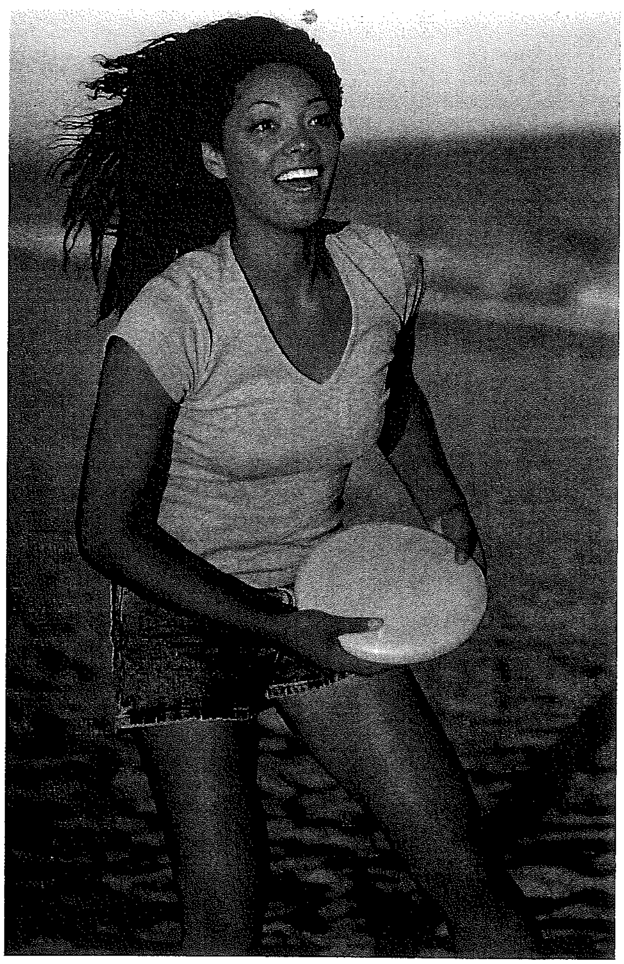
Components of Physical Fitness

The health, joie de vivre, and creativity of a well-developed personality depend to a great degree upon general fitness levels. Fitness is your functional readiness and level of effectiveness that are required for everything you do. It involves the ability to adapt to the demands and stresses of daily life and is directly related to the amount and intensity of your physical activity. The term fitness is used in many ways, and has many dimensions, including physical, emotional, social, and intellectual. The focus of this chapter will be on physical fitness.

Physical fitness is more than just a concept – it is a way of life. It incorporates many components important for health, such as cardiorespiratory endurance; flexibility; muscular strength, power, and endurance; and body composition. Each of these components offers unique benefits and advantages that affect your health in a positive way. Engaging in physical exercise provides numerous benefits that help you control your weight, manage stress, and boost your immune system, as well as protect you against disease. Not only does exercise help you look and feel good, but it allows you to have fun while achieving a state of health and vitality. Fitness need not be boring and monotonous, or restricted to running and cycling; there are many options available, and all you need to do is discover what activities interest you most. Exercise is one of the most important, and indeed, most controllable, factors affecting your general health.



General physical fitness forms the basis for sport-specific fitness and is ultimately related to it. High levels of general fitness are of utmost importance to athletes who strive to achieve high levels of performance. High levels of general fitness constitute important prerequisites for the effective and optimal development of sport-specific fitness. Both develop on the basis of the training principles governing exercise.

In order to get the most out of exercise and physical activity, you need the basic knowledge and an understanding about how to exercise properly and most effectively. This chapter will provide you with concepts related to components of fitness and equip you with basic knowledge governing training principles and their interrelationships.

Definition of Terms

Physical fitness can be defined as the ability of the body to adjust to the demands and stresses of physical effort and is thought to be a measure of one's physical health. In contrast, **physical activity** is defined as "any movement carried out by the skeletal muscles requiring energy." The term **exercise** is considered to be a subset of physical activities that are planned, structured (usually repetitive bodily movements), and designed to improve or maintain physical fitness.

Although physical activity and physical fitness are related measures, physical fitness should be distinguished from physical activity. Physical fitness is an achieved condition which limits the

