Chapter 29: Musculoskeletal Exercise Prescription

Progressive overload

Progressive overload is a universal training principle stipulating that one needs to continually increase the exercise demands to see progression in a performance variable, as defined within the construct of the variable being trained (i.e., strength, power, or local muscular endurance).

As a muscle becomes capable of producing greater force or greater power or has more local muscular endurance, the stress needs to be increased to maintain an overload and have further gains.

Methods to increase overload:
- Increase resistance
- Increase volume (sets and repetitions) and/or decrease the rest time between sets

Specificity of training

As for cardiorespiratory training, resistance training should be performed according to the desired goals with respect to enhancing strength or power and be specific to the muscle groups that are to be affected.

Utilize the **SAID principle**: Specific Adaptations to Imposed Demands

Periodization of training

- Allows for variation in training stimulus to avoid overtraining
- Utilizes micro (short) or macro (long) cycles that are planned
- Can use linear (alterations each week) or nonlinear (alterations within a week) periodization processes
Needs Analysis

• First must assess the training needs with respect to:
  – Intended timeframe for achieving goals
  – Targeted areas or muscle groups
  – Health issues (e.g., hypertension, asthma, diabetes)
  – Musculoskeletal limitations
  – Recent surgeries
  – Chronic injuries and sites of pain
• Need to perform baseline assessments and follow-up assessments and need to determine which assessments should be performed
• Metabolic demands
  – Can have different metabolic response, ranging from short rest period workouts that are physiologically very demanding to heavy resistance workouts with long rest periods that focus on maximal force development
  – These should match individual goals
• Biomechanical actions
  – After analysis of patient or client ADLs or activities, the resistance training program should be designed to maximize these movements with respect to the desired training effect
• Injury potential
  – Plans should be in place to minimize risk of injury, particularly if an injury already exists or has occurred previously
• Should attempt to avoid these potential problems:
  – *All programs look the same and thus do not meet the specific needs of an individual*
  – *An individual does not progress and training plateaus occur*

• Choice of exercises
  – *Should relate to biomechanical goals*
  – *Primary exercises train the prime movers in a particular movement and are typically major muscle group exercises (e.g., leg press, bench press, hang pulls).*
  – *Assistance exercises train predominantly a single muscle group (e.g., triceps press, bicep curls) that aid (synergists) in the movement produced by the prime movers.*
  – *Multijoint exercises require the coordinated action of several muscle groups and joints*
    • Power cleans, hang power cleans, power snatches, dead lifts, bench presses, lateral pull-downs, military presses, and squats
    – *Single-joint exercises involve single joints and/or single muscle groups*
      • Bicep curls, knee extensions, and knee curls

• **Order of exercises**
  - The training sequence is important to allow focus on the desired results.
  - When training all major muscle groups in a workout:
    • Perform large muscle group exercises before small muscle group exercises
    • Perform multijoint exercises before single-joint exercises
    • Rotate upper and lower body exercises
  - When training individual muscle groups:
    • Perform multijoint exercises before single-joint exercises
    • Perform higher intensity exercises (i.e., those that require a greater percentage of one’s 1-RM) before lower intensity exercises
    • An alternative technique sometimes used by bodybuilders is to perform single-joint exercises (i.e., triceps) before multijoint exercises (i.e., bench press) to prefatigue the assistance muscles, thus increasing the overload on the primary muscles.
  - Split routines: a portion of the body is trained 2 or 3 nonconsecutive days per week and a separate portion is trained on alternate days
    • Allows the lifter to perform a greater total volume of training without becoming overly fatigued in a given lifting session
    • Similar guidelines as for training the entire body in one workout
• Number of sets
  – One set is a good starting point for beginners
  – Sets are a factor of *volume* of exercise (i.e., sets = reps × resistance)
  – Multiple-set programs have been found to be superior for strength, power, hypertrophy, and high-intensity endurance improvements, although gains can be achieved in single-set programs.
• Intensity of exercise
  – Repetition maximum is often used to guide intensity
    • Can be either a % of the 1-RM or a specific RM (e.g., 10-RM)
  – For general conditioning, lifting to the point of muscular fatigue (not complete failure) in 8 to 12 repetitions is recommended (corresponding to approximately 60%–80% of the 1-RM)
• Rest between sets and exercises
  – Rest periods of 3 to 5 minutes are recommended for large muscle mass multijoint exercises (such as squat, power clean, or dead lift), whereas shorter rest periods of 1 to 2 minutes may be sufficient for smaller muscle mass exercises or single-joint movements.
  – For a novice to intermediate resistance exercise protocol, rest periods of 2 to 3 minutes may suffice for large muscle mass multijoint exercises.
### Table 1. Recommendations for acute programme variables\[4, 12, 20, 21, 22\]

<table>
<thead>
<tr>
<th>Specific outcome</th>
<th>Muscle action</th>
<th>Loading (RM) and volume</th>
<th>Exercise selection and order</th>
<th>Rest periods</th>
<th>Repetition velocity</th>
<th>Frequency (d/wk)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Muscular endurance</td>
<td>ECC : CON</td>
<td>&gt;20 high</td>
<td>SJ/MJ mixed</td>
<td>30–60 sec</td>
<td>1 : 0 : 1</td>
<td>1–2</td>
</tr>
<tr>
<td>Power</td>
<td>ECC : CON</td>
<td>1–3 low</td>
<td>MU lge → sml</td>
<td>5–8 min</td>
<td>Explosive</td>
<td>4–6</td>
</tr>
</tbody>
</table>

**CON** = concentric; **ECC** = eccentric; **high** = 4–6 sets per exercise; **ISO** = isometric; **lge** = large muscle mass; **low** = 2–4 sets per exercise; **MU** = multi-joint; **mod** = 3–5 sets per exercise; **RM** = repetition maximum; **SJ** = single-joint; **sml** = small muscle mass.

