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Muscular Flexibility

“Regrettably, most people neglect flexibility training, limiting freedom of movement, physical and mental relaxation, release of muscle tension and soreness, and injury prevention.”
American Council on Exercise (ACE)

Objectives

▶ Explain the importance of muscular flexibility to adequate fitness.
▶ Identify the factors that affect muscular flexibility.
▶ Explain the health–fitness benefits of stretching.
▶ Become familiar with a battery of tests to assess overall body flexibility (Modified Sit-and-Reach Test, Total Body Rotation Test, Shoulder Rotation Test).
▶ Be able to interpret flexibility test results according to health–fitness and physical–fitness standards.
▶ Learn the principles that govern development of muscular flexibility.
▶ List some exercises that may cause injury.
▶ Become familiar with a program for preventing and rehabilitating low-back pain.
▶ Create your own personal flexibility profile.

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Will stretching before exercise prevent injuries? The research on this subject is controversial. Some data suggest that intense stretching prior to physical activity modestly increases the risk for injuries and leads to a temporary decrease in muscle contraction velocity, strength, and power. Other studies, however, show no changes and even some improvement with intense pre-exercise stretching. The most important factor prior to vigorous exercise is to gradually increase the exercise intensity through mild calisthenics and light- to moderate-intensity aerobic exercise.

To prevent injuries while participating in activities that require flexibility, the American College of Sports Medicine recommends stretching following an appropriate warm-up phase. For activities that do not require much flexibility, you can perform the flexibility program following the aerobic and/or strength-training phase of your training.

Does strength training limit flexibility? A popular myth is that individuals with large musculature, frequently referred to as “muscle-bound,” are inflexible. Data show that strength-training exercises, when performed through a full range of motion, do not limit flexibility. With few exceptions, most strength-training exercises can be performed from complete extension to complete flexion. Body builders and gymnasts, who train heavily with weights, have better than average flexibility.

Will stretching exercises help me lose weight? The energy (caloric) expenditure of stretching exercises is extremely low. In 30 minutes of aerobic exercise you can easily burn an additional 250 to 300 calories as compared with 30 minutes of stretching. Flexibility exercises help develop overall health-related fitness but do not contribute much to weight loss or weight maintenance.

How much should stretching “hurt” to gain flexibility? Proper stretching should not cause undue pain. Pain is an indication that you are stretching too aggressively. Stretching exercises should be performed to the point of “mild tension” or “limits of discomfort.” It is best to decrease the degree of stretch to mild tension and hold the final position for a longer period of time (15 to 60 seconds).

Real Life Story  Gina’s Experience

When I was younger, I was in ballet and we stretched all the time; so I was very flexible. After I stopped taking lessons, I also stopped stretching. I would exercise once in a while, but I wasn’t interested in stretching because it doesn’t burn that many calories and I was exercising just to lose weight. My second year of college, however, I was really stressed out. I was working a ton of hours, going to classes, keeping up with homework, and on top of that, I had back pain that I had to deal with. Sometimes I would be sitting and trying to do the reading for class, but my back would hurt and I could feel my heart speeding and my breathing rate accelerating really fast because I couldn’t stop worrying about all the things that were going on in my life. My back pain was sometimes so bad that I considered taking medication, but I didn’t really want to do that. Then my friend got me to go to a yoga class with her. I didn’t think I would like it, but I was shocked by how much it helped me. My back pain improved that same day and after each class my body felt great and I was calm and relaxed! In time, my flexibility improved, my back pain disappeared, my usual anxiety was gone, and I was sleeping great at night. I now attend yoga classes two to three times a week. If I can’t get to a class, I do a few poses in my room or even some of my old ballet stretches. I am so happy to have found something that has helped my back and also really helps calm me down when I am stressed. For me, stretching is the pain-killer and anti-anxiety medication that has no side effects!
My Personal Flexibility Health