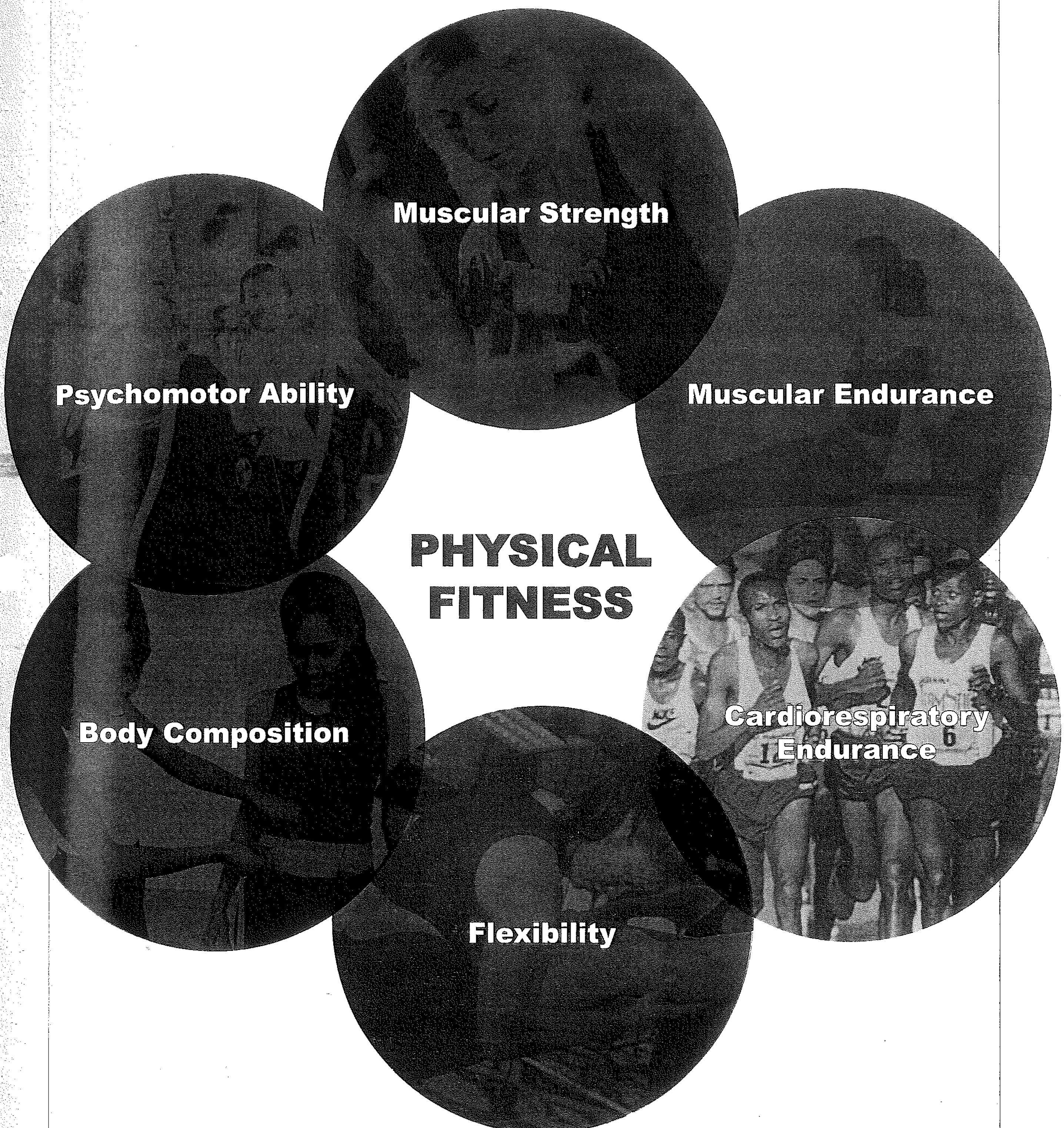


Figure 9.1 The components of physical fitness.

amount of physical activity that can be performed. A physical activity such as walking, cross-country skiing, or swimming might be considered exercise by an unfit person, while considered physical activity by someone who is very fit. The point is that a physical activity–exercise continuum exists. It demonstrates the specific nature of exercise and physical activity. How much activity, what type, how intense, and how often one should exercise are all important questions that should be considered before any exercise program is designed. In what follows, the terms exercise and physical activity are used interchangeably.

Components of Physical Fitness

Physical fitness is achieved when all of the physiological systems of the body are functioning efficiently to meet the physical demands of everyday activities. The components of physical fitness include muscular strength, muscular and cardiorespiratory endurance, flexibility, psychomotor ability, as well as body composition (Figure 9.1).

Muscular Strength

Muscular strength is commonly measured as a maximal value and can be defined as the ability of a muscle or muscle group to exert force against a resistance. Thus, strength and force are synonymous. The force generated by a muscular contraction may be applied against a movable object, as in weightlifting, or against a fixed object, such as the starting blocks in sprinting. Force is the product of mass times acceleration ($F = m \cdot a$) and when a force is applied through a distance (D), work (W) is accomplished ($W = F \cdot D$). It follows that the greater the mass of a muscle, the greater its capability of generating force (see Chapter 4). Think of sports that require great strength. Do the athletes that participate in these sports have large muscles?

Power

As defined in Chapter 4, **power** is the ability to overcome external resistance at a high rate of muscular contraction. It is the force that can be generated at speeds characteristic of the activity to overcome gravity (see discussion on gravity in Chapter 7) and thus accelerate the body or an implement. The ability to exert force is in turn dependent on muscular strength. Thus, power is an important derivative of muscular strength and is decisive in performance in most sports and many recreational activities (Figure 9.2; also see discussion on power in Chapter 4).

Muscular Endurance

Muscular endurance is defined as the ability of

Agonist–Antagonist Training

When planning training, care must be taken to include exercises that stimulate both the agonists (working muscles) and the antagonists (counter-acting muscles; see discussion on muscle teamwork in Chapter 3). A program that focuses only on increasing agonist strength tends to shorten the agonist muscles and weaken the antagonist muscles. This results in a change in the proportion of strength between agonists and antagonists which, under normal circumstances, is well balanced. This shift in strength equilibrium can result in impaired joint positions, and make articular cartilage and muscles (especially the tendons) prone to disease and injury.

Thus, a program that includes exercises to develop the biceps should also include exercises to enhance the triceps; trunk extensor training should be complemented with trunk flexor training. This approach to strength training is referred to as **agonist–antagonist training** (Figure 9.3).

To achieve a balanced development of strength your strength program must assure a balance between the training of agonists and antagonists.

