

7

Strength Training

In this chapter you will learn about:

- ◆ Muscle strength.
- ◆ Muscle endurance.
- ◆ Strength training guidelines.
- ◆ Designing a strength training program.
- ◆ Proper training techniques.

Muscle strength and endurance training are essential components of overall fitness. Your ability to perform daily tasks and strenuous physical tasks can be enhanced by strength training. As you read through this chapter think about the physical tasks you perform routinely in your job or at home, the strength needed to perform those tasks, and which exercises mimic those tasks. The focus of your strength training routine should be functional or applied strength for job-specific activities, military readiness, and injury prevention. This chapter outlines the principles of muscle strength and muscle endurance training and the proper use of exercise equipment to help you achieve your goals.

Strength versus Endurance



- ◆ Muscle strength is the force your muscle or group of muscles can exert against resistance. As you lift and lower a weight your muscle must generate enough force to move that weight.
- ◆ Muscle endurance is the ability of your muscles to repeatedly apply force to lift and lower a weight. Muscle endurance describes how long or how many times (number of repetitions) you can lift and lower a given weight.

Benefits of Strength Training

Strength training should complement aerobic training workouts because each type of training results in different benefits. General benefits of strength training include:

- ◆ Increased muscle strength and muscle endurance, greater lean body mass, less body fat, and higher energy metabolism.
- ◆ Increased connective tissue (ligaments that hold bones to bones; and tendons that hold muscles to bones) strength.
- ◆ Increased coordination and greater protection against injury.
- ◆ Increased self-esteem and less perceived stress.
- ◆ With respect to military readiness, greater muscle strength and endurance translates into better performance of physically-demanding, job-related tasks. [Table 7-1](#) lists the strength requirements needed to perform some physical tasks in the Navy.

Table 7-1. Strength Requirements in Navy Jobs

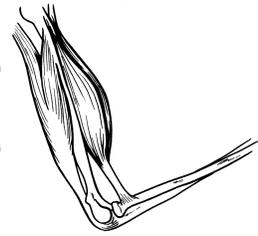
Strength Classification (Percent of Navy Jobs)	Strength and Endurance Requirements	Examples of Some Occupational Codes
High/High (23.9%)	Occasionally lift over 100 lbs (45 kg); Typically lift over 50 lbs (23 kg)	Artillery and Gunnery (GM); Aircraft Engines (AE) & Accessories (ABE); Construction (CM); Electricians (CE).
High/Moderate (20.9%)	Occasionally lift 100 lbs (45 kg); Typically lift 50 lbs (23 kg)	Machinists (MR); Food Service (MS); Supply Administration(SK); Teletype and Cryptographic Equipment (WT).
Moderate/Moderate (9.0%)	Occasionally lift 80 lbs (36 kg); Typically lift 40 lbs (18 kg)	Air Crew (PR); Missile Guidance and Control (FC); Medical Care and Treatment (HM); Interior Communications (IC).
Moderate/Low (4.5%)	Occasionally lift 50 lbs (23 kg); Typically lift 25 lbs (11 kg)	Musicians (MU); Supply Administration (AK).
Low/Low (41.7%)	Occasionally lift 20 lbs (9 kg); Typically lift 10 lbs (5 kg)	Radio/Radar (ET); Sonar (OTA); Air Traffic Control (AC); Analysts (CTI); Information/Education (JO); Administration(YN).

Adapted from Institute of Medicine. (1996) *Assessing Readiness in Military Women: The Relationship of Body Composition, Nutrition, and Health*. Washington, D.C.; National Academy Press.

Which classification in [Table 7-1](#) best matches the requirements of your job? Which classification best describes your leisure activities?