I. Can you touch your toes without bending your knees while sitting on the floor? _______ Yes _______ No
   How about the tips of your fingers behind your back with the preferred upper arm (hand) over your shoulder and the
   other hand coming up from behind your lower back? _______ Yes _______ No

II. The most important factor that determines range of motion about a joint is the degree of physical activity.
      _______ Yes _______ No

III. Vigorous stretching conducted prior to participating in athletic events that rely on force and power for peak perfor-
      mance enhances sports performance. _______ Yes _______ No

IV. Back pain can be reduced greatly through aerobic exercise, muscular flexibility exercise, and muscular strength
      and endurance training. _______ Yes _______ No

V. Have you ever experienced back pain episodes similar to Gina’s and can you explain the probable cause of Gina’s pain?
      _______ Yes _______ No

Very few people who exercise take the time to stretch, and only a few of those who stretch do so properly. When joints are not regularly moved through their entire range of motion, muscles and ligaments shorten in time, and flexibility decreases. Repetitive movement through regular/structured exercise, such as with running, cycling, or aerobics, without proper stretching also causes muscles and ligaments to tighten. Most fitness participants underestimate and overlook the contribution of good muscular flexibility to overall fitness.

Flexibility refers to the achievable range of motion at a joint or group of joints without causing injury. Some muscular/skeletal problems and injuries are thought to be related to a lack of flexibility. In daily life, we often have to make rapid or strenuous movements that we are not accustomed to making. Abruptly forcing a tight muscle beyond its achievable range of motion may lead to injury.

A decline in flexibility can cause poor posture and subsequent aches and pains that lead to limited and painful joint movement. Inordinate tightness is uncomfortable and debilitating. Approximately 80 percent of all low-back problems in the United States stem from improper alignment of the vertebral column and pelvic girdle, a direct result of inflexible and weak muscles. This backache syndrome costs U.S. industry billions of dollars each year in lost productivity, health services, and worker compensation.

Benefits of Good Flexibility

Improving and maintaining good range of motion in the joints enhances the quality of life. Good flexibility promotes healthy muscles and joints. Improving elasticity of muscles and connective tissue around joints enables greater freedom of movement and the individual’s ability to participate in many types of sports and recreational activities. Adequate flexibility also makes activities of daily living such as turning, lifting, and bending much easier to perform. A person must take care, however, not to overstretch joints. Too much flexibility leads to unstable and loose joints, which may increase injury rate, including joint subluxation and dislocation.

Taking part in a regular stretching program increases circulation to the muscle(s) being stretched, prevents low-back and other spinal column problems, improves and maintains good postural alignment, promotes proper and graceful body movement, improves personal appearance and self-image, and helps to develop and maintain motor skills throughout life.

Flexibility exercises have been prescribed successfully to treat dysmenorrhea1 (painful menstruation), general neuromuscular tension (stress), and knots (trigger points) in muscles and fascia. Regular stretching helps decrease the aches and pains caused by psychological stress and contributes to a decrease in anxiety, blood pressure, and breathing rate.2 Stretching also helps relieve muscle cramps encountered at rest or during participation in exercise.

Key Terms

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
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<tbody>
<tr>
<td>Flexibility</td>
<td>The achievable range of motion at a joint or group of joints without causing injury.</td>
</tr>
<tr>
<td>Subluxation</td>
<td>Partial dislocation of a joint.</td>
</tr>
<tr>
<td>Stretching</td>
<td>Moving the joints beyond the accustomed range of motion.</td>
</tr>
<tr>
<td>Dysmenorrhea</td>
<td>Painful menstruation.</td>
</tr>
</tbody>
</table>

1. Dysmenorrhea
2. Stretching
Mild stretching exercises in conjunction with calisthenics are helpful in warm-up routines to prepare for more vigorous aerobic or strength-training exercises, and in cool-down routines following exercise to facilitate the return to a normal resting state. Fatigued muscles tend to contract to a shorter-than-average resting length, and stretching exercises help fatigued muscles reestablish their normal resting length.

