

# The basics

**E**xactly what is strength training? What is power training? How can a combination of these activities change your body for the better? You'll find answers to these questions here. You'll also learn how muscles work and how aging and disuse contribute to loss of muscle strength and power.

## Strength training: A traditional approach

Strength training is a popular term for exercises that build muscle by harnessing resistance—that is, an opposing force that muscles must strain against. Strength training is sometimes called resistance training, progressive resistance training, or weight training. Resistance can be supplied by your body weight, free weights such as dumbbells and weighted cuffs, elasticized bands, or specialized machines. No matter what kind of resistance you use, putting more than the usual amount of load on your muscles makes them stronger. Because the muscles being exercised are attached to underlying bone, these exercises may actually strengthen your bones as well.

Strength training should not be reserved for young souls in search of buff bodies or bulked-up muscles. While it certainly can reshape your silhouette in a pleasing way, it's also a way to boost the strength you call upon as you go about everyday

tasks. Just about any activity becomes easier with stronger muscles. So will any sport you enjoy.

Weak muscles can make even minor exertion—such as walking a few blocks, climbing stairs, or simply getting out of bed—difficult. Equally important, weak muscles compromise balance. Often a debilitating cycle is set in motion when a fall or disabling condition such as arthritis curtails activity. It's natural to adapt to limitations, but many people find that the less they do, the less they are able to do as time goes on. But people can regain their abilities and reverse the cycle with exercises that rebuild lost muscle and recapture a reasonable range of motion.

## Power training: A new approach

Another type of training, known as power training, may prove to be just as important as traditional strength training in helping maintain or restore functional abilities, such as carrying groceries, doing housework, and climbing stairs.

As the name suggests, power training is aimed at increasing power, which is the product of strength (the ability to exert maximal force) and speed. Optimal power reflects how quickly you can exert a given force to produce the desired movement. Thus, faced with a four-lane intersection, you may have enough strength to walk across the street. But can you get across all four lanes of traffic before the light changes? Power, not just strength, can get you from

## Benefits at a glance

Practically any regular exercise benefits your health. Specifically, strength and power training can yield some of the following gains:

- strengthen muscles
- strengthen bones
- prevent falls and fractures by improving balance and preserving power to correct missteps
- help control blood sugar
- relieve some of the load carried by the heart
- improve cholesterol levels
- improve the body's ability to pluck oxygen and nutrients from the bloodstream
- boost metabolism even while resting and thus help keep weight within a healthy range
- prevent or ease lower back pain
- relieve arthritis pain and expand a limited range of motion
- raise confidence, brighten mood, and help fight mild to moderate depression
- ward off loss of independence by keeping muscles strong enough for routine tasks.

one side to the other safely. Likewise, by helping you react swiftly if you start to trip or lose your balance, it can actually prevent falls.

As you age, muscle power ebbs even more swiftly than strength does. So exercises that can produce

### **Power training can make everyday tasks more manageable for older adults.**

gains in power become especially important later in life. That's why some investigators in the field of physical medicine are now combining the swift or high-velocity propulsive moves of power training with the more deliberate and slow ones of strength training to reap the benefits of both activities. One aim of power training is to help stem a tide that commonly sweeps older people from gradual impairment to limited daily functioning and then to outright disability.

A few small studies have confirmed that power training can make everyday tasks more manageable for older adults. A 2003 study in the *Journals of Gerontology: Biological Sciences and Medical Sciences* examined data from over 1,000 adults ages 65 or older who had difficulty walking in order to determine which affected their ability to walk and perform everyday activities more: muscle strength or power. They concluded that muscle power had a greater effect than strength did. Another 2003 study, also published in the *Journals of Gerontology*, reported similar findings. In this study, 39 men and women with below-average leg power were divided into three groups—one that performed strength training exercises, one that practiced power training, and a control group. Those in the first two groups exercised three times a week for 16 weeks. Using measures of strength and functional performance, the researchers found that strength training was beneficial, but power training was even more helpful at improving a person's ability to accomplish daily tasks.

