Exercise Prescription for Muscular Fitness (I)

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References

Learning Objectives

- Understand the effects of resistance training
- Learn how to prescribe resistance exercise programs using different types of resistance training
Muscular Fitness

- **Muscular strength**
  - The greatest force that can be generated by a specific muscle group or groups
  - Measured by devices such as handgrip dynamometers, or by performing a one-repetition maximum (1RM)

- **Muscular endurance**
  - The ability to perform multiple repetitions at a given percentage of 1RM
  - Measured by 1-min sit-ups or 1-min push-ups
Effects of Resistance Training

- Morphological Factors
  - Muscle hypertrophy due to increase in contractile proteins, number and size of myofibrils, connective tissues, and size of type II muscle fibers
  - No change in relative amounts of type I and II muscle fibers
  - Little or no change in the number of muscle fibers (<5%)
  - Increase in size and strength of ligaments and tendons
  - Increase in bone density and bone strength
  - Increase in muscle capillary density
Biochemical Factors

- Minor increase in ATP and CP stores
- Minor increase in CPK, myosin ATPase, and myokinase activity
- Decrease in mitochondrial volume density
- Increase in testosterone, growth hormone, IGF–I, and catecholamines during resistance training exercises
Effects of Resistance Training

- Neural Factors
  - Increase in motor unit activation and recruitment
  - Increase in discharge frequency of motor neurons
  - Decrease in neural inhibition
Effects of Resistance Training

- Additional Factors
  - Little or no change in body mass
  - Increase in fat-free mass
  - Decrease body fat level
  - Improved bone health (i.e., reduces the risk of osteoporosis and falls as one ages)
  - Increase in metabolic rate
  - Lowers blood pressure in hypertensive individuals
  - Improved mood (e.g., depression)
  - May prevent low back pain
Types of Resistance Training

- Static (isometric)
- Dynamic (concentric and eccentric)
- Isokinetic
- Functional Training
Static (Isometric) Training

- Muscle contraction without changes in joint angles
- Advantage: can be performed anywhere and at any time with little or no equipment
- Disadvantage: strength gains are specific to the joint angle used during training
- Widely used in rehabilitation programs to counteract strength loss and muscle atrophy (e.g., fracture)
Static (Isometric) Training

- Contraindicated for individuals with CHD and hypertension
  - Static contraction may produce large increases in intrathoracic pressure
  - Reduces the venous return to the heart
  - Increases the work of the heart
  - Causes a substantial rise in blood pressure
# Static (Isometric) Training

<table>
<thead>
<tr>
<th>Type</th>
<th>Intensity</th>
<th>Duration</th>
<th>Repetitions</th>
<th>Frequency (days/week)</th>
<th>Length of program</th>
</tr>
</thead>
<tbody>
<tr>
<td>Static strength</td>
<td>100% MVC*</td>
<td>5 sec/contraction</td>
<td>5-10</td>
<td>5</td>
<td>4 wk or more</td>
</tr>
<tr>
<td>Static endurance</td>
<td>60% MVC or less</td>
<td>Until fatigued</td>
<td>1/session</td>
<td>5</td>
<td>4 wk or more</td>
</tr>
</tbody>
</table>

*Maximal voluntary contraction.
Static (Isometric) Training

- Chest Push
Static (Isometric) Training

- Shoulder Pull
Static (Isometric) Training

- Triceps Extension
Static (Isometric) Training

- Arm Curls
Static (Isometric) Training

- Ball Squeeze
Static (Isometric) Training

- Leg and Thigh Extensions
Static (Isometric) Training

- Leg Press
Static (Isometric) Training

- Leg Curl
Static (Isometric) Training

- Knee Squeeze
Static (Isometric) Training

- Knee Pull
Static (Isometric) Training

- Pelvic Tilt
Static (Isometric) Training

- Gluteal Squeeze
Types of Resistance Training

- Static (isometric)
- Dynamic (concentric and eccentric)
- Isokinetic
- Functional Training
Dynamic Resistance Training

- Suitable for developing muscular fitness of men and women of all ages
- Involves concentric and eccentric contractions of the muscle group
- Perform contractions against a constant or variable resistance
- Free weights (barbells and dumbbells) and constant- or variable-resistance machines are commonly used
Dynamic Resistance Training

Important concepts for prescribing dynamic resistance training programs:
- Intensity
- Repetitions
- Set
- Frequency
- Training volume
- Order of exercises
Intensity

Expressed as
- A percentage of one-repetition maximum (% 1–RM)
- The repetition maximum (RM)
  - The maximum weight that can be lifted for a given number of repetitions of an exercise
  - Example: 8–RM equals the maximum weight that can be lifted for eight repetitions

Average number of repetitions and %1–RM values
- 60% 1–RM = 15– to 20–RM
- 65% 1–RM = 14–RM
- 70% 1–RM = 12–RM
# Intensity

## TABLE 6.12  Average Number of Repetitions and %1-RM Values

<table>
<thead>
<tr>
<th>Repetitions</th>
<th>% 1-RM&lt;sup&gt;a&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>100</td>
</tr>
<tr>
<td>2</td>
<td>95</td>
</tr>
<tr>
<td>3</td>
<td>93</td>
</tr>
<tr>
<td>4</td>
<td>90</td>
</tr>
<tr>
<td>5</td>
<td>87</td>
</tr>
<tr>
<td>6</td>
<td>85</td>
</tr>
<tr>
<td>7</td>
<td>83</td>
</tr>
<tr>
<td>8</td>
<td>80</td>
</tr>
<tr>
<td>9</td>
<td>77</td>
</tr>
<tr>
<td>10</td>
<td>75</td>
</tr>
</tbody>
</table>

<sup>a</sup>These values may vary slightly for different muscle groups and ages.