**Factors Affecting Flexibility**

The total range of motion around a joint is highly specific and varies from one joint to another (hip, trunk, shoulder), as well as from one individual to the next. Muscular flexibility relates primarily to genetic factors. A regular stretching program helps maintain range of motion about a joint and can help improve it as well. Joint structure (shape of the bones), joint cartilage, ligaments, tendons, muscles, skin, tissue injury, and adipose tissue (fat)—all influence range of motion about a joint. Body temperature, age, and gender also affect flexibility.

The range of motion about a given joint depends mostly on the structure of that joint. Greater range of motion, however, can be attained through plastic and elastic elongation. Plastic elongation is the permanent lengthening of soft tissue. Even though joint capsules, ligaments, and tendons are basically nonelastic, they can undergo plastic elongation. This permanent lengthening, accompanied by increased range of motion, is best attained through proper stretching exercises.

Elastic elongation is the temporary lengthening of soft tissue. Muscle tissue has elastic properties and responds to stretching exercises by undergoing elastic or temporary lengthening. Elastic elongation increases extensibility, the ability to stretch the muscles.

Changes in muscle temperature can increase or decrease flexibility. Individuals who warm up properly have better flexibility than people who do not. Cool tem-

**Flexibility in Older Adults**

Similar to muscular strength, good range of motion is critical in older life (see “Exercise and Aging” in Chapter 9). Because of decreased flexibility, older adults lose mobility and may be unable to perform simple daily tasks such as bending forward or turning. Many older adults cannot turn their head or rotate their trunk to look over their shoulder but, rather, must step around 90° to 180° to see behind them. Adequate flexibility is also important in driving. Individuals who lose range of motion with age are unable to look over their shoulder to switch lanes or to parallel park, which increases the risk for automobile accidents.

Physical activity and exercise can be hampered severely by lack of good range of motion. Because of the pain during activity, older people who have tight hip flexors (muscles) cannot jog or walk very far. A vicious circle ensues, because the condition usually worsens with further inactivity. Lack of flexibility also may be a cause of falls and subsequent injury in older adults. A simple stretching program can alleviate or prevent this problem and help people return to an exercise program.
Temperatures have the opposite effect, impeding range of motion. Because of the effects of temperature on muscular flexibility, many people prefer to do their stretching exercises after the aerobic phase of their workout. Aerobic activities raise body temperature, facilitating plastic elongation.

Another factor that influences flexibility is the amount of adipose (fat) tissue in and around joints and muscle tissue. Excess adipose tissue will increase resistance to movement, and the added bulk also hampers joint mobility because of the contact between body surfaces.

On the average, women have better flexibility than men, and they seem to retain this advantage throughout life. Aging does decrease the extensibility of soft tissue, though, resulting in less flexibility in both sexes.

The most significant contributor to lower flexibility is sedentary living. With less physical activity, muscles lose their elasticity and tendons and ligaments tighten and shorten. Inactivity also tends to be accompanied by an increase in adipose tissue, which further decreases the range of motion around a joint. Finally, injury to muscle tissue and tight skin from excessive scar tissue have negative effects on range of motion.

**Assessment of Flexibility**

Because of the lack of practical flexibility tests, most health and fitness centers rely strictly on the Sit-and-Reach Test as an indicator of flexibility. This test measures flexibility of the hamstring muscles (back of the thigh) and, to a lesser extent, the lower back muscles.

Flexibility is joint specific. This means that a lot of flexibility in one joint does not necessarily indicate that other joints are just as flexible. Therefore, the Total Body Rotation Test and the Shoulder Rotation Test—indicators of the ability to perform everyday movements such as reaching, bending, and turning—are included to determine your flexibility profile.

