Exercise to increase strength

Course objectives, Control of Human Movement 2

Reading for Control of Human Movement 2:

sections on "exercise prescription for muscular strength" from:

American College of Sports Medicine. (1998). American College of Sports Medicine Position Stand. The recommended quantity and quality of exercise for developing and maintaining cardiorespiratory and muscular fitness, and flexibility in healthy adults. *Medicine & Science in Sports & Exercise, 30,* 975-91.

Full text versions of this article are available through the University's Medline account on OVID (unique identifier 98287757) or by accessing the list of position stands listed at the ACSM web site.

Prescription parameters (American College of Sports Medicine, 1998).

1. **Frequency of training: 2 to 3 days a week.**

2. **Intensity of training:**
   Therapists use the concept of a "repetition maximum" (RM) to prescribe the weight or load that one lifts.
   "... most experts recommend 8-12 repetitions per set; however, a lower repetition range, with a heavier weight, e.g., 6-8, repetitions may better optimize strength and power. Because orthopaedic injury may occur in ... participants [who are] approximately 50-60 yr of age and above ... when performing efforts to volitional fatigue using a high-intensity, low-to-moderate repetition maximum (RM), the completion of 10-15 repetitions or RM is recommended" (ACSM, 1998).

   The ACSM's prescription guidelines differ from older Delorme and Oxford strengthening protocols.

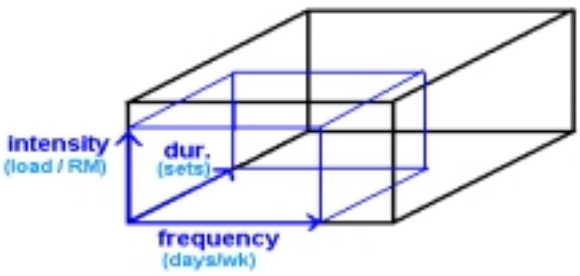
3. **Duration of training:**
   "One set of 8-10 exercises that conditions the major muscle groups is recommended. Multiple-set regimens may provide greater benefits if time allows."

4. **Mode of training**
   The ACSM recommends no specific mode of exercise. Resistance to produce training stimulus can come from the weight of the body or any of its segments, from free weights, elastic tubing, equipment.

The prescription parameters contribute to a total stimulus called training volume

Overload:

We strengthen muscles by producing overload, that is, exposing muscles to activity in which the combination of intensity, frequency, and duration exceeds that which they normally encounter. Overload induces muscles to adapt, to increase their ability to generate force.



progressive overload

> **Once muscles have adapted to overload, the overload stimulus must be increased to produce further training effects**

Exercise prescriptions produce changes that are specific to:

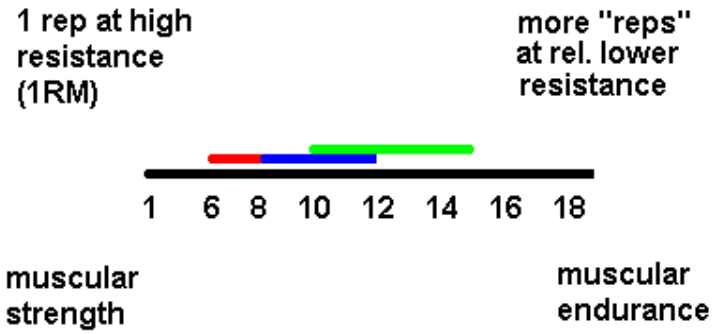
1. **muscle group (Sale, 1988)**
2. **joint angle or range of motion (Graves, Pollock, Jones, Colvin, & Leggett, 1989)**
3. **type of muscle action**
4. **speed of muscle action**
5. **muscle fiber type**
6. **metabolic energy system**

Modes of Exercise

- **Isotonic: alternating concentric and eccentric muscle activation that moves a body part through an arc of motion against resistance**
- **Isokinetic: exercise that involves specialized equipment that provides "accomodating resistance" so that the joint moves at a constant angular velocity**
- **Isometric: muscle action that is performed against resistance at any point in a joint's range of motion, for periods of 5-10 seconds, and that produces no joint movement**
- **Plyometric: exercise that requires eccentric activation of muscles against a resistance, followed by a brief amortization period, followed by concentric activation**

Measuring exercise intensity

Repetition maximum (RM): "maximal number of times a load can be lifted before fatigue using good form and technique (ACSM, 1998)." A "1RM" signifies the maximum resistance a person can move in one repetition of an exercise.



