Measurement of Muscle Strength

- Cable tensiometry
- Dynamometry
  - One-repetition maximum (1-RM)
- Computer-assisted, electromechanical, and isokinetic methods
  - Isokinetic dynamometer
- Resistance-training equipment categories

Strength-testing considerations
- Standardize pre-testing instructions
- Uniformity of warm-up
- Adequate practice
- Standardize testing protocol
  - Body position
  - Joint angles
  - Reps
  - Scoring criteria

Learning Affects Strength Measurements

Gender Differences

- Strength related to muscle cross-sectional area
  - Specific tension is similar in males and females

- Absolute vs. Relative muscle strength
  - Males score
    - 30% higher on lower body lifts-Absolute
    - 50% higher on upper body lifts-Absolute

Training to Become Stronger

- Muscles need to be overloaded
- Overload may be obtained in many ways:
  - Progressive resistance training
  - Isokinetic training
  - Isometric training

Types of Muscle Contractions

- Difference muscle action forms
  - Concentric action
    - Muscle shortens
  - Eccentric action
• Muscle lengthens
  – Isometric action
  • No net change in muscle length

Types of Muscle Contractions
Resistance Training for Children
• Closely supervised
• Only concentric contractions emphasized
• High Reps, Low resistance
• Increase weight gradually (small increments)
• Focus on technique
• Emphasize spotting & safety
• Avoid maximal lifts

Resistance Training
• Progressive resistance exercise recommendations:
  – Use 3-RM to 12 – RM
  – Use 1-RM one time per week, weeks 2 – 6
  – One set is effective if 10-RM is used
    • Produce most of the health benefits
    • Increase compliance
    • 2 – 3 days/week is most effective
• Progressive resistance exercise
  • Variations on PRE-isotonic (free weight/mach.)
• Periodization
  – Preparation phase
  – First transition phase
  – Competition phase
  – Second transition phase (active recovery)

Practical Recommendations for Initiating a Weight-training Program

• Avoid max lifts initially
• Use 12-RM to 15-RM initially
• Increase weight after 2 weeks
  – Use 6 – 8 RM
  – Progress gradually
• Work larger muscle groups first

Resistance Training
• Guidelines for sedentary adults, the elderly, and cardiac patients:
  – Focuses on benefits in health and disease
  – Single sets
  – 8 to 15-RM
  – At least 2 days per week
Combining Strength & Endurance Training

- Resistance training plus aerobic training equals less *strength improvement*
- Incorporate a break between workouts
- *Health benefits* of both types of training may be obtained by training for both strength & endurance

Isometric Strength Training

- Isometric exercise limitations
  - Strengthens muscle at a specific point in ROM
  - Time consuming
- Isometric exercise benefits
  - Useful for testing
  - Helpful in rehabilitation

Isokinetic Resistance Training

Accommodating-resistance exercise

- Isokinetics versus standard weight lifting
  - Provides variable resistance throughout ROM
  - Avoids limitations of sticking - point
  - Fast versus slow-speed isokinetic training
    - Faster speeds result in increased size of Type IIb fibers
    - More increases in power seen in fast & slow movements when fast training is used

Plyometric training

- Uses explosive jumps to mobilize the stretch-recoil properties of muscle
  - Stretch-shortening cycle
- Ballistic resistance training
  - Allows athlete to develop greater power at the end of the movement
  - Simulates sports performance more closely then regular lifting

Structural and Functional Adaptations to Resistance Training

Factors Modifying Strength

- Psychologic-neural factors include:
  - More efficient neural recruitment patterns
  - Increased CNS activation
  - Improved motor unit coordination
  - Lowered neural inhibitory reflexes
  - Inhibition of GTO

- Psychologic-neural factors account for most initial strength gains
Factors Modifying Strength
• Muscular changes include increases in
  – Muscle fiber size = hypertrophy
  – Enzymes Phosphofructokinase, Creatine Phosphokinase & Myokinase
  – Resting levels of ATP & PCr
  – Strength of tendons & ligaments
  – Bone mineral content
• Muscular changes include decreases in
  – Body fat
  – Mitochondria volume & density

Muscle Cell Remodeling
• Muscle hyperplasia: Are new muscle fibers made?
  • Longitudinal splitting & lateral budding
  – Training induces changes in muscle fiber-type composition

Comparative Training Responses in Men and Women
• Muscular hypertrophy occurs to a much greater extent in men
  – Represents the largest gender difference in response to resistance training
  – Both genders experience similar percentage strength improvements

The Elderly Respond
• Both men & women respond to strength training regardless of age

• Resistance training may be used to reduce the sarcopenia often experienced by sedentary adults

Detraining
Gains in strength may be seen after 1 to 2 weeks of training

Training as few as 1 to 2 times per week may be adequate to maintain strength training gains

Stop training for 2 weeks and you will see a decrease in endurance (not so much strength)

Muscle Soreness and Stiffness
• Delayed-onset muscle soreness (DOMS)
• Eccentric actions produce muscle soreness
• Cell damage
  – Altered sarcoplasmic reticulum
  – Current DOMS model