The Sit-and-Reach Test has been modified from the traditional test to take length of arms and legs into consideration in determining the score (see Figure 8.1). In the original Sit-and-Reach Test, the 15-inch mark

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**Key Terms**

- **Plastic elongation** Permanent lengthening of soft tissue.
- **Elastic elongation** Temporary lengthening of soft tissue.

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To perform this test, you will need the Acuflex I* Sit-and-Reach Flexibility Tester, or you may simply place a yardstick on top of a box 12” high.

1. Warm up properly before the first trial.
2. Remove your shoes for the test. Sit on the floor with the hips, back, and head against a wall, the legs fully extended, and the bottom of the feet against the Acuflex I or sit-and-reach box.
3. Place the hands one on top of the other and reach forward as far as possible without letting the head and back come off the wall (the shoulders may be rounded as much as possible, but neither the head nor the back should come off the wall at this time). The technician then can slide the reach indicator on the Acuflex I (or yardstick) along the top of the box until the end of the indicator touches the participant’s fingers. The indicator then must be held firmly in place throughout the rest of the test.
4. Now your head and back can come off the wall. Gradually reach forward three times, the third time stretching forward as far as possible on the indicator (or yardstick) and holding the final position for at least 2 seconds. Be sure that during the test you keep the backs of the knees flat against the floor.
5. Record the final number of inches reached to the nearest half inch.

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You are allowed two trials, and an average of the two scores is used as the final test score. The respective percentile ranks and fitness categories for this test are given in Tables 8.1 and 8.4.

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*The Acuflex I Flexibility Tester for the Modified Sit-and-Reach Test can be obtained from Figure Finder Collection, Novel Products, P. O. Box 408, Rockton, IL 61072-0480. Phone: 800-323-5143, Fax 815-624-4866.
of the yardstick used to measure flexibility is always set at the edge of the box where the feet are placed. This does not take into consideration an individual with long arms and/or short legs or one with short arms and/or long legs. All other factors being equal, an individual with longer arms or shorter legs, or both, receives a better rating because of the structural advantage.

The procedures and norms for the flexibility tests are described in Figures 8.1, 8.2, and 8.3 and Tables 8.1, 8.2, and 8.4.
This test can be done using the Acuflex III* Flexibility Tester, which consists of a shoulder caliper and a measuring device for shoulder rotation. If this equipment is unavailable, you can construct your own device quite easily. The caliper can be built with three regular yardsticks. Nail and glue two of the yardsticks at one end at a 90° angle, and use the third one as the sliding end of the caliper. Construct the rotation device by placing a 60” measuring tape on an aluminum or wood stick, starting at about 6” or 7” from the end of the stick.

1. Warm up before the test.
2. Using the shoulder caliper, measure the biacromial width to the nearest fourth of an inch (use the top scale on the Acuflex III). Measure biacromial width between the lateral edges of the acromion processes of the shoulders.
3. Place the Acuflex III or homemade device behind the back and use a reverse grip (thumbs out) to hold on to the device. Place the index finger of the right hand next to the zero point of the scale or tape (lower scale on the Acuflex III) and hold it firmly in place throughout the test. Place the left hand on the other end of the measuring device wherever comfortable.
4. Standing straight up and extending both arms to full length, with elbows locked, slowly bring the measuring device over the head until it reaches about forehead level. For subsequent trials, depending on the resistance encountered when rotating the shoulders, move the left grip a half inch to one inch at a time, and repeat the task until you no longer can rotate the shoulders without undue strain or starting to bend the elbows. Always keep the right-hand grip against the zero point of the scale. Measure the last successful trial to the nearest half inch. Take this measurement at the inner edge of the left hand on the side of the little finger.
5. Determine the final score for this test by subtracting the biacromial width from the best score (shortest distance) between both hands on the rotation test. For example, if the best score is 35” and the biacromial width is 15”, the final score is 20” (35 – 15 = 20). Using Tables 8.3 and 8.4, determine the percentile rank and flexibility fitness category for this test.