Muscle Fiber Types

Before discussing strength training exercises and guidelines, here is a quick review of muscle physiology. To generate force, muscles contract. This action requires ATP (see [Chapter 4, page 31](#)). Muscle fibers are classified according to which energy system they use to make ATP. The three types of skeletal muscle fibers are:



- ◆ **Slow Twitch Oxidative (Type I) fibers** are mostly involved in endurance activities. They rely on ATP from aerobic energy metabolism (see [page 31](#)) and are generally resistant to fatigue.
- ◆ **Fast Twitch Glycolytic (Type IIb) fibers** are involved in quick, strong muscle contractions and rely on the anaerobic energy systems to produce ATP. These fibers are susceptible to fatigue.
- ◆ **Fast Twitch Oxidative-Glycolytic (Type IIa) fibers** are a cross between the slow and fast twitch fibers since they rely on both aerobic and anaerobic systems (see [page 31](#)) for energy.

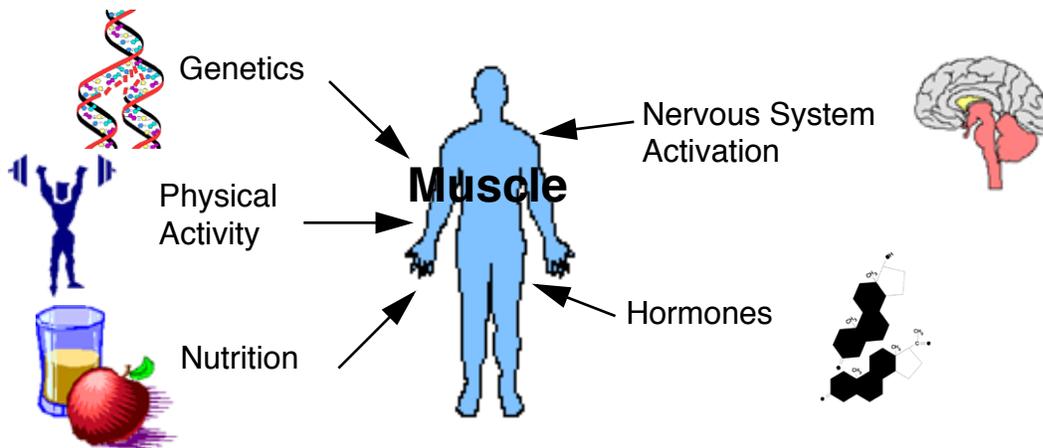
Everyone has all three muscle fiber types; however, genetics determine which fiber type is more abundant in each person. Physical training can lead to changes in the characteristics of the muscle fibers. For example, endurance training makes the Type IIa fiber act more like the slow-twitch, Type I fiber.

Determinants of Muscle Size

Apart from muscle fiber type, various factors influence muscle size (see [Figure 7-1](#)). Although some factors cannot be controlled, two factors that we can control are exercise and nutrition habits ([Chapters 3, 4, and 11](#)).



Figure 7-1. Factors that Affect Muscle Size



Adapted from WD McArdle, FI Katch, and VL Katch. *Exercise Physiology, 4th ed.* Baltimore; Williams & Wilkins, 1996.



Men generally have more muscle mass than women, mainly because men produce more testosterone than women. Strength training may increase muscle mass slightly in women; however, a common **misconception** is that strength training will cause women to “bulk up.” Importantly, strength training will greatly increase muscle strength and endurance and reduce the risks for injury. Moreover, women tend to have poor upper body strength and many military tasks require upper body strength.

Strength Training Guidelines

Training Form

Correct lifting techniques are critical for achieving maximum benefits and preventing injury (see [Appendix C](#)). If your form is incorrect, strength training can lead to injury, not strength gains.

- ◆ When learning a new exercise, start with minimal weight.
- ◆ Use a closed grip (fingers and thumbs wrap around the bar or handle and touch each other), and place hands equidistant from the ends of the bar. Load the weights evenly across the bar.
- ◆ For free weights, feet should be hip to shoulder width apart, knees slightly bent, and your back should keep its natural curve. Keep your head level and eyes focused straight ahead. If maintaining this posture is difficult than the weight is too heavy.