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• Periodization of training
  - Classic periodization
    • Use a progressive increase in the intensity with only small variations in each 2- to 4-week microcycle.
    • The group of four microcycles is termed a mesocycle.
    • A long-term training program consisting of several mesocycles is termed a macrocycle (e.g., a 1-year training plan)
  - Nonlinear periodization
    • Variation in the intensity and volume within each microcycle (typically 7–10 days) over the course of the training program (e.g., a 16-week mesocycle)
<table>
<thead>
<tr>
<th>Microcycle 1</th>
<th>Microcycle 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>3–5 sets of 12–15RM</td>
<td>4–5 sets of 8–10RM</td>
</tr>
<tr>
<td><strong>Microcycle 3</strong></td>
<td><strong>Microcycle 4</strong></td>
</tr>
<tr>
<td>3–4 sets of 4–6RM</td>
<td>3–5 sets of 1–3RM</td>
</tr>
</tbody>
</table>

Each microcycle lasts 4 weeks in this example. The group of four microcycles is a mesocycle. The next mesocycle would repeat the pattern with higher absolute resistance.
• Breathing
  – Goal is to avoid large increases in intrathoracic pressure and the Valsalva maneuver.
  – Therefore, the lifter should inhale just before and during the eccentric (lowering) phase of the repetition and exhale during the concentric (lifting) phase.

• Full range of movement
  – Consider equipment that is adjustable to allow for movement through a full range.

• Movement speed
  – Maximal speed is used to move the weight explosively for power training.
  – Slower speeds provide greater control over the weight.
  – Speed slows as fatigue increases.

• Warm-up
  – Ideally perform 5 to 10 minutes of cardiorespiratory exercise followed by several minutes of dynamic stretching.
  – Goal is to increase blood flow to the exercising muscles.
• Machine and free weight exercises
  – Consider the pros and cons of each.

• Spotting requirements
  – Responsibility is to keep the lifter safe by helping to prevent injury.

• Supplemental equipment
  – Weight-training belts
    • Designed to support the lower back
  – Weight-training gloves and shoes
    • Used to enhance grip and reduce the risk of slipping
    • Also used to protect the palm from injury from the weight bar

<table>
<thead>
<tr>
<th>MODALITY</th>
<th>DEFINITION</th>
<th>EXAMPLES</th>
<th>ADVANTAGES</th>
<th>DISADVANTAGES</th>
</tr>
</thead>
</table>
| Variable resistance devices   | Absolute resistance changes during the range of motion | - Machines with a cam or roll bar  
- Elastic bands                | Increase the absolute resistance at the point in the range of motion where the musculoskeletal system is at a biomechanical advantage | At the beginning of a muscle flexion, the resistance is low and not offering a maximal tissue stimulus |
| Constant resistance devices   | Absolute resistance remains constant throughout the range of motion | - Dumbbells  
- Barbells  
- Machines with a fixed pivot point or that use cables and pulleys  
- Medicine balls | Low or no limitation in the range of motion allowed  
Exercise can easily be adapted to accommodate for the size of an individual | Does not stimulate the neuromuscular systems involved maximally throughout the entire range of motion |
| Static resistance devices     | Involve isometric muscle action                      | - Pushing against an immovable object, such as a wall  
- Hydraulic machines  
- Isokinetic devices | May be used for an athlete to overcome a sticking point  
No real advantage over variable or constant resistive devices outside of a rehabilitation setting | Not practical for most sports or for everyday functioning  
Hydraulic machines typically have no eccentric movement  
- Impractical  
- Expensive |
| Accommodating resistance devices | Maximum resistance throughout the whole range of motion is maintained by controlling the speed of the movement | | | |
Types of flexibility

- Static stretching
  - Most popular form of stretching
  - Voluntary passive relaxation of the muscle while it is elongated
  - Stretch position is held for 15 to 60 seconds
  - Must not hold your breath
- Dynamic or ballistic stretching
  - Swinging, bouncing, or bobbing movement during the stretch as the final position in the movement is not held.
- Slow movements
  - Examples such as arm rotations are considered an active stretching method.
- Proprioceptive neuromuscular facilitation techniques: require a partner to assist with stretching process to provide maximal results
  - Hold-relax (or contract-relax)
    - Contraction occurs in the muscle being stretched before the stretch and is followed immediately by the stretch
  - Agonist contract-relax
    - Same as for the hold-relax, except that during the stretch the agonist muscle is contracted