*The Acuflex III Flexibility Tester for the Shoulder Rotation Test can be obtained from Figure Finder Collection, Novel Products, Inc., P. O. Box 408, Rockton, IL 61072-0408. Phone: (800) 323-5143, Fax 815-624-4866.
Interpreting Flexibility Test Results

After obtaining your scores and fitness ratings for each test, you can determine the fitness category for each flexibility test using the guidelines given in Table 8.4. You should look up the number of points assigned for each fitness category in this table. The overall flexibility fitness category is obtained by totaling the number of points from all three tests and using the ratings given in Table 8.5. Record your results in Activity 8.1 and Appendix A.

8.2, and 8.3. The flexibility test results in these three tables are provided in both inches and centimeters (cm). Be sure to use the proper column to read your percentile score based on your test results. For the flexibility profile, you should take all three tests. You will be able to assess your flexibility profile in Activity 8.1. Because of the specificity of flexibility, pinpointing an “ideal” level of flexibility is difficult. Nevertheless, flexibility is important to health and fitness and independent living, so an assessment will give an indication of your current level of flexibility.
Table 8.3 Percentile Ranks for the Shoulder Rotation Test

<table>
<thead>
<tr>
<th>Percentile Rank</th>
<th>≤18 in.</th>
<th>19–35 in.</th>
<th>36–49 in.</th>
<th>≥50 in.</th>
</tr>
</thead>
<tbody>
<tr>
<td>99</td>
<td>2.2</td>
<td>-1.0</td>
<td>2.5</td>
<td>18.1</td>
</tr>
<tr>
<td>95</td>
<td>15.2</td>
<td>10.4</td>
<td>24.6</td>
<td>20.4</td>
</tr>
<tr>
<td>90</td>
<td>18.5</td>
<td>15.5</td>
<td>39.4</td>
<td>20.8</td>
</tr>
<tr>
<td>80</td>
<td>20.7</td>
<td>18.4</td>
<td>46.7</td>
<td>23.3</td>
</tr>
<tr>
<td>70</td>
<td>23.0</td>
<td>20.5</td>
<td>52.1</td>
<td>24.7</td>
</tr>
<tr>
<td>60</td>
<td>24.2</td>
<td>22.9</td>
<td>58.2</td>
<td>26.6</td>
</tr>
<tr>
<td>50</td>
<td>25.4</td>
<td>24.4</td>
<td>62.0</td>
<td>28.0</td>
</tr>
<tr>
<td>40</td>
<td>26.3</td>
<td>25.7</td>
<td>65.3</td>
<td>30.0</td>
</tr>
<tr>
<td>30</td>
<td>28.2</td>
<td>27.3</td>
<td>69.3</td>
<td>31.9</td>
</tr>
<tr>
<td>20</td>
<td>30.0</td>
<td>30.1</td>
<td>76.5</td>
<td>33.3</td>
</tr>
<tr>
<td>10</td>
<td>33.5</td>
<td>31.8</td>
<td>80.8</td>
<td>36.1</td>
</tr>
<tr>
<td>05</td>
<td>34.7</td>
<td>33.5</td>
<td>85.1</td>
<td>37.8</td>
</tr>
<tr>
<td>01</td>
<td>40.8</td>
<td>42.6</td>
<td>108.2</td>
<td>43.0</td>
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</tbody>
</table>

Table 8.4 Flexibility Fitness Categories According to Percentile Ranks

<table>
<thead>
<tr>
<th>Percentile Rank</th>
<th>Fitness Category</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>≥90</td>
<td>Excellent</td>
<td>5</td>
</tr>
<tr>
<td>70–80</td>
<td>Good</td>
<td>4</td>
</tr>
<tr>
<td>50–60</td>
<td>Average</td>
<td>3</td>
</tr>
<tr>
<td>30–40</td>
<td>Fair</td>
<td>2</td>
</tr>
<tr>
<td>≤20</td>
<td>Poor</td>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Total Points</th>
<th>Flexibility Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>≥13</td>
<td>Excellent</td>
</tr>
<tr>
<td>10–12</td>
<td>Good</td>
</tr>
<tr>
<td>7–9</td>
<td>Average</td>
</tr>
<tr>
<td>4–6</td>
<td>Fair</td>
</tr>
<tr>
<td>≤3</td>
<td>Poor</td>
</tr>
</tbody>
</table>