Athletes have long used power training to help improve performance. Football players and high jumpers, for example, use power moves tailored to their sports in their training regimens. While power training for nonathletes is still in its infancy, a small randomized study in the *Journal of the American Geriatrics Society* in 2002 showed that workouts using weighted vests improved power substantially in older adults. Three times a week, one group donned the

vests and climbed up and down stairs at a comfortable pace. A control group engaged in a standard walking program. Once acclimated, the stair climbers spent roughly 10 minutes at their task; the walkers started with 15 minutes and worked toward a maximum of 45 minutes. After 12 weeks, investigators reported that the weighted-vest workouts delivered a 17% improvement in leg power and 12% more stair-climbing power over the walking program. As an added bonus, both groups improved on certain aerobic measures—which is surprising for a 10-minute exercise, although it would be expected for 45 minutes of walking.

Should everyone hurry out to buy a weighted vest? Not yet, although it may yet become standard equipment, says study co-author Dr. Jonathan Bean, the medical director of the Spaulding Cambridge Outpatient Center in Massachusetts. Studies now under way may confirm the worth and safety of the workouts soon.

In the meantime, you can safely incorporate some power moves—with or without the weighted vest, as you choose—into your exercise plan. These are explained in detail in Workout I (see page 22) and Workout II (see page 26).

## **A look at muscle and movement**

Before you turn to the question of which exercises to do, it helps to learn a bit about how your muscles work. Strength training—or actually any voluntary movement in the body—is made possible by skeletal muscles, which are fused to bone. The body boasts more than 600 skeletal muscles. These muscles are composed of many fibers and are surrounded by connective tissue known as the epimysium. The fibers are grouped together in small bundles known as fasciculi; each bundle is sheathed in connective tissue known as the perimysium.

One muscle may have 10,000 to over a million muscle fibers (also known as muscle cells). Each of these fibers consists largely of hundreds of thousands of interlocked strands called myofibrils. These, in turn, are built of myofilaments, fundamental muscle proteins that create force.

A membrane called the sarcolemma attaches the end of each muscle fiber to a tendon. Tendons are cords of connective tissue that tether muscle to bone.

A single nerve cell, or motor neuron, directs activity in a specific group of muscle fibers. Together, this grouping of nerve cell and muscle fibers is called a motor unit. If a given nerve cell commands few muscle fibers, the motor unit marshals less force; the more fibers a nerve cell controls, the greater the force the unit exerts.

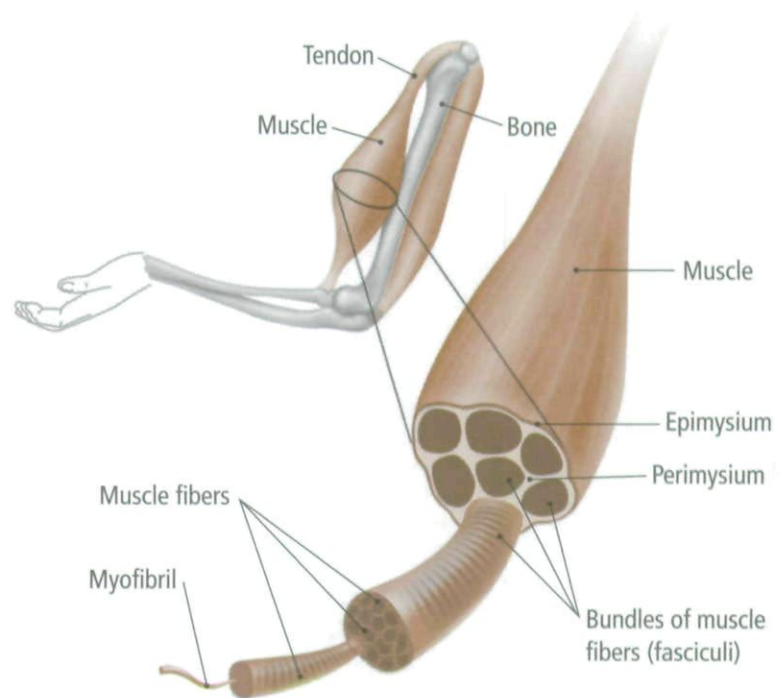
When nerve impulses originating in the brain shoot along neural pathways toward a muscle, they trigger a complex set of chemical reactions that cause myofilaments to slide over each other, generating force. Movement occurs when that force ripples through the muscle structure to the tendons, which in turn tug on the bones. Essentially, the bunching muscles act like strings that make a puppet spring to life.