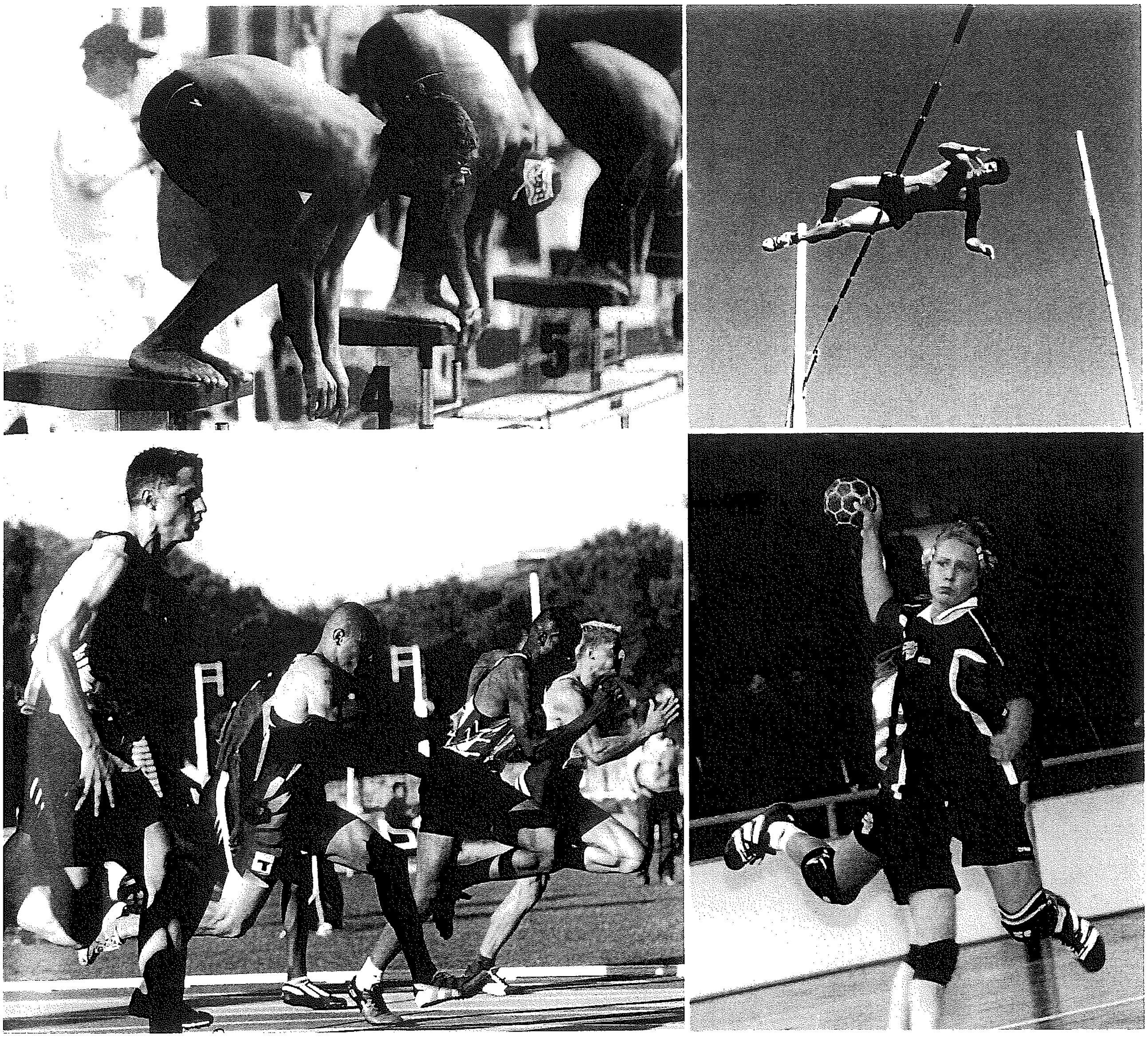


Figure 9.2 Activities requiring explosive power.

a muscle or muscle group to sustain a given level of force (static exercise) or to contract and relax (dynamic exercise) repeatedly at a given resistance. Static exercises involve sustained contractions, which often compromise blood flow. As a result, oxygen is rapidly used up and metabolic by-products accumulate causing fatigue. Performing a flexed arm hang will provide you with this experience. Your heart and lungs do not have much trouble performing during a flexed arm hang, but your arm muscles (local muscle group) feel a strong burning sensation and fatigue rapidly.

In contrast to static exercises, dynamic exercises involve continuous rhythmical contractions and relaxations that allow for oxygen to be continually delivered to the muscle and metabolic by-products to be removed. Thus, other physiological systems play a greater role and, depending upon intensity, fatigue may take longer to develop. For example, during cycling, in addition to your leg muscles requiring muscular endurance, your cardiorespiratory system is also involved. Exercises that employ large muscle groups for prolonged periods of time such as distance running, cross-

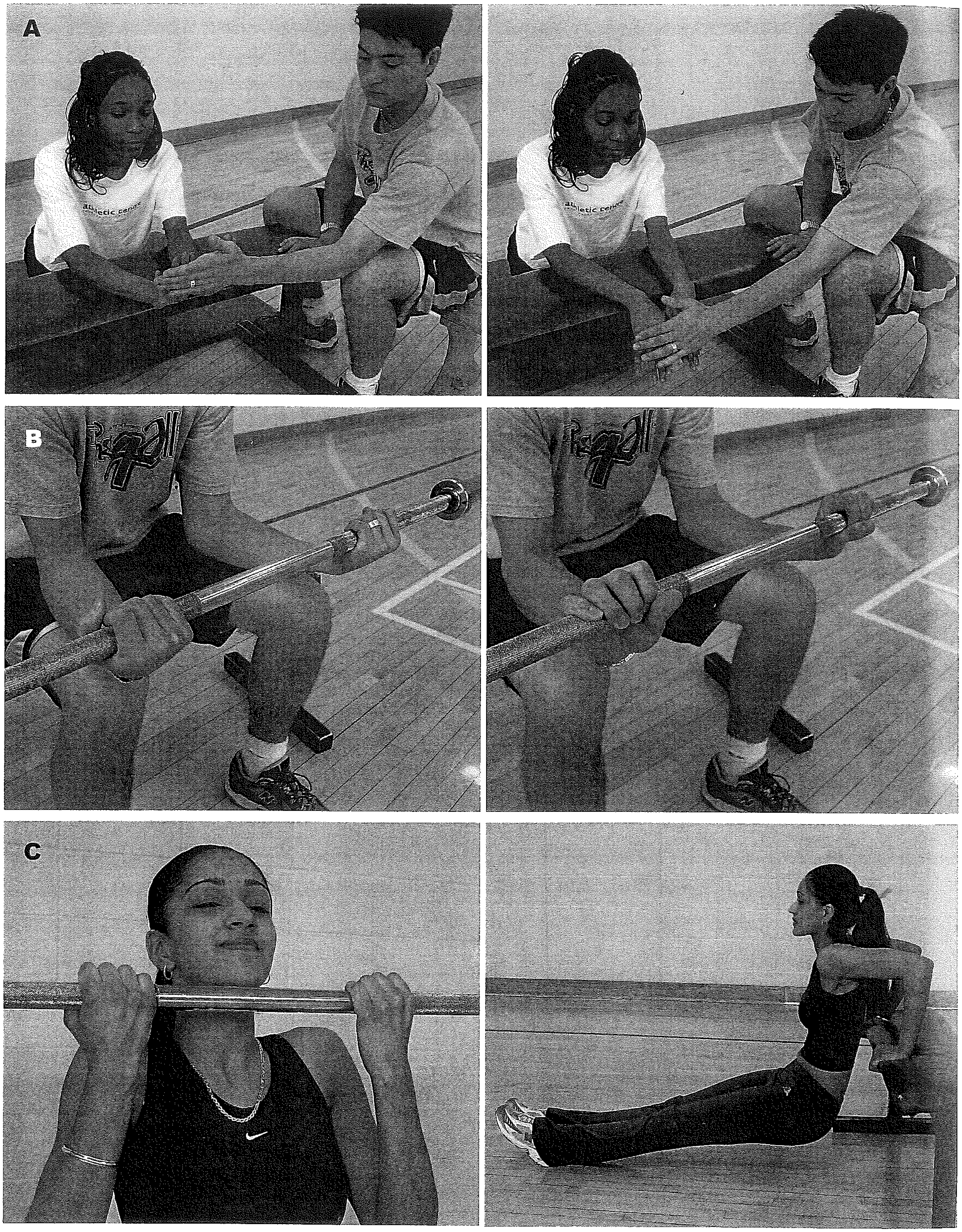
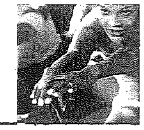