Principles of Muscular Flexibility Prescription

Even though genetics play a crucial role in body flexibility, the range of joint mobility can be increased and maintained through a regular stretching program. Because range of motion is highly specific to each body part (ankle, trunk, shoulder), a comprehensive stretching program should include all body parts and follow the basic guidelines for development of flexibility.

The overload and specificity of training principles (discussed in conjunction with strength development in Chapter 7) also apply to the development of muscular flexibility. To increase the total range of motion of a joint, the specific muscles surrounding that joint have to be stretched progressively beyond their accustomed length.

The principles of mode, intensity, repetitions, and frequency of exercise can also be applied to flexibility programs.

Modes of Training

There are several modes of stretching exercises and some modes are safer and more effective in terms of helping to increase flexibility:

1. Static (slow-sustained stretching)
2. Passive stretching
3. Ballistic stretching
4. Dynamic stretching
5. Controlled ballistic stretching
6. Proprioceptive neuromuscular facilitation (PNF) stretching
Static Stretching
With static stretching or slow-sustained stretching, muscles are lengthened gradually through a joint’s complete range of motion and the final position is held for a few seconds. A slow-sustained stretch causes the muscles to relax and thereby achieve greater length. This type of stretch causes little pain and has a low risk for injury. In flexibility-development programs, slow-sustained stretching exercises are the most frequently used and recommended.

Passive Stretching
Although similar to static stretching, in passive stretching, the muscles are relaxed, that is, they are in a passive state; and an external force, provided by another person or apparatus, is applied to increase the range of motion.

Ballistic Stretching
Ballistic stretching requires the impetus of a moving body or body part to force a joint or group of joints beyond the normal range of motion. This type of stretching requires a fast and repetitive bouncing motion to achieve a greater degree of stretch. An example would be repeatedly bouncing down and up to touch the toes. Ballistic stretching is the least recommended form of stretching. Fitness professionals feel that it causes muscle soreness and increases the risk of injuries to muscles and nerves. Limited data, however, are available to corroborate such effects. This form of stretching should never be performed without a previous mild aerobic warm-up and only gentle bouncing actions are recommended for those who wish to use this mode of stretching.

Dynamic Stretching
Speed of movement, momentum, and active muscular effort are used in dynamic stretching to increase the range of motion about a joint or group of joints. Unlike ballistic stretching, it does not require bouncing motions. Exaggerating a kicking action, walking lunges, and arm circles are all examples of dynamic stretching. Research indicates that dynamic stretches are preferable to static stretches before competition because dynamic stretching does not seem to have a negative effect on the athlete’s strength and power. Dynamic stretching is beneficial for athletes such as gymnasts, dancers, figure skaters, divers, hurdlers, whose sports activities require ballistic actions.

Precautions must be taken not to overstretch ligaments with ballistic and dynamic stretching. Ligaments undergo plastic or permanent elongation. If the stretching force cannot be controlled—as often occurs in fast, jerky movements—ligaments can easily be overstretched. This, in turn, leads to excessively loose joints, increasing the risk for injuries.

Controlled Ballistic Stretching
Controlled ballistic stretching, that is, exercises that are performed through slow, gentle, and controlled ballistic movements (instead of jerky, rapid, and bouncy movements) is quite effective in developing flexibility. Properly performed, this type of stretching can be done safely by most individuals.

