The Art and Science of Exercise Prescription

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What are your goals when prescribing exercise?

Prescribe a program that:
- Promotes positive physiological changes
- Is safe and avoids injuries
- Fosters exercise adherence

If exercise could be packaged in a pill, it would be the most widely prescribed medication in the world.
**Exercise is Medicine:**
Prescribing the Right Dosage

<table>
<thead>
<tr>
<th>Medicine</th>
<th>Exercise</th>
</tr>
</thead>
<tbody>
<tr>
<td>• What kind?</td>
<td>• Type or modality</td>
</tr>
<tr>
<td>• How much?</td>
<td>• Intensity</td>
</tr>
<tr>
<td>• How often?</td>
<td>• Frequency</td>
</tr>
<tr>
<td>• How long?</td>
<td>• Time or duration</td>
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</table>

**Exercise Prescription for Aerobic Exercise**

**FITT Principle**

- Frequency
- Intensity
- Time or duration
- Type or modality
Frequency

- 3 - 5 days per week

Time / Duration

- 20 - 60 minutes of continuous activity
  - shoot for 30 - 40 minutes
    1. reduces boredom
    2. less chance for injury

Latest Guidelines: AHA/ACSM 2007

“To promote and maintain health, older adults need moderate-intensity aerobic physical activity for a minimum of 30 minutes on 5 days each week or vigorous-intensity aerobic activity for a minimum of 20 minutes or more on 3 days each week.”
Can you break up your workout into smaller segments?

(e.g., 3 - 10 minute segments vs. 1 - 30 minute bout)

Type or Modality

- Any large muscle, sustainable activity is acceptable
- No one modality has proven to be superior, however those modes with an upper body component may have some advantages:
  - increased upper body muscular endurance
  - sharing of workload, so lower perceived effort (RPE)

Changes in aerobic capacity following 12 weeks of stationary cycling, treadmill walking, stepping, or simulated cross-country skiing
Changes in body weight and % fat following 12 weeks of stationary cycling, treadmill walking, stepping, or simulated cross-country skiing.

<table>
<thead>
<tr>
<th>Change</th>
<th>Control</th>
<th>Bike</th>
<th>Tmill</th>
<th>Stepper</th>
<th>Skier</th>
</tr>
</thead>
</table>

**SPECIFICITY**

**SAID PRINCIPLE**

Specific Adaptation to Imposed Demands

**Intensity**

- 40 - 85% of maximal capacity
How do we get people there?

- Objective criteria
  - %VO₂max
  - %HRmax or HRR (Karvonen)
- Subjective methods
  - RPE
  - Talk test

Heart Rate Methods

Heart Rate Reserve (Karvonen)

THR = [(max HR - rest HR) X desired % + rest HR]

<table>
<thead>
<tr>
<th></th>
<th>Lower Limit</th>
<th>Upper Limit</th>
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</thead>
<tbody>
<tr>
<td>Maximal heart rate</td>
<td>180</td>
<td>180</td>
</tr>
<tr>
<td>Resting heart rate</td>
<td>-60</td>
<td>-60</td>
</tr>
<tr>
<td>Heart rate reserve</td>
<td>120</td>
<td>120</td>
</tr>
<tr>
<td>Desired %</td>
<td>X .60</td>
<td>X .80</td>
</tr>
<tr>
<td>Resting heart rate</td>
<td>+60</td>
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<tr>
<td></td>
<td>132</td>
<td>156</td>
</tr>
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</table>
Heart Rate Methods

% HR max - usually underestimates Karvonen method by 5-18%; therefore we usually adjust percentages up by this amount (i.e. use 60 - 90% vs 40 - 85%)

180 x .60 = 108  
180 x .70 = 126  
180 x .80 = 144  
180 x .85 = 153

% Karvonen % HR max
40 60
45 62
50 65
55 67
60 70
65 75
70 80
75 82
80 85
85 90

Intensity Violators
Signs and Symptoms Below Which an Upper Limit for Exercise Intensity Should be Set