Data from Baechle, Earle, and Wathen (2000).
Intensity

For muscular strength:
- Intensity ranges between 60% and 100% 1–RM (1–RM to 12–RM for most individuals)
- General prescriptions:
  - 60–70% 1–RM for novice lifters
  - 70–85% 1–RM for intermediate lifters
  - 80–100% 1–RM for advanced lifters

For muscular endurance:
- Prescribe intensity < 60% 1–RM
- Also brings some strength gains
Repetitions

- Inversely related to intensity
- More repetitions with lighter resistance for muscular endurance
- Fewer repetitions with heavier resistance for muscular strength
The number of consecutive repetitions of the exercise

General recommendations:
- 1–3 sets for novice and intermediate lifters
- ACSM recommends 1 set performed to the point of fatigue for each exercise

Other recommendations:
- 4 sets for each muscle group for untrained and trained lifters
- 8 sets for each muscle group for collegiate and professional athletes
- Multiple sets using periodization for athletes, powerlifters, and bodybuilders
Variations for sets:

- Perform multiple sets at a constant intensity for each exercise
- Perform multiple sets, vary the intensity of each set:
  - Lift progressively heavier weights (light-to-heavy sets; pyramiding)
  - Lift progressively lighter weights (heavy-to-light sets)
  - Pyramiding: (for experienced weightlifters only)
    - 10– to 12–RM
    - 8–RM
    - 6–RM
    - 4–RM
- Perform single set of 3 or more different exercises for the same muscle group
Frequency

- For healthy populations:
  - ACSM recommends 2–3 nonconsecutive days per week
- For advanced lifters & competitive athletes:
  - 4–6 days per week
  - Each muscle group should be exercised twice a week
  - Split routines are recommended
- Split routine
  - Target different muscle groups on consecutive days
  - Allow at least one day of recovery for each muscle group
Sample split routine for a bodybuilder:
- Chest and shoulders on Monday and Thursday
- Hips and legs on Tuesday and Friday
- Back and arms on Wednesday and Saturday

Prescribe 48 hr of rest between workouts
- Allow the muscles to recover from training
- Prevent injury from overtraining
Training volume

- Total amount of weight lifted during the workout
- Sum of the products of the weight lifted, repetitions, and sets for each exercise
- Volume and intensity must be increased overtime to ensure continued strength improvements
- Alter training volume by:
  - Change the number of exercises performed for each session
  - Change the number of repetitions performed for each set
  - Change the number of sets performed for each exercise
- Periodized training can be used to systematically vary volume and intensity
A resistance training program should include at least one exercise for each of the major muscle groups.

First, do multijoint exercises:
- Seated leg press, bench press
- Involve larger muscles and more muscle groups

Next, do single–joint exercises:
- Leg extension, arm curl
- Involve smaller muscle groups
# Order of Exercises

## TABLE 7.6  Example of Exercise Order for a Basic Resistance Training Program

<table>
<thead>
<tr>
<th>Body segment</th>
<th>Type of exercise*</th>
<th>Joint actions</th>
<th>Exercise</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Hips and thighs</td>
<td>Multijoint</td>
<td>Hip extension and knee extension</td>
<td>Seated leg press</td>
</tr>
<tr>
<td>2. Chest</td>
<td>Multijoint</td>
<td>Shoulder horizontal flexion and elbow extension</td>
<td>Flat bench press</td>
</tr>
<tr>
<td>3. Upper and midback</td>
<td>Multijoint</td>
<td>Shoulder extension/adduction and elbow flexion</td>
<td>Lat pull-down</td>
</tr>
<tr>
<td>4. Legs</td>
<td>Single joint</td>
<td>Knee extension</td>
<td>Leg extension</td>
</tr>
<tr>
<td>5. Shoulders and upper arms</td>
<td>Multijoint</td>
<td>Shoulder abduction and elbow flexion</td>
<td>Upright row</td>
</tr>
<tr>
<td>6. Lower back</td>
<td>Multijoint</td>
<td>Trunk extension and hip extension</td>
<td>Back extension</td>
</tr>
<tr>
<td>7. Upper arms</td>
<td>Single joint</td>
<td>Elbow extension</td>
<td>Triceps push-down</td>
</tr>
<tr>
<td>8. Leg</td>
<td>Single joint</td>
<td>Knee flexion</td>
<td>Leg curl</td>
</tr>
<tr>
<td>9. Upper arms</td>
<td>Single joint</td>
<td>Elbow flexion</td>
<td>Arm curl</td>
</tr>
<tr>
<td>10. Calves</td>
<td>Single joint</td>
<td>Ankle plantar flexion</td>
<td>Toe raise</td>
</tr>
<tr>
<td>11. Forearms</td>
<td>Single joint</td>
<td>Wrist flexion and extension</td>
<td>Wrist curl</td>
</tr>
<tr>
<td>12. Abdomen</td>
<td>Single joint</td>
<td>Trunk flexion</td>
<td>Curl-up</td>
</tr>
</tbody>
</table>