Strength training exercises muscle beyond its usual capacity. Some experts theorize that muscles grow in response to this stimulus because the exercises cause microscopic tears in muscle fibers. The body rushes protein to the tear sites to pave over the damage done. When this cycle occurs repeatedly, muscles become visibly larger. Another theory, tested mostly in animals and a few studies on bodybuilders, suggests that new muscle fibers actually develop in response to the microscopic injuries. Interestingly, even if there is no muscle growth, strength training enhances the ability of the nervous system to activate motor units.

### Slow-twitch and fast-twitch

Most skeletal muscles have two main types of muscle fibers: slow-twitch and fast-twitch fibers. Usually, a combination of these fibers gets pressed into service when you exercise. Slow-twitch fibers work best during low-intensity activities, when they can be supplied with oxygen. These fibers can keep acting for long periods of time and are called upon first for most activities. During anaerobic activities (which don't require sending significantly more oxygen to the muscles), fast-twitch fibers step into the breach to create bursts of power. Fast-twitch fibers churn out more force than slow-twitch fibers, but are more quickly exhausted. Successful distance runners tend to have greater numbers of slow-twitch fibers in the muscles of their calves, while elite sprinters generally have more fast-twitch fibers.

FIGURE 1 An in-depth look at muscle



Your muscles are tethered to bone by cords of tissue known as tendons and are covered in connective tissue known as the epimysium. If you could look inside your muscles, you would find that they are composed of small bundles of muscle fibers, known as fasciculi. These bundles are surrounded by connective tissue, or perimysia. One muscle may have anywhere from 10,000 to more than a million muscle fibers. In turn, each muscle fiber consists of hundreds to thousands of tiny, interlocking strands called myofibrils.

Only a small percentage of muscle fibers available for a task are recruited at one time. More force requires more fibers working in unison. Once they are drained of glycogen (the stored sugar that's their main energy supply), depleted short-twitch and fast-twitch fibers pass the baton to fresh reinforcements so that activity can continue. This relay goes on until you've exhausted the muscle fibers held in reserve.

It's harder for the body to recruit some types of fast-twitch fibers. That may play a role in why you become tired while exercising. Interestingly, some data suggest that it's possible to convert some muscle fiber types—such as exchanging one form of fast-twitch fiber for another. Theoretically, that might offer advantages if it resulted in improved performance. Whether that conversion affects practical abilities or gains, however, has not been determined.

## Muscles at work

When muscles go to work, they engage in three types of action:

- **Concentric action** occurs when muscles shorten and joints move. An example of this is when you exert the force needed to pick up a bag of groceries.
- **Isometric (static) action** creates force, too, but muscles don't shorten or lengthen much and joints do not move. If you push against a wall, for example, or try to lift an object that is far too heavy for you, you'll feel your arm muscles tense. Since your muscles can't generate enough force to lift the object or shift the wall, they stay in their usual position instead of shortening.
- **Eccentric action** occurs when muscles are asked to exert force and move joints while lengthening. Examples of this would be when you slowly lower a hand weight or walk downhill.

Concentric and eccentric muscle actions are dynamic—that is, they create movement whether you are jogging or simply walking across a room. Isometric

muscle action results in very little movement, such as when a soldier stands at attention or you maintain your balance. Isometric actions are helpful when you want to exercise muscles

but have little room to do so or wish to limit movement, such as when joints hurt or are inflamed.

Any time you move, your muscles are applying force. To balance this force properly, different sets of muscles move in opposition to one another. The muscle that delivers most of the force needed for a specific movement—say, walking up a flight of stairs—is called an agonist. To help control the speed and force of the movement and prevent injury, an antagonist that opposes the primary muscle also contracts. So, as you walk up stairs, the quadriceps muscles on the fronts of your thighs act as agonists while the hamstring muscles at the backs of your thighs work as antagonists.