Figure 9.3 Agonist–antagonist training. **A.** Using partner-assisted exercises. **B.** Using free weights. **C.** Using one's own body weight.



country skiing, cycling, or swimming involve cardiorespiratory endurance, another important component of physical fitness (Figure 9.4).

Cardiorespiratory Endurance

As its name implies, **cardiorespiratory** (also called **cardiovascular**) **endurance** or **fitness** involves both the heart (cardio) and the lung (respiratory) systems. A major function of the cardiorespiratory system is to provide oxygen to the tissues. The maximal rate at which the body can take up, transport, and utilize oxygen is known as **aerobic power** or endurance which is expressed as maximal oxygen uptake or $\dot{V}O_2max$. $\dot{V}O_2max$ is also the maximal rate of aerobic metabolism and is the single most important criterion of physical fitness (see discussion on aerobic power in Chapter 5).

Cardiorespiratory fitness is the ability to produce energy through an improved delivery of oxygen to the working muscles. It is needed for exertions over relatively longer periods of time regardless of the activity. It is intimately related to muscular endurance, as the working muscles rely on the oxygen supply sent by the pumping heart, delivered via the blood, and used by the muscles. The major improvements or training effects related to cardiorespiratory endurance were discussed in Chapter 5.

Maximal Oxygen Uptake ($\dot{V}O_2max$)

$\dot{V}O_2max$ can be measured, estimated, or predicted in many ways. Measuring the $\dot{V}O_2max$ of a person