- Angina
- Drop in SBP
- Significant ST depression on previous GXT
- Increased frequency of ventricular ectopy
- Onset of heart blocks (e.g., BBBs, 2º or 3º AV block)
- Other signs/symptoms of intolerance to exercise (e.g., extreme SOB)

Exercise heart rate should be set at least 10 bpm below the HR associated with any of the above criteria

Problems with using HR methods:

1. Maximal HR is usually estimated
   - 220 – age or 206.9 - .67 (age); SD = ± 10-12 bpm
If you don’t have a maximal exercise test on someone, you have no idea what their maximal heart rate is, especially if they are older, have disease, and are on medications. Thus, do not use predicted HRmax for exercise prescription!

2. People goof when taking their pulse
3. Normal day-to-day variability
   • Heat, cold, altitude, illness, excitement, timing of meds, etc.
4. HR/VO₂ relationship is different for different modalities

Figure 1. The %VO₂max/%HRmax relationship for 10 cardiac rehabilitation patients during progressive treadmill exercise (TM), combined arm and leg ergometry (ALE), leg ergometry (LE), and arm ergometry (AE).
5. The relative % concept does not prescribe the same level of metabolic overload for all patients, due to individual differences in the anaerobic threshold (AT).

What does this have to do with anything?

2 studies: Katch et al., 1978; Dwyer et al., 1994

- At 50-70% of HR reserve, 50% of subjects were above their anaerobic threshold and 50% were below
Subjective Methods

- Ratings of Perceived Exertion (RPE)
- Talk Test

Surveys have found that ~60% of exercisers prefer subjective methods to guide their exercise program.
Perceived exertion: A note on history and methods

Gunnar A. V. Borg
MSSE, 1973

“There are two ordinary things in a man’s life that make his heart beat faster: walking up stairs and watching pretty girls.”

RPE Method (Borg Scales)

<table>
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<th>1 - 10 Scale</th>
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<tr>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>7 Very, very light</td>
<td>0.5 Extremely weak</td>
</tr>
<tr>
<td>8</td>
<td>1 Very weak</td>
</tr>
<tr>
<td>9 Very light</td>
<td>2 Weak</td>
</tr>
<tr>
<td>10</td>
<td>3 Moderate</td>
</tr>
<tr>
<td>11 Fairly light</td>
<td>4 Strong</td>
</tr>
<tr>
<td>12</td>
<td>5 Strong</td>
</tr>
<tr>
<td>13 Somewhat hard</td>
<td>6 Very strong</td>
</tr>
<tr>
<td>14</td>
<td>7 Very strong</td>
</tr>
<tr>
<td>15 Hard</td>
<td>8</td>
</tr>
<tr>
<td>16</td>
<td>9</td>
</tr>
<tr>
<td>17 Very hard</td>
<td>10 Very, very strong</td>
</tr>
<tr>
<td>18</td>
<td>* Maximal</td>
</tr>
<tr>
<td>19 Very, very hard</td>
<td></td>
</tr>
<tr>
<td>20</td>
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- 11 - 13 (3-4) moderate intensity = 40 - 60% HR reserve
- 14 - 16 (4-6) high intensity = 60 - 85% HR reserve

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Problems with using RPE:

- People get distracted (not clued in)
- Group setting – compare themselves to others
- Assumes steady-state exercise
- Some people just don’t get it!!!!

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Gloria

- 73 year-old woman
- Exercise HRs: 70-80 bpm
- ~40-50% of HRmax
- RPE = 17 (very hard)

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Ron

- 74 year-old man
- Exercise HRs: 125-140 bpm
- 75-90% of HRmax
- RPE = 10 (fairly light)
Talk Test

Exercise at an intensity where you can still carry on a conversation!