## Age and muscle loss

No matter how many birthdays come and go, muscles do the same type of work. But as muscle

mass in the body shrinks with the passing years, strength also declines. Sarcopenia—the gradual decrease in muscle tissue—starts at around age 30. The average 30-year-old can expect to lose about 25% of muscle mass and strength by age 70 and another 25% by age 90.

Some of these changes stem from the physiological effects of aging, but disuse plays a bigger role than many people suspect. Studies of older adults assigned to strength training consistently prove that a good deal of the decline in strength can be recouped.

Likewise, power can be regained. With age and disuse, the nerve signaling system that recruits muscle fibers for tasks deteriorates. Fast-twitch fibers, which provide bursts of power, are lost at a greater rate than slow-twitch fibers. You might think of a nerve pathway as a set of paving stones leading to a destination. As the years pass, the path may become overgrown and disappear in spots rather than remain well traveled and clearly marked. Preliminary power training studies suggest that movements designed to restore neural pathways can reverse this effect.

Having smaller, weaker muscles doesn't just change the way people look or move. Muscle loss affects the body in many ways. Strong muscles pluck oxygen and nutrients from the blood much more efficiently than weak ones. That means any activity requires less cardiac effort and puts less strain on your heart. Strong muscles are better at sopping up sugar in the blood and helping the body stay sensitive to insulin (which helps cells remove sugar from the blood). In these ways, strong muscles can help keep blood sugar levels in check—which in turn helps prevent or control type 2 diabetes. Strong muscles enhance weight control, too (see “Muscles, metabolism, and weight,” page 9).

On the other hand, weak muscles hasten the loss of independence as everyday activities—such as walking, cleaning, shopping, and even dressing—become more difficult. They also make it harder to balance your body properly when moving or even standing still, or to catch yourself if you trip. The loss of power compounds this. Perhaps it's not so surprising that, by age 65, one in three people suffers a fall. Because bones also weaken over time, 1 out of every 20 of these falls causes a fracture, usually of the hip, wrist, or leg.

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Loss of muscle strength and mass aren't the only factors that contribute to age-related declines in functioning and mobility. New research has identified another potential culprit: fat. The Health, Aging, and Body Composition study (commonly called the Health ABC study) revealed that people who have a greater amount of fat between their muscle fibers may be more likely to experience mobility problems. The location of the fat is a key factor: The fat normally found in muscle cells can provide fuel for exercising muscles, but fat that accumulates between muscle fibers (intermuscular

fat) may have negative consequences. The amount of fat found here increases with age. Diet and exercise also play an important role. Compared with other kinds of fat stores, intermuscular fat is particularly affected by diet and exercise. The good news here is that you lose proportionately more of this kind of fat with diet and exercise than you would other types of body fat. More studies are under way to examine how the extent of fat infiltration in muscles affects function and the progression of certain health problems, such as knee osteoarthritis. ♥

## Muscles, metabolism, and weight



Strong muscles never sleep. Even when at rest, they actually raise metabolism a notch. This lets you burn more calories than usual, even while you're sitting or sleeping. Coupled with the calories you use up during regular workouts, this increase in metabolism may help you lose weight or stay at a healthy weight (provided you're eating right).

A solid line of research shows that shaving off as little as 10% of excess weight pays big health dividends. Because obesity factors into many health prob-

lems—including high blood pressure, heart disease, gallbladder disease, arthritis, diabetes, and certain cancers—that's an investment that keeps giving back.

Strength training also gradually replaces fat with muscle. As you know, muscle tissue shrinks with disuse and age. Typically, the body doesn't just lose muscle, though. It supplants muscle with fat. This unkind trade raises the risk for diabetes, partly because muscle tissue is better than fat tissue at controlling blood sugar and retarding insulin insensitivity (the primary cause of type 2 diabetes). In addition, strength training can help peel away an unhealthy girdle of abdominal fat, reducing the risk for heart disease, stroke, and diabetes.

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