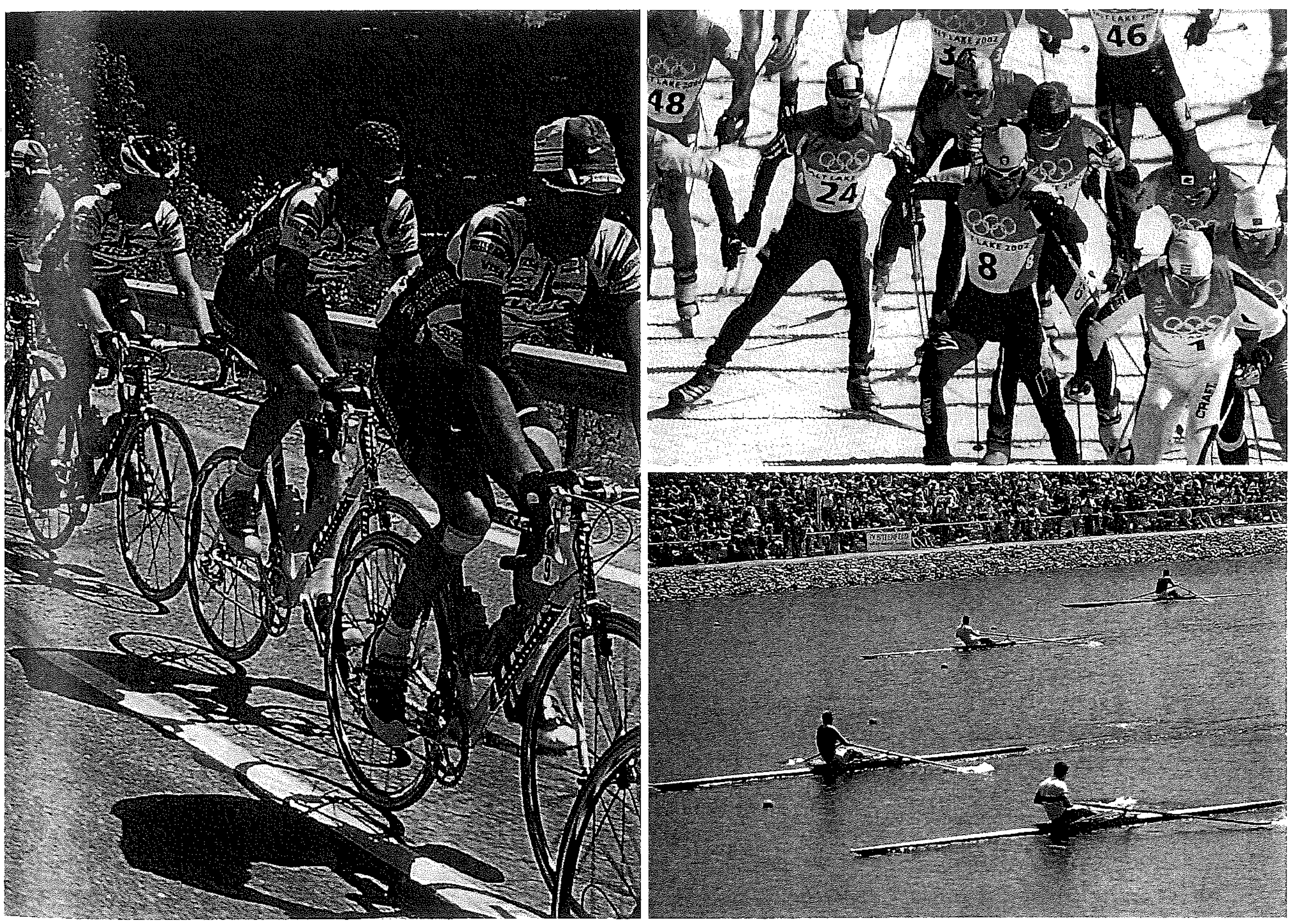


Figure 9.4 Performances in rowing, cycling, and cross-country skiing are based on muscular and cardiovascular endurance.

running on a treadmill involves having a person run at a given speed or workload for a few minutes (2-3 min) (Figure 9.5), while oxygen uptake or consumption is measured over a period of time (2-3 min) at each workload. The workload is gradually increased by increasing the speed or the treadmill slope. At each new workload, the individual demand for oxygen increases, i.e., as the workload is increased more oxygen is taken up by the lungs, delivered by the heart, and utilized by the muscles. However, eventually a point will be reached where the increased workload cannot be supported by an increase in oxygen uptake. Oxygen consumption is said to have reached a plateau or reached a maximal value. This plateau is known as one's **$\dot{V}O_2max$**.

Prediction of $\dot{V}O_2max$ With each new workload, as more oxygen is required, the heart will pump more blood, delivering more oxygen to the exercising muscles. Thus, at each new workload heart rate will also increase and eventually reach a maximal value. The linear relationship between heart rate and workload that exists over a given workload range is the basis for estimations or predictions of $\dot{V}O_2max$.

Absolute $\dot{V}O_2max$ $\dot{V}O_2$ is expressed in an absolute manner as a **volume per unit time,** litres per minute (L/min). In general, an **absolute $\dot{V}O_2max$** measurement is related to mass, especially muscle mass. Larger individuals usually have higher $\dot{V}O_2max$ values due to their greater muscle mass.

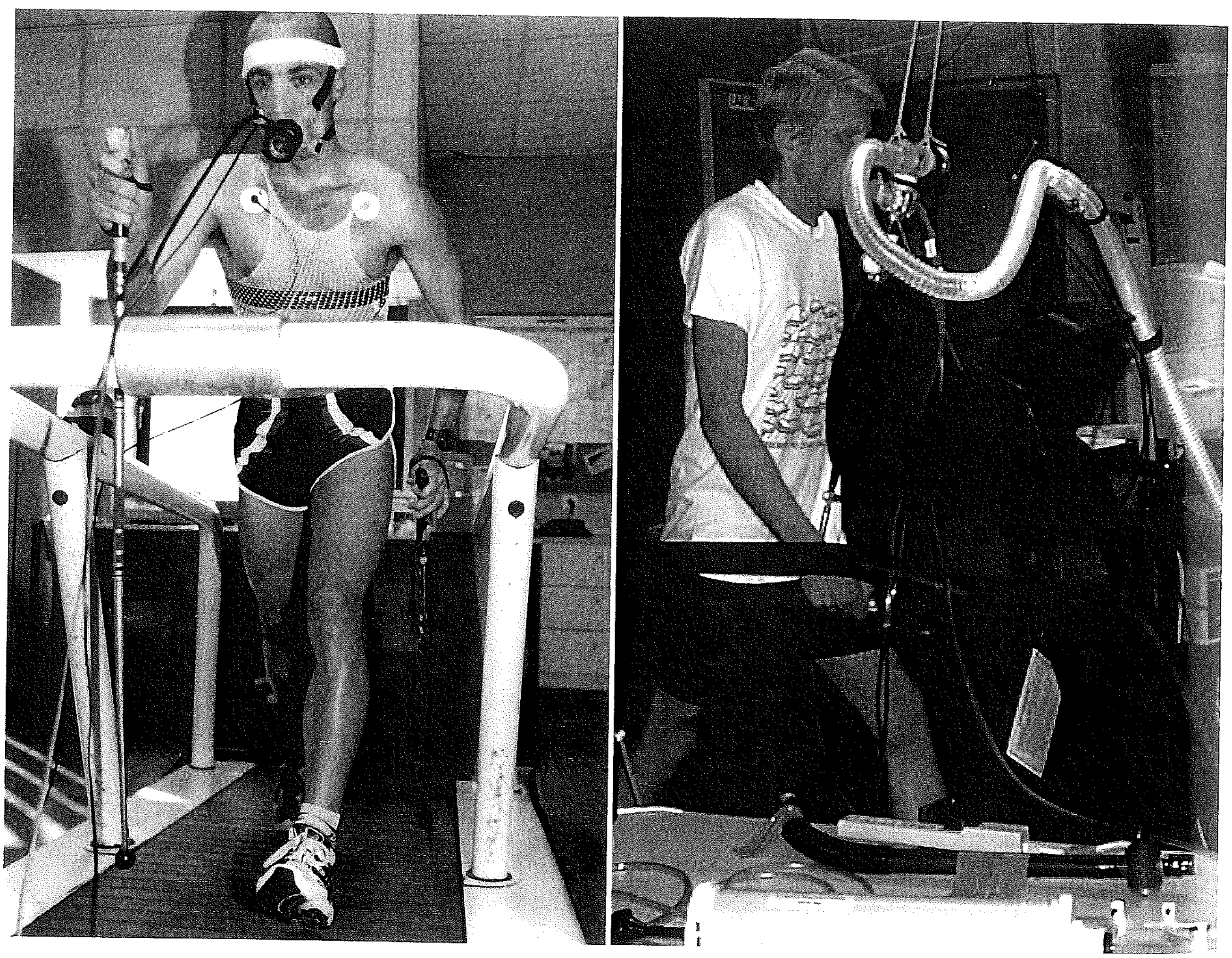


Figure 9.5 Testing for $\dot{V}O_2max$ can only be carried out in a laboratory setting.