• Last positive stage: + TT
• Equivocal stage: +/- TT
• First negative stage: - TT

• A study from our lab found that the last stage where subjects could pass the Talk Test (last +) corresponded to 64% of VO$_2$max, 70% of HRmax, and an RPE of 13 (3).
What about High Intensity Interval Training (HIIT)

Interval Training

Interval training

Steady state exercise

Oxygen consumption (litre • min⁻¹)

[Graph showing the comparison between steady state exercise and interval training]

Area of anaerobic threshold
Anaerobic Threshold
Steady state exercise
Interval training
Minute-by-minute HR responses to the four P90X workouts
Minute-by-minute VO₂ responses to the four P90X workouts

Interval training compared to steady state exercise:

• Greater increases in aerobic capacity (46 vs. 14%)
• Results in as little as 6 sessions
• In only a fraction of the time
  – Tabata method:
    • 20 sec work/10 sec rest
    • Repeated 8x
    • Total of 4 minutes of exercise

ROM Machine
All the exercise you need in exactly 4 minutes a day!
Manufactured in California since 1990.
Price $14,615!
• Knab et al., MSSE, 43(9): 1643-1648, 2011
• 45-min exercise bout (73% VO_{max})
• Burned 519 kcal during exercise
• Burned additional 190 kcal after exercise (37%)
• Metabolic rate stayed elevated for 14 hours

How do you do it?

Exercise Prescription for Resistance Training
Benefits of Resistance Training

- Increase in muscular strength and endurance of 40-100%

  – Framingham study found that 50% of women over 65 years old could not lift 10 pounds to shoulder height

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**Average Combined Self-Efficacy Improvements**

<table>
<thead>
<tr>
<th></th>
<th>Ambulatory</th>
<th>Strength</th>
<th>Personal Appearance</th>
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<tbody>
<tr>
<td>Experimental</td>
<td>24%</td>
<td>22%</td>
<td>60%</td>
</tr>
<tr>
<td>Control</td>
<td>-5%</td>
<td>-9%</td>
<td>-1%</td>
</tr>
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The Gun Show!!
• Every pound of muscle burns an additional 20-30 kcal day
• RMR ↑ 5%; 1 set, 9 exercises, 3-6 reps, 80% 1 RM
  Kirk et al., MSSE, 2009

Other Benefits
• Increased bone mass
• Better balance/reduced chance of falls
• Minor improvement in resting SBP and DBP
• Improved glucose control
  – Glut 4 receptors
    • Aerobic training .5 point decrease in HbA1c
    • Resistance training .5 point decrease in HbA1c
    • Combination training – 1 point decrease in HbA1c

How do you do it?
FITT Principle for Resistance Training

- Frequency
- Number of sets
- Number of repetitions per set
- Load
- What exercises

All Current Recommendations Suggest:
(ACSM, AHA, AACVPR, Federal Guidelines)

- 1 set
- 8-10 exercises
- 8-15 repetitions
  - 8-12 reps for adults < 65 years old
  - 10-15 reps for older adults
- 2 or more non-consecutive days per week
- Moderate – high intensity: RPE of 13-16 (5-8)

- Muscle strengthening activities include a progressive weight training program, weight bearing calisthenics, and similar resistance training exercises.

- Improvement in strength
  - 3 set group: 38%
  - 1 set group: 34%

- Adherence to resistance training
  - 3 set group: 63%
  - 1 set group: 84%

- Increase in lean body mass (muscle)
  - 3 set group: 1.5 kg
  - 1 set group: .9 kg
What exercises/muscle groups?

- Front of upper arms (biceps)
- Back of upper arms (triceps)
- Shoulders
- Chest
- Back
- Abdominals
- Front of thigh (quadriceps)
- Back of thigh (hamstrings)
- Gluteus maximus (buttocks)
- Gastrocnemius (calf)

How much weight should people lift?

Determining Resistance

- Perform one-repetition maximal testing (1-RM)
- Titration Method
  - WAG
  - SWAG
What Modalities?

- Resistance is resistance!
  - Body weight
  - Surgical tubing
  - Dynabands
  - Dumbbells/barbells
  - Machines

Fullerton Functional Fitness Test

- Chair sit-to-stand (13%)
- Biceps curls (14%)
- 6-minute walk (7%)
- Chair sit-and-reach (15%)
- Back scratch (43%)
- 8 foot up-and-go (13%)
Bottom Line:
One size fits NONE!