The ACSM recommends exercising at an intensity of 8 to 12 RM. Two classic strengthening protocols (Arnheim & Prentice, 1993) require a person to determine the 10RM for a given exercise, and then to perform several sets of the exercise:

- **Delorme Method of Strengthening:**
  1. **10 reps @ 50% of 10RM**
  2. **10 reps @ 75% of 10RM**

3. **10 reps @ 100% of 10RM**

- **Oxford Technique of Strengthening:**
  1. **10 reps @ 100% of 10RM**
  2. **10 reps @ 75% of 10RM**
  3. **10 reps @ 50% of 10RM**

Estimating 1RM from a "n-RM"

To estimate a person's 1RM after you've determined a "n RM" (where n=10, for example), you can use a regression equation attributed to Brzycki (1993).

1 RM = weight lifted during n RM / (1.0278 - .0278(n))

Alternatively,

1 RM = weight lifted during n RM * (1 + (0.033(n))

The formula permits one to "assess muscular strength in a safe, efficient manner ... [without requiring] clients to attempt maximum lifts " (Brzycki, 2000). Brzycki's equation predicts the 1 RM in a bench press more accurately than competing formulas, as long as its estimate is based on ten or fewer repetitions (Mayhew, Prinster, Ware, Zimmer, Arabas, & Bemben, 1995).

Brzycki's equation also estimates loads for a "nRM" as a percentage of the 1RM:

The estimated load for a	10 RM	8 RM	6 RM	5 RM	4RM
is _____ percent of a 1 RM	75	80.5	86	89	91.7

An online calculator programmed for Brzycki's equation

Responses to strength training

Functional changes	Structural changes
• more motor units recruited during a task • more synchronized recruitment of motor units • less activation of antagonist muscles	• increased activity in muscle's metabolic enzymes • increased size and activity in mitochondria • hypertrophy of muscle fibers due to myofibril synthesis • splitting of fibers, but no true hyperplasia

Strength gains that occur in the first two to three weeks of an exercise program are due to functional changes. Structural changes take longer.

Muscle strength and flexibility:

Stretch-shorten cycle (SSC): activities in which eccentric muscle action precedes and amplifies force production during concentric muscle activity. During the walking cycle, the stretch shorten cycle occurs in the ankle plantar flexors, the knee extensors, and the hip flexors.

More flexible muscles may develop greater force during the SSC because:

- **flexibility permits potentiation of the muscle's stretch reflex**
- **flexibility permits greater energy storage (Wilson, Elliott, & Wood, 1992; Benn, Forman, Mathewson, Tapply, Tiskus, Whang, & Blanpied, 1998)**

Compliant muscles, muscles that are relatively less stiff and more flexible "enhance the use of elastic strain energy in SSC [stretch shorten cycle] movements, for at a given value of applied force, a more compliant elastic system will extend to a greater distance, consequently storing more strain energy as compared with the stiffer ... system" (Wilson, Elliott, & Wood, 1992, p. 116).

Stored strain energy is estimated by the area under the length-tension curve. In the figure, a given force (F_1) elongates the more flexible muscle so that its stored strain energy (area OCD) exceeds that of the stiffer muscle (area OAB). The stored energy adds to the force that the muscle produces during the concentric phase of the stretch shorten cycle.

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American College of Sports Medicine. (1998). American College of Sports Medicine position stand. The recommended quantity and quality of exercise for developing and maintaining cardiorespiratory and muscular fitness, and flexibility in healthy adults. Medicine and Science in Sports and Exercise, 30, 975-91. (full text version is available on Medline; Unique Identifier 98287757)

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