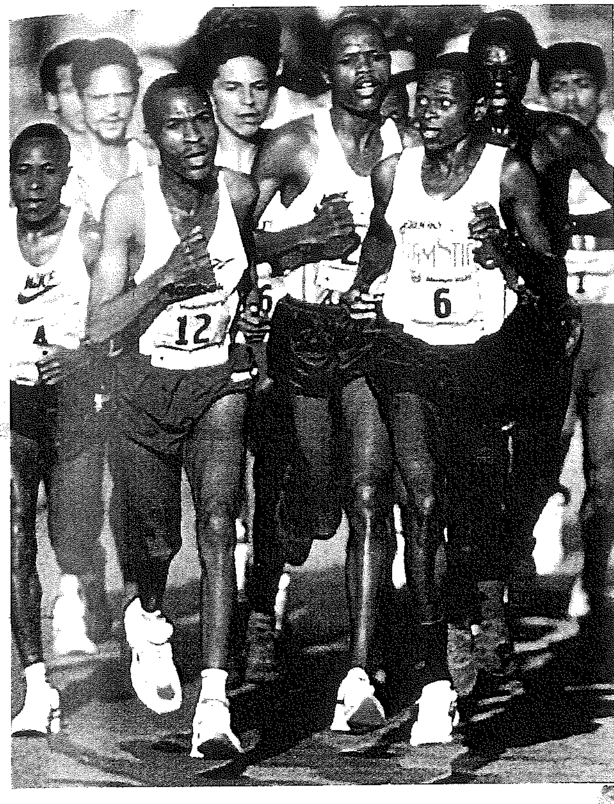


Figure 9.6 Marathon runners are among the best when it comes to relative $\dot{V}O_2$max.

For example, it is not uncommon for elite male rowers who are generally tall and muscular to have $\dot{V}O_2$max values of approximately 6.0 L/min. In contrast, shorter and comparatively slighter runners might have $\dot{V}O_2$max values of only 4.5 L/min.

Absolute measurements of $\dot{V}O_2$max are useful for comparison within groups, but limited when comparing two groups that differ in mass or body composition.

Relative $\dot{V}O_2$max To account for differences in mass, $\dot{V}O_2$max can also be expressed in a relative manner, i.e., in relation to mass expressed in kilograms. Thus, when comparing two athletes playing different sports, it is often useful to divide their absolute $\dot{V}O_2$max by their mass to obtain **relative $\dot{V}O_2$max** values (Figure 9.6). When $\dot{V}O_2$ is expressed relative to mass, the units used are expressed in **ml/kg/min**, thus indicating the consumed volume of oxygen in millilitres per kilogram of body weight per minute. Using our male rower and runner example, if the rower weighed 90 kg and the runner weighed 68 kg, then both have the same relative $\dot{V}O_2$max, 66 ml/kg/min (this value was obtained by dividing their absolute $\dot{V}O_2$max by their mass).

Flexibility

Have you ever wondered how gymnasts or ballet dancers perform the splits or arch their spines so far? This type of performance illustrates their ability to perform movements that require a great measure of **flexibility**.

Flexibility is defined as the ability of a joint to move through its full range of motion. Flexibility is determined primarily by joint structure and to a lesser extent by muscle elasticity and length.

Connective tissue is the most important part of muscle in terms of its flexibility. The main structural protein in connective tissues is **collagen**. Collagen fibres provide structure and support to tissues, ligaments, tendons, and joints. Collagen is a **triple helix** that can withstand very high tensile forces. In addition to collagen, another protein known as **elastin** provides an athlete with stretching ability.

A number of factors such as age, sex, and inactivity can affect flexibility. Just compare the level of flexibility of a young and active rhythmic gymnast (Figure 9.7) to that of an elderly person with arthritis. Flexibility promotes good joint health, slows joint deterioration, and generally improves quality of life for most individuals. It may

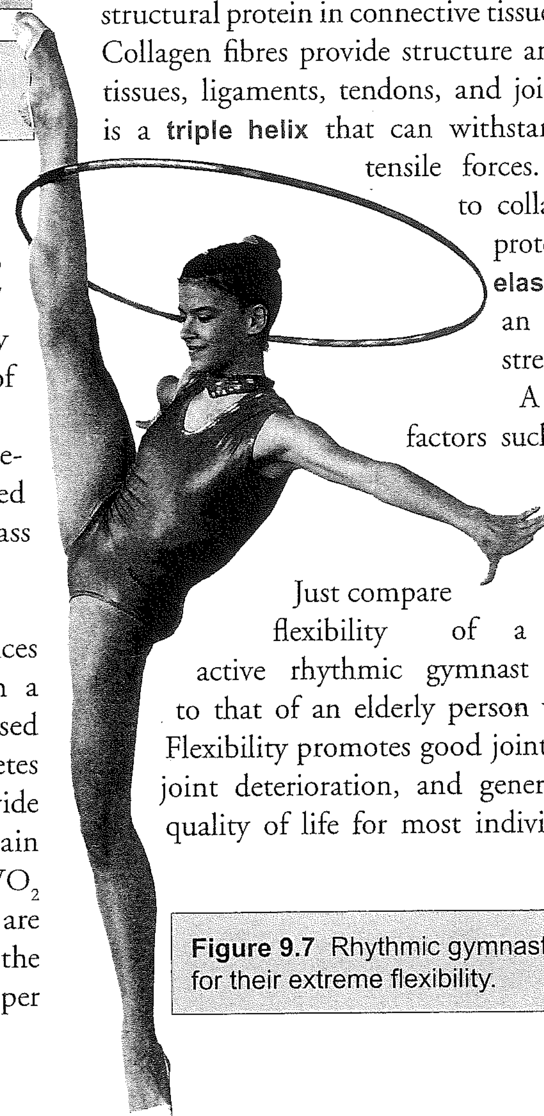


Figure 9.7 Rhythmic gymnasts are known for their extreme flexibility.

