Muscular Strength and Endurance Testing

Definitions
- Strength – maximal force that can be generated by a muscle or muscle group
- Endurance – ability of a muscle group to execute repeated contractions over a period of time adequate to cause muscular fatigue or to maintain a specific percentage of MVC (maximal voluntary contraction) for a prolonged period of time

Types of Muscle Contractions
- Isometric or static – generate tension with no change in muscle length
- Isotonic – generate constant tension throughout the ROM
  - Concentric
    - Against gravity or resistance
    - Muscle fiber shortening
  - Eccentric
    - Control phase (with gravity)
    - Muscle fiber lengthening

Types of Muscle Contractions
- Isokinetic – rate of shortening or lengthening is constant (same motion)

Equipment Terminology
- Dynamic constant resistance – resistance is constant throughout ROM
  - Cables
  - Pulleys
  - Free weights
- Dynamic variable resistance – resistance varies throughout the ROM
  - Ideally to match strength curve of muscle
  - Cams - Nautilus and Cybex
Types of Tests to Assess Muscular Strength

- Static – assess strength as a specific joint angle
  - Cable Tensiometer
    - Cable anchored at right angles to bony lever
    - Tensiometer measures tension on cable
  - Dynamometer
    - As force applied, spring is compressed, moving needle
      - Grip strength
      - Back
      - Legs

Types of Tests to Assess Muscular Strength

- Dynamic
  - 1 RM Bench Press
  - 1 RM Leg Press
  - See protocol in lab manual for procedures
  - Corrected for strength to body weight ratio or FFM
  - Estimation of 1RM using Tables or Prediction Equations - novices or borderline hypertensives

Based on Estimated 1 RM

- Prediction Equations – most accurate when loads are heavier – use ≤ 10 RM (≥ 75% 1RM)
- Record load for a 10 RM or less and use Table 18.8 on page 410 – 411 to estimate 1 RM
  - Example: Client lifts 8 repetitions to fatigue of 72 pounds
  - Table 18.8 – go across top to reps performed (8 RM)
  - Go down column to weight lifted (72 pounds)
  - Move to left on that row to load listed under 1 RM (left across the row to 90 pounds)
  - Estimated 1 RM = 90 pounds

Weaknesses of % 1 RM Tables

- Assume a linear relationship – may be curvilinear
- Resistance-trained athletes may be able to exceed number of reps in Table (lower body)
- Bench press, squat or power clean – specificity
- Machines (more reps) vs free weights
- Smaller vs large muscles – may get less reps with smaller muscles and more than predicted with larger muscles
- Best validity - fewer reps
Muscular Endurance

- Types of Tests
  - Relative – uses a proportionate amount of a load – body wt or 50% of 1 RM
  - Absolute – set load for all subjects – YMCA bench press (35# and 80#)

Factors Affecting Flexibility

- Gender
  - Females > males
- Age
  - Loss of soft tissue elasticity
  - Decrease in physical activity
- Physical Activity
  - Lack of activity or chronic participation
  - Habitual postures

Types of Flexibility Measurements

- Active – measurement is performed at active end ROM
  - Client moves joint
- Passive – measurement is performed at passive end ROM
  - Technician moves limb to end ROM
  - No muscle force required for movement
  - Passive > Active
  - Goal is = ROM

Assessing Flexibility

- Direct Methods
  - Goniometer – measures joint angle
    - Center aligned with axis of rotation
    - Arms aligned with longitudinal axis of moving segment
  - Leighton Flexometer
    - Weighted 360º dial
    - ROM measured relative to downward pull on dial

Muscular Endurance

- Types of Tests
  - Dynamic – identical repetitions of a movement over time – sit-ups, push-ups (although the test may ask subject to perform as many repetitions as possible in 1 minute, it is considered a dynamic muscular endurance test instead of timed)
  - Static repetitive – number of times a force equal to a % of 1 RM can be repeated with a dynamometer – squeeze dynamometer generating a force of 50% 1 RM repetitively until subject can no longer generate the required force
  - Static Timed – amount of time a muscle contraction is maintained – 90-90 sit, flex arm hang

Factors Affecting Flexibility

- Temperature
  - Warming joint to 113º F produces a 20% increase in ROM
  - Cooling joint to 65 º F decreased ROM by 10-20%
Indirect Methods

- Sit-and-reach
  - Influenced by length of body segments
  - Short legs relative to trunk – advantage

- Modified sit-and-reach
  - Account for limb length discrepancies
  - Corrects for distance from fingertips to box

Plumb Line Test for Posture

- Are the points of reference in alignment?
- Subject steps so that plumb line is just in front of lateral malleolus

Right vs Left Handed Postural Patterns

- Ear Lobe
- Cervical Vertebrae
- Shoulder Joint
- Lumbar Vertebrae
- Greater Trochanter
  - Slightly posterior to axis of hip joint
- Knee Joint
  - Slightly anterior to axis of knee joint
  - Slightly anterior to lateral malleolus

Jackson and Baker (1986)
- Reported to measure lower back and hamstring flexibility
- Moderate (0.64) correlation with hamstring
- Poor (0.16) with low back flexibility for 13-15 yr old girls

Jackson and Langford (1989)
- High correlations (0.89) with hamstring in men
- Moderate correlation with low back (0.59) in men
- Moderate correlation with hamstring (0.70) in women
- Poor correlation with low back (0.12) in women
Low Back Problems
- 80% of low-back problems are due to improper alignment of spine and pelvis
- Maintaining alignment
  - Check for pelvic tilt
    - ASIS > PSIS - posterior pelvic tilt (flat back)
      - Tight hamstrings
      - Tight abdominals
      - Weak erector spinae
    - PSIS > ASIS - anterior pelvic tilt (lumbar lordosis)
      - Tight iliopsoas and rectus femoris
      - Weak abdominals
      - Tight erector spinae

Low Back
- 10-12 Cartilaginous rings
- No blood supply
- Nutrients through absorption
- Posterior wall is weak
- Least stress - normal spinal curve
- Flexion + Rotation most stress

Issues
- What does S&R tell us? Not much
- Is it safe? Not in all persons
- Are there better tests? Definitely

Low Back
- Rings gradually damaged with poor body mechanics and posture
- Goal – perfect posture
  - Strengthening
  - Stretching