*Multijoint exercises involving larger muscle groups are followed by single-joint exercises for smaller muscle groups.*
Order of Exercises

- For novice weightlifters:
  - Arrange the exercises so that successive exercises do not involve the same muscle group
  - Allow time for the muscle to rest and recover

- For advanced weightlifters:
  - Compound sets/tri-sets
    - Completely fatigue a targeted muscle group
    - Perform 2 or 3 exercises consecutively for the same muscle group
    - Little or no rest between the exercises
  - Supersets
    - Exercise agonistic and antagonistic muscle groups consecutively without resting
  - Perform single-joint exercises prior to performing multijoint exercises
Periodization

- Systematically varies the intensity and volume of resistance training

Two goals:
- (1) to maximize the gains in strength, endurance, power, and hypertrophy by systematically changing the training stimulus
- (2) to minimize overtraining and injury by planning rest and recovery

Training stimulus may be varied by:
- Training volume
- Training intensity
- Type of contraction (concentric, eccentric, isometric)
- Training frequency
Recommended amounts of rest between sets and exercises:
- Lower intensity requires shorter rests and vice versa
- For strength or power training:
  - Rests should last at least 3–5 min
  - Allow resynthesis of ATP and creatine phosphate (CP)
  - Prevent excessive accumulation of muscle and blood lactate
### Exercise Intensity and Recommended Rest Periods (Kraemer 2003)

<table>
<thead>
<tr>
<th>Intensity</th>
<th>Length of rest</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;13-RM ~ &lt;65% 1-RM</td>
<td>&lt;1 min</td>
</tr>
<tr>
<td>11-RM to 13-RM ~ 65 to 74% 1-RM</td>
<td>1-2 min</td>
</tr>
<tr>
<td>8-RM to 10-RM ~ 75 to 80 % 1-RM</td>
<td>2-3 min</td>
</tr>
<tr>
<td>5-RM to 7-RM ~ 76 to 87% 1-RM</td>
<td>3-5 min</td>
</tr>
<tr>
<td>&lt;5-RM ~ &gt;87% 1-RM</td>
<td>&gt;5 min</td>
</tr>
</tbody>
</table>
Periodization

- Three common periodization models:
  - Linear periodization (LP)
  - Reverse linear periodization (RLP)
  - Undulating periodization (UP)

- All periodized training programs are divided into periods or cycles
- Duration and training stimulus differ depending on the model used
Divided into 3 types of cycles:
- Macrocycle: 9–12 months
- Mesocycles: 3–4 months
- Microcycles: 1–4 weeks

Within and between cycles, training intensity increases as training volume decreases

Example: a 3 months (12 wks) mesocycle can be divided into three 4 wk microcycles:
- Wk 1–4, 3 sets of 12 repetitions at 70% 1–RM
- Wk 5–8, 3 sets of 10 repetitions at 75% 1–RM
- Wk 9–12, 3 sets of 8 repetitions at 80% 1–RM
Reverse Linear Periodization Model

- Reverses the progression of the LP model
- Between and within cycles, training intensity decreases as training volume increases
- Example: a 3 months (12 wks) mesocycle can be divided into three 4 wk microcycles:
  - Wk 1–4, 3 sets of 8 repetitions at 80% 1–RM
  - Wk 5–8, 3 sets of 10 repetitions at 75% 1–RM
  - Wk 9–12, 3 sets of 12 repetitions at 70% 1–RM
The microcycles for UP are shorter (biweekly, weekly, or even daily)

Training stimulus (intensity and volume) is frequently changed

Example: a 3 days/wk UP program
- Day 1: 3 sets of 8–RM
- Day 2: 3 sets of 6–RM
- Day 3: 3 sets of 4–RM
- In subsequent microcycles (each week), repeat the same training stimulus or change the order (day 1 = 4–RM, day 2 = 6–RM, day 3 = 8–RM)
Advantages of UP program:
- Provide different training stimulus to the exercising muscles on a daily or weekly basis
- May avoid plateaus in training
- Maintain the client’s interest and motivation for long-term resistance training
Summary

- Muscular fitness includes muscular strength and endurance
- Different effects of resistance training
- Four types of resistance training
- Dynamic resistance training is suitable and commonly used for developing muscular fitness in general population
Next Week

Exercise Prescription for Muscular Fitness (II)