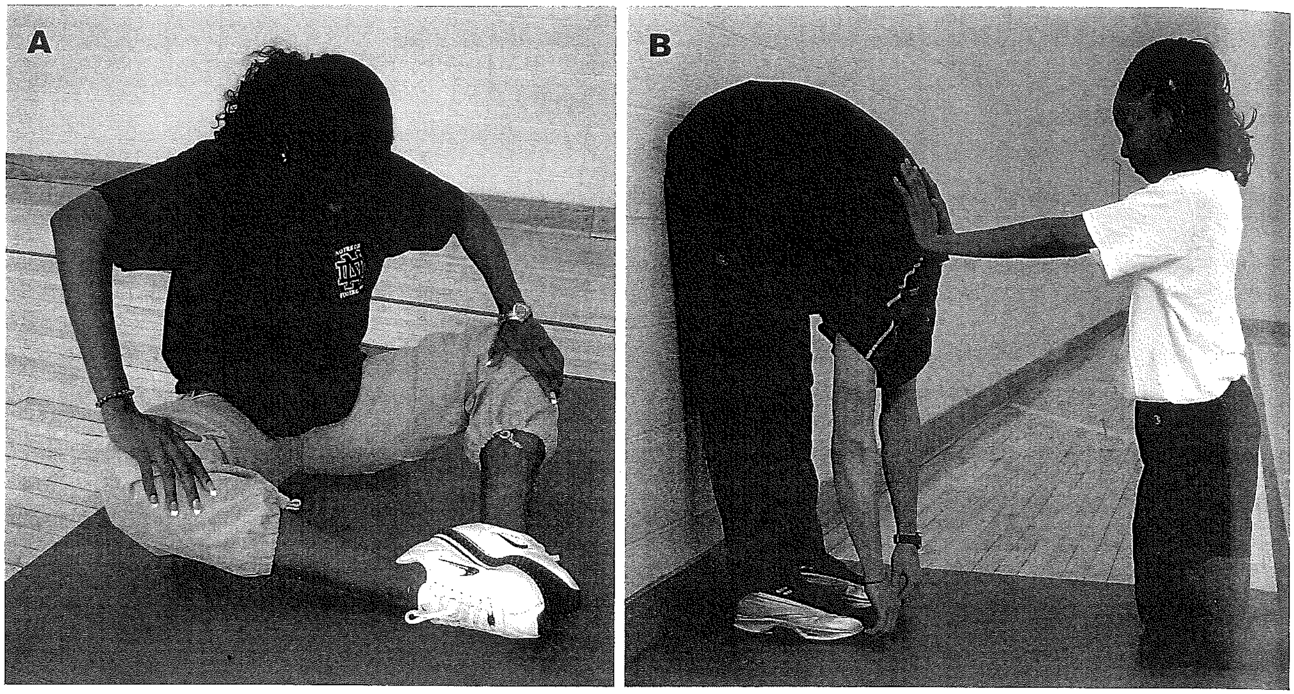


Figure 9.8 **A.** Active stretching. **B.** Passive stretching.

also prevent lower back pain and injuries as well as reduce the frequency and severity of injuries.

Active and Passive Flexibility

Flexibility can be active or passive. **Active flexibility** is the range of movement generated by individual effort, while **passive flexibility** is the range of movement achieved with the help of external forces (a partner, weight, rubber band, etc.). Passive flexibility exercises help achieve a wider range of movement than do active flexibility exercises (Figure 9.8).

Stretching Methods

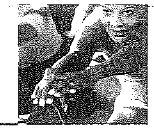
There are three stretching methods: the static, dynamic, and proprioceptive neuromuscular facilitation methods.

Static Stretching **Static stretching** refers to holding a fully stretched position, such as the splits. Using this method, an athlete slowly relaxes the muscles to be stretched and holds himself/herself in a stretched position over 10-30 seconds. The process may be enhanced by an assisting partner. The process is repeated four to six times for maximal efficiency.

Dynamic Stretching **Dynamic** or **ballistic stretching** refers to rapidly moving a joint through its full range of motion, such as the arm of a baseball pitcher. The method involves stretching with repetitive bouncing movements using small intervals, rather than just one pull. An athlete begins the first repetition over a relatively small range of joint motion, gradually increasing the amplitude range, reaching the maximal range after 10-20 movements. The process is then repeated three to five times, using body weight or an assisting partner (Figure 9.9).

Pre-stretching The **pre-stretching** or **proprioceptive neuromuscular facilitation (PNF)** method exploits the natural protective reflex of the muscle and its tendon sensors – the muscle spindles and golgi tendon organs. It is regarded as the most efficient stretching method.

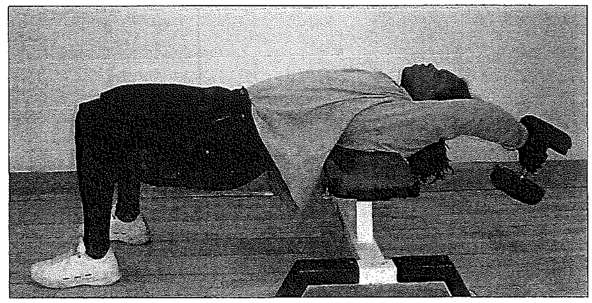
The PNF method is carried out in three phases with a partner.