- ◆ If using resistance machines, adjust the pads to fit your body size. This is very important since the pads support you during the lift. Keep your head level and eyes focused straight ahead.
- ◆ **Lifts should be slow, smooth, and controlled.** Lift the weight for at least 2 seconds and lower the weight for at least 4 seconds to ensure that your muscle, not momentum, moves the weight.
- ◆ **Exhale** during the exertion (moving the weight against gravity), and **inhale** when returning to the start position. Holding your breath (Valsalva maneuver) causes extremely high increases in blood pressure and can damage the cardiovascular system. **Never hold your breath while exercising!**
- ◆ Always use a spotter when lifting free weights.

The most common training errors occur when people focus on lifting the weight rather than focusing on stabilizing themselves and controlling the weight. The best way to avoid training mistakes is to ask a staff member at the gym to teach you new exercises and to suggest the best exercises for you based on your fitness level and goals. See [Appendix C](#) for examples of common errors in training techniques.

FITT Principle Guidelines

Once you are comfortable with the basic training techniques for performing strength exercises, follow the FITT Principle, illustrated in the Physical Activity Pyramid ([Chapter 4, Figure 4-2](#)), to set up your routine. The FITT guidelines for strength training are:

- ◆ Frequency - 2 to 3 times per week for each major muscle group on non-consecutive days.
- ◆ Intensity - the total weight lifted or the resistance.
- ◆ Time - the duration of the exercise.
- ◆ Type - equipment used and the exercises performed.

Two terms you need to know are **repetition (rep)** and **set**. A repetition is a single lifting and lowering of the weight. For example, one rep of a leg curl is equivalent to lifting your ankle toward your buttocks, pausing one second, then returning your ankle to the start position. A set is the number of reps performed without stopping to rest. For example, if you perform 10 leg curls, rest for 60 seconds, followed by another 10 leg curls, you would have performed 2 sets, each of 10 leg curls. When recording the number of sets and reps performed, write “**sets x reps**” (e.g., 2x10 for the leg curl example above).

Intensity of Exercise

Focus on the intensity of your training only **after** you have perfected your lifting form. The basis of strength training is to gradually increase the amount of weight that you lift during training to ultimately increase the amount of force your muscles are capable of generating. This is called progressively overloading the muscle to achieve gains in strength without causing injury. The following intensity guidelines for general strength gains are for beginners, for people who are restarting their routines after a break, or for people learning new exercises.

- ◆ Once your form is perfected ([page 58](#)), gradually increase the weight you are lifting until you reach a weight that you can lift only 12 times with good form. If you can perform 13 or more reps with relative ease, increase the weight. Conversely, if you cannot perform 12 reps while maintaining proper form, decrease the weight. Finding this 12-rep weight will be trial and error at first. Be patient and gradually increase the weight to avoid straining or injuring yourself.
- ◆ Your 12-rep weight will increase as you gain strength, so increase the weight you are lifting appropriately (by no more than 10% per week).
- ◆ Start a training routine consisting of one to two sets of 12 reps for each major muscle group (defined in [“Type of Exercise” on page 61](#)). Perform this routine for at least eight weeks.

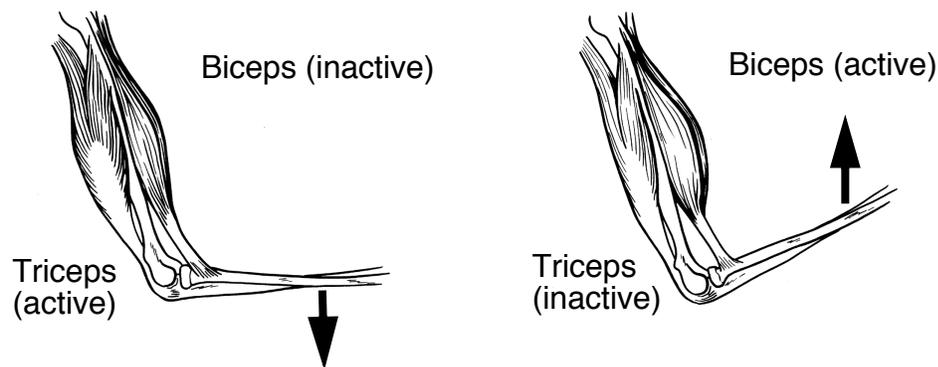
A long-term strength routine of one to two sets of 12 reps is excellent for maintaining and increasing general strength, even beyond the first eight weeks of training. In addition, this type of routine only takes roughly 30 minutes to perform. Once you have developed a solid strength and endurance base you may be interested in pursuing more specific training goals. In general, the following guidelines apply to the various types of strength training goals:

- ◆ Muscle endurance - two to three sets, 12-15 reps (with a weight that cannot be lifted more than 15 times); 30-60 seconds rest between sets.
- ◆ Muscle hypertrophy (increase in muscle mass) - three to six sets, eight to 12 reps (with a weight that cannot be lifted more than 12 times); 30-90 seconds rest between sets.
- ◆ Muscle strength - three to five sets, two to eight reps (with a weight that cannot be lifted more than eight times); at least 120 seconds rest between sets.

Note: Do not perform maximal lifts when strength training.

Type of Exercise

Muscle balance refers to the strength ratio of opposing muscle groups across a common joint; i.e., the biceps and triceps muscles in the upper arm. By performing exercises that target the opposing muscle groups across the joints, you improve the function of the joints and reduce your risks for injury. With this in mind, select at least one exercise for each of the major muscle groups. The **major muscle groups** are the chest, back, shoulders, arms, legs, lower back, and abdominals. (See [Worksheet B-2](#).)



From Harmon, E. The biomechanics of resistance exercise. In *Essentials of Strength Training and Conditioning*. Baechle, TR. (Ed.). Human Kinetics. Champaign, IL. 1994. p.20.

With respect to **exercise order**, perform multi-joint exercises (e.g., squats) before single-joint exercises (e.g., leg curl). To determine which exercises are multi- versus single joint exercises, watch and feel how many joints move while you perform the exercise. An example of a multi-joint exercise is the bench press because your upper and lower arms move at the shoulder and elbow joints, respectively. An example of a single-joint exercise is a biceps curl because only your lower arm moves at the elbow. Single-joint exercises target and fatigue the smaller muscle groups that are needed to perform multi-joint exercises. Therefore, fatiguing the smaller muscle groups by first performing single-joint exercises will alter your lifting form and decrease the amount of weight you can lift in the multi-joint exercises. Lastly, lower back and abdominal exercises should be performed at the end of your workout because these muscles are used during other exercises for balance and posture. [Figure 7-2](#) is a diagram of the muscle groups and the exercises that target them. Pick at least one exercise per major muscle group.

