOS SF-36)

• Comorbidities
  • obesity
  • orthopedic limitations
  • chronic obstructive pulmonary disease
  • peripheral arterial disease
  • diabetes mellitus
  • cerebrovascular accident
  • smoking status
Statistics

- Paired t-tests
  - Training response

- $X^2$ and ANOVA
  - between group comparisons

- ANCOVA
  - adjustments for baseline sex differences that could influence VO$_{2\text{peak}}$

- Results are presented as mean ± SD.

- Statistical significance p<0.01
### Demographics

#### Females (n=940)

<table>
<thead>
<tr>
<th>Measure</th>
<th>Baseline</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>64±12</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>75±17</td>
</tr>
<tr>
<td>Body Mass Index</td>
<td>29.4±6.6</td>
</tr>
<tr>
<td>Waist Circumference (cm)</td>
<td>95.5±15.1</td>
</tr>
<tr>
<td>VO$_{2peak}$ (ml*kg$^{-1}$*min$^{-1}$)</td>
<td>15.2±4.7</td>
</tr>
<tr>
<td>Handgrip Strength (kg)</td>
<td>23±6</td>
</tr>
<tr>
<td>MOS SF-36 Physical Function</td>
<td>56±25</td>
</tr>
<tr>
<td>Days to CR Entry (mean)</td>
<td>42±27</td>
</tr>
</tbody>
</table>

#### Index Diagnosis

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>CABG</td>
<td>24%</td>
</tr>
<tr>
<td>Myocardial Infarction</td>
<td>34%</td>
</tr>
<tr>
<td>Percutaneous Coronary Intervention</td>
<td>25%</td>
</tr>
<tr>
<td>Valvular disease</td>
<td>10%</td>
</tr>
<tr>
<td>Chronic Heart Failure</td>
<td>3%</td>
</tr>
<tr>
<td>Cardiac Dysrhythmia</td>
<td>3%</td>
</tr>
<tr>
<td>Stable Angina</td>
<td>2%</td>
</tr>
</tbody>
</table>
Female Training Response

<table>
<thead>
<tr>
<th>Females (n=407)</th>
<th>Entry</th>
<th>Exit</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>66±11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>75±17</td>
<td>74±16</td>
<td>-1±4 (1%)*</td>
</tr>
<tr>
<td>Body Mass Index</td>
<td>29.1±6.4</td>
<td>28.7±6.1</td>
<td>-0.4±1.4 (1%)*</td>
</tr>
<tr>
<td>Waist Circumference (cm)</td>
<td>94.5±14.2</td>
<td>93.1±14.0</td>
<td>-1.4±4.3 (1%)*</td>
</tr>
<tr>
<td>VO$_{2}$peak (ml*kg$^{-1}$*min$^{-1}$)</td>
<td>15.6±4.6</td>
<td>17.6±5.0</td>
<td>+2.0±2.7 (13%)*</td>
</tr>
<tr>
<td>Handgrip Strength (kg)</td>
<td>23±6</td>
<td>24±6</td>
<td>+1±3 (4%)*</td>
</tr>
<tr>
<td>MOS SF-36 Physical Function</td>
<td>58±26</td>
<td>76±23</td>
<td>+18±23 (31%)*</td>
</tr>
</tbody>
</table>

$p<0.001*$
### Female and Male Comparisons

<table>
<thead>
<tr>
<th></th>
<th>Females (n=407)</th>
<th>Males (n=1382)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>66±11</td>
<td>64±10</td>
<td>p&lt;0.001</td>
</tr>
<tr>
<td>Baseline VO(<em>{2})(</em>{\text{peak}}) (ml*kg(^{-1})*min(^{-1}))</td>
<td>15.6±4.6</td>
<td>20.3±6.5</td>
<td>p&lt;0.001</td>
</tr>
<tr>
<td>Training Response (ml*kg(^{-1})*min(^{-1}))</td>
<td>+2.0±2.7 (+13%)</td>
<td>+3.5±3.8 (+17%)</td>
<td>p&lt;0.001</td>
</tr>
<tr>
<td>RER Baseline</td>
<td>1.06±0.12</td>
<td>1.12±0.11</td>
<td>p&lt;0.001</td>
</tr>
<tr>
<td>RER Exit</td>
<td>1.07±0.11</td>
<td>1.11±0.10</td>
<td>p&lt;0.001</td>
</tr>
<tr>
<td>Handgrip Strength (kg)</td>
<td>23±6</td>
<td>39±10</td>
<td>p&lt;0.001</td>
</tr>
<tr>
<td>Obesity Rates (waist circumference)</td>
<td>63%</td>
<td>53%</td>
<td>p&lt;0.001</td>
</tr>
<tr>
<td>Orthopedic Limitations</td>
<td>21%</td>
<td>16%</td>
<td>p&lt;0.01</td>
</tr>
<tr>
<td>Peripheral Arterial Disease</td>
<td>2%</td>
<td>5%</td>
<td>p&lt;0.04</td>
</tr>
</tbody>
</table>
ANCOVA

• Differences in \( \text{VO}_{2\text{peak}} \) remain following adjustments:
  • age
  • handgrip strength
  • obesity (waist circumference)

• Changes evident when expressed as absolute value (L/min)
• Failure to improve ($VO_{2peak}$)
  • 24% (96/407) females
  • 16% (224/1382) males
    • Similar cohort from 2003-07
      – 31% females
      – 19% males

• +13% improvement $VO_{2peak}$ following CR training
  • Compared to 11% (2003-2007)

• Importance of directly measured $VO_{2peak}$
  • Estimated METs may not be as sensitive

Discussion

• RER achieved was <1.10
  • Target HRs may be inappropriate

• Training intensity
  • interval training in 6% females vs 11% males
  • patients receiving differing exercise prescriptions/advice?

• RPE higher for similar relative intensity

• Studies optimizing female exercise prescriptions should be explored
  • Female controls
Limitations

- Non-randomized
  - Single clinical center
- Lack female controls
- No direct measure of lean muscle mass and fat mass
  - Handgrip, waist circumference as proxy
- No cellular or genetic data