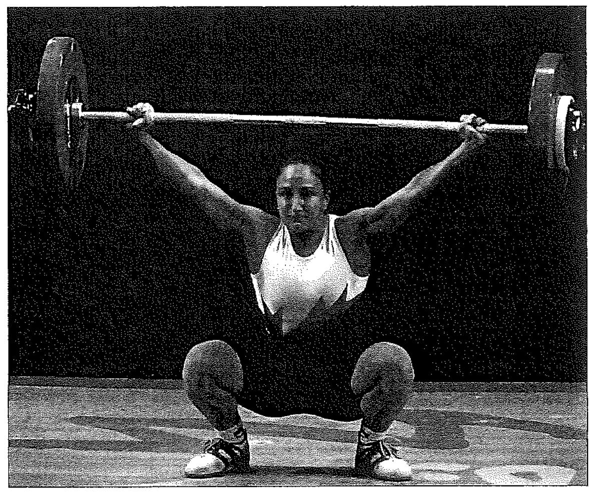


Strength Training and Flexibility

Some exercises may have a dual training effect by developing both strength and flexibility. Arm raising exercises from the mat, for instance, involve little stretching; when performed from the bench, however, the same exercise allows for a far larger range and thus promotes the stretching of the pectoral muscles in particular. Half-knee bends, if overused, cause the quadriceps to shorten; deep-knee bends help stretch them.

It is for this reason that weightlifters, who must often assume very deep squatting positions to clean or snatch heavy loads, have extremely elastic leg muscles. Similarly, competitive swimmers develop extreme flexibility in their shoulder girdles. Such examples show that, under certain conditions, the same exercises may develop both strength and flexibility. However, the movement range around a joint must always be exploited to its full capacity. If not, muscle stretching will not occur; indeed, the muscle may shorten, and strength training may then lead to impaired flexibility. To achieve optimal flexibility through strength training, you must exploit the full range of joint movement that can be achieved during any given exercise.





- During the first **active stretching phase**, the muscles to be stretched are actively pulled to the very limit of the movement range. This initial stretching movement should be performed slowly and continuously. This prevents the muscle spindles from initiating the stretching reflex and thus contracting the muscles.

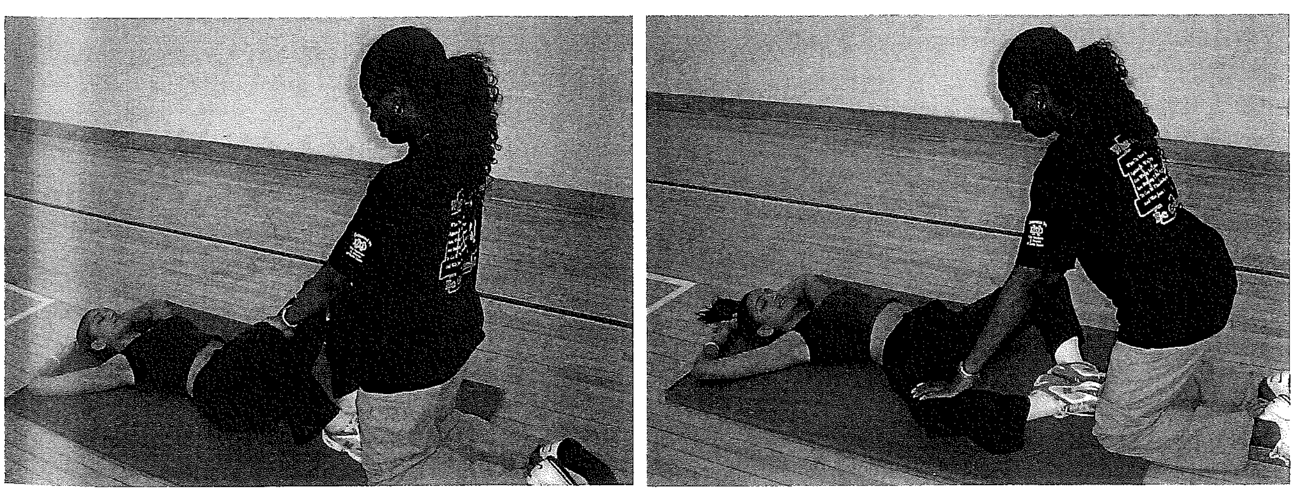


Figure 9.9 Partner-assisted dynamic stretching.

- In the second **pre-tension phase**, the trainee exerts a full static resistance (a strong isometric contraction) against partner resistance for approximately seven seconds. This causes the tendon golgi organs to release inhibitory impulses which in turn cause an involuntary relaxation of the muscles to be stretched.
- In the third **passive stretching phase**, the partner pushes the body further into a stretched position almost to the point of pain. This final position is then held, with all muscles relaxed, for approximately six seconds. The partner's pressure must be applied slowly and constantly in order to prevent muscle spindles from initiating a reflex contraction, which may cause injury.

Body Composition

Body composition refers to the amounts of body constituents, such as fat, muscle, bone, and other organs, and is regarded as one of the major components of physical fitness. Of particular interest are percentages of lean body mass and fat body mass. Typically, an active physically fit individual has a lower percentage of body fat than an inactive unfit person. The large number of overweight young people in our society is a cause for concern. Any fitness program, strength or cardiovascular, should be designed with an aim to help reduce body fat. For detailed information about body composition, weight management, and the effects of obesity see Chapter 12.

Psychomotor Ability

Successful athletes appear to move effortlessly. In addition, they can respond easily or readily to changes in their surroundings. To accomplish this, athletes must monitor their environment, collect information, make decisions, and execute their movements. It is their **psychomotor ability** that allows them to complete these tasks quickly and accurately.

A high level of psychomotor ability serves to integrate the workings of the central nervous system with the more physical components of fitness. The body constantly monitors both its internal and external environments, collecting information and making decisions about what is relevant information and what is irrelevant information.

Figure 9.10 Archery requires hand steadiness as well as undivided concentration.

The psychomotor domain may seem an unimportant component of physical fitness; however, it is of utmost importance to effective functioning in all environments.

Psychomotor abilities are many. The most significant ones are reaction time and anticipation, visual skills, hand–eye coordination, perception, attention and concentration, balance, proprioception or muscle feeling, memory processes and recall, and decision making (Figure 9.10). These abilities are presented in more detail in Chapter 16.