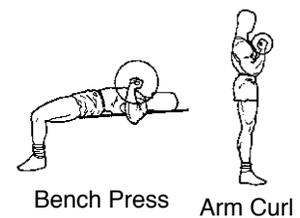
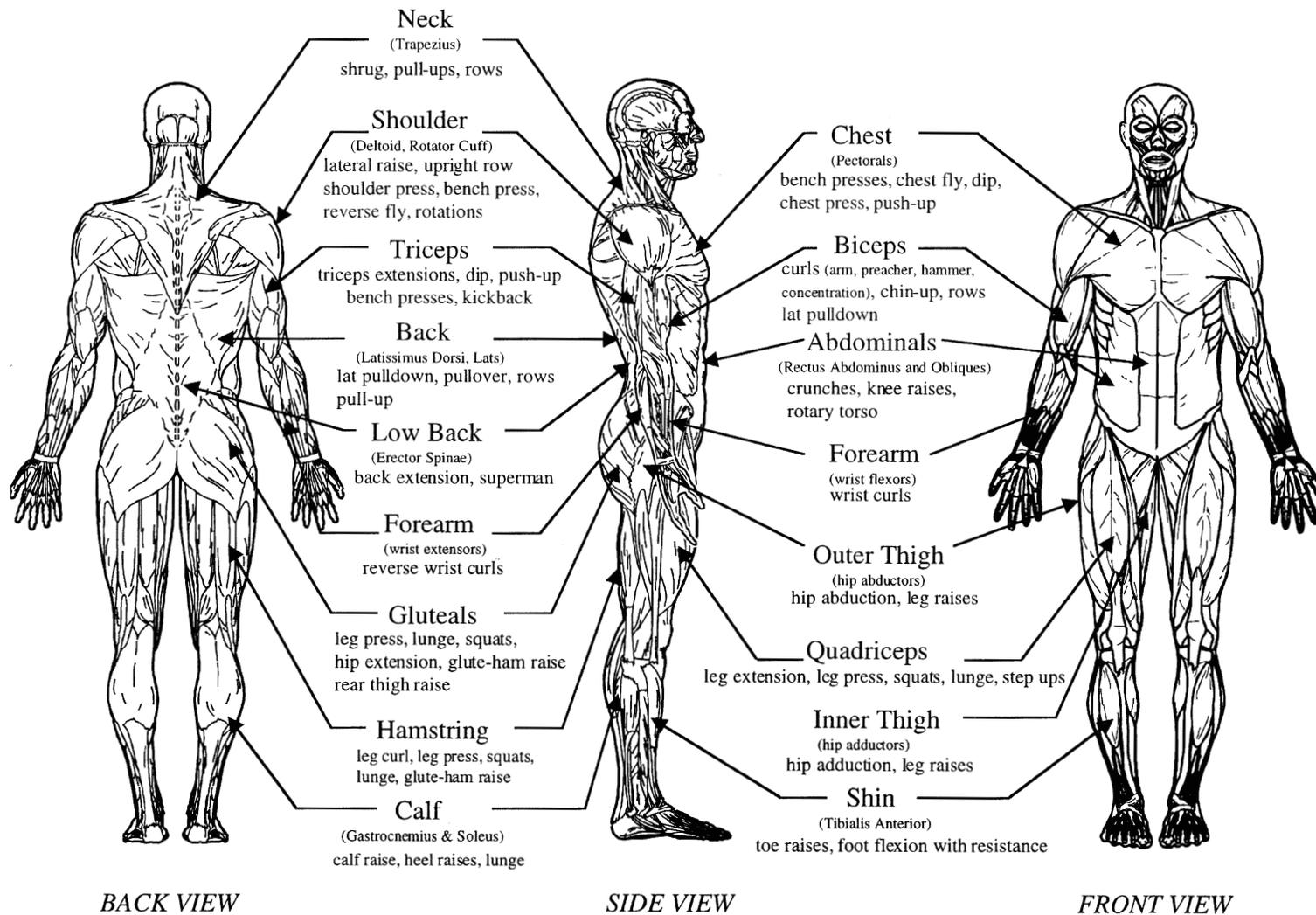


Figure 7-2. Exercises for Various Muscle Groups



Use [Worksheet B-2](#) as a template to design your workout and to record your training progress. Change the exercises you perform for each muscle group every four to eight weeks, even if you keep the same set and rep routine. Changing exercises will overload the muscles differently, increase your strength gains, and alleviate boredom. To increase their upper body strength, women should perform exercises that target the back, neck, chest, shoulders and arms ([Figure 7-2](#)).

Equipment

Strength training requires minimal personal gear: weights, a pair of supportive shoes, fitted lifting gloves, and standard PT attire. A weight lifting belt is only recommended during maximal or near maximal lifts, and is not recommended at all for exercises that do not stress the back. This is because the belt takes over the role of the abdominal muscles in stabilizing the torso, preventing the strengthening of the abdominal muscles which can increase the risk for injury when lifting a heavy object without the belt.

The most common barbells found in gyms are Olympic style barbells. These barbells have a narrow center bar for gripping and wider ends for loading weights. They are 5 to 7 ft. long and weigh 30 to 45 pounds (lbs) or 13 to 20 kilograms (kg). The plates used to load the bars are available in both lbs and kg, and range between 2.5 to 45 lbs or 1.25 to 20 kg. Make sure you pay attention to the weight measurements in your gym; there is a big difference between 10 lbs and 10 kg! Lastly, you are encouraged to use adjustable collars to keep the plates on the bar. Depending on the style of collar, the pair can add 1 to 5 lbs to your bar. There are several other styles of barbells which range in size and weight. Ask a staff member at your gym to help you determine which barbell would best suit your needs.

Choosing free weights, machines, or a combination of both depends largely on your goals and training experience. [Table 7-2](#) lists a comparison of free weights and machines to help you with your choice. If you are new to a fitness center or if you are unsure how to work a piece of equipment, ask a fitness center staffer for an orientation. This orientation will help you design a workout routine based on the equipment selection at your fitness center.

Table 7-2. Free Weights vs. Resistance Machines

Free Weights		Resistance Machines
Low cost and versatile.		Expensive, less versatile, need access to equipment.
Form is crucial; spotter is needed.		Supports the body during the exercise; easy to adjust.
Trains balance and posture; mimics daily activities.		Isolates muscle groups more easily than free weights.
Can perform multi-joint and single-joint exercises.		Machines made for multi-joint and single-joint exercises.
Muscles trained through joint's full range of motion.	Muscle training occurs in a limited range of motion.	

Though this chapter focuses on resistance machines and free weights, resistance for strength training can come from a variety of sources, including your own body weight. To learn about other exercise techniques and equipment available for strength training see [Chapters 8](#) and [10](#). These other options may be most beneficial when space and equipment are limited.

Types of Workouts

Following is a description of several strength training routines. Choose the routine that is best for you based on the time available, your goals, your training experience, and your fitness level.

- ◆ **Full body workouts** - All the major muscle groups (as listed in [Worksheet B-2](#)) are exercised during a single session. Perform one to two sets of an exercise for each muscle group and rest between sets. This should take 20-45 minutes. For general strength training purposes; should be done at least twice a week.
- ◆ **Circuit Training** - Combines aerobic and strength exercise stations. Each exercise station takes 30-45 seconds to perform and stations alternate between upper and lower body exercises. The circuit is repeated two or more times per session. It improves aerobic conditioning and moderately increases strength when performed three times per week. This routine is good for people who have less than 45 minutes to do both aerobic and strength exercises. (See [Table 10-2](#) for an example.)

The following routines are more advanced workouts. They should only be performed once you have developed a solid strength base using one of the above formats, and you have exercised regularly for at least eight weeks, and are comfortable with the correct lifting techniques.

- ◆ **Split-routine workouts** - Different muscle groups are targeted on alternate training days. Examples include: upper versus lower body, or push (e.g., chest press, leg extension) versus pull (e.g., seated row, leg curl) exercises. Allows for more intense training for each muscle group per training session; is time consuming.
- ◆ **Pyramid sets** - Successive sets of the same exercise are performed with progressively greater resistance while decreasing the number of reps. For example: perform 10 reps with a 10-rep weight in set 1; perform eight reps with an eight-rep weight in set 2; perform six reps with a six-rep weight in set 3. Rest between sets. You can mix up the number of sets and reps per set that are performed. Allows for a varied training intensity, but is more time consuming than performing one set per exercise per muscle group.
- ◆ **Super sets** - Performing two exercises for opposing muscle groups without a rest period between sets. Example: a set of a chest exercise immediately followed by a set of a back exercise, followed by a rest. This combination can be repeated one to two more times. Limit this type of workout to once a week; on the remaining workout days, rest between each set. May be useful for muscle hypertrophy.
- ◆ **Compound sets** - Performing two exercises for the same muscle group without a rest period between sets. Example: a set of one chest exercise immediately followed by a set of a different chest exercise, followed by a rest. Repeat this combination one to two more times. Limit this type of workout to once a week; on the remaining workout days, rest between each set. May be useful for muscle hypertrophy.

Use the guidelines provided to develop sound strength training programs and alternate exercises with in each muscle group every four to eight weeks to maximize strength gains, enhance job-related fitness, and have fun!