Proprioceptive Neuromuscular Facilitation
Proprioceptive neuromuscular facilitation (PNF) stretching is based on a “contract-and-relax” method and requires the assistance of another person. The procedure is as follows:

1. The person assisting with the exercise provides initial force by pushing slowly in the direction of the desired stretch. This first stretch does not cover the entire range of motion.
2. The person being stretched then applies force in the opposite direction of the stretch, against the assistant, who tries to hold the initial degree of stretch as close as possible. This results in an isometric contraction at the angle of the stretch.
3. After 5 or 6 seconds of isometric contraction, the person being stretched relaxes the target muscle(s) completely. The assistant then increases the degree of stretch slowly to a greater angle and for the PNF technique the stretch is held for 10 to 30 seconds.
4. If a greater degree of stretch is achievable, the isometric contraction is repeated for another 5 or 6 seconds, after which the degree of stretch is slowly increased again and held for 10 to 30 seconds.
If a progressive degree of stretch is used, steps 1 through 4 can be repeated up to five times. Each isometric contraction is held for about 6 seconds. The progressive stretches are held for 10 seconds, until the last trial, when the final stretched position is held for up to 30 seconds.

Theoretically, with the PNF technique, the isometric contraction helps relax the muscle being stretched, which results in lengthening the muscle. Some fitness leaders believe PNF is more effective than slow-sustained stretching. Another benefit of PNF is an increase in strength of the muscle(s) being stretched. Research has shown approximately 17 and 35 percent increases in absolute strength and muscular endurance, respectively, in the hamstring muscle group after 12 weeks of PNF stretching.4 The results were consistent in both men and women and are attributed to the isometric contractions performed during PNF. Disadvantages of PNF are (1) more pain, (2) the need for a second person to assist, and (3) the need for more time to conduct each session.

Physiological Response to Stretching

Located within skeletal muscles are two sensory organs, also known as proprioceptors: The muscle spindle and the Golgi tendon organ. Their function is to protect muscles from injury during stretching.

Muscle spindles are located within the belly of the muscle and their primary function is to detect changes in muscle length. If over-stretched or stretched too fast, the spindles send messages to the central nervous system, and through a feedback loop, motor neurons are activated and cause muscle contraction to resist muscle stretch. This mechanism is known as the stretch reflex. Muscle spindle action explains why injury rates are higher with ballistic stretching. Fast stretching speeds trigger the stretch reflex and cause muscles to contract and develop tension that can lead to injury.

Golgi tendon organs are located at the point where muscle fibers attach to the muscle tendon. When excessive force is generated by a muscle, these organs trigger a response opposite to that of the spindles; an inverse stretch reflex action that inhibits the muscle contraction and leads to muscle relaxation. The Golgi tendon organ prevents injury to the muscle by keeping it from generating too much tension while being stretched. This response explains the effectiveness of the PNF technique in increasing joint range of motion. The isometric contraction following the initial stretch triggers the inverse stretch reflex, thus lessening the tension and allowing the muscle to relax. At this point, the muscle tolerates a greater degree of stretch.

All stretching should be done to slightly below the pain threshold. As participants reach this point, they should try to relax the muscle being stretched as much as possible. If you feel pain, the load is too high and may cause injury. After completing the stretch, the body part is brought back gradually to the starting point.

Critical Thinking

Carefully consider the relevance of stretching exercises to your personal fitness program. How much importance do you place on these exercises? • Have some conditions improved through your stretching program, or have certain specific exercises contributed to your health and well-being?

Repetitions

The time required for an exercise session for development of flexibility is based on the number of repetitions and the length of time each repetition is held in the final stretched position. As a general recommendation, a minimum of 15 minutes of flexibility exercise, including the major muscle/tendon units of the body, should be performed. Four or more repetitions per exercise should be done, holding the final position each time for 15 to 60 seconds.5

As flexibility increases, a person can gradually increase the time each repetition is held from 15 to about 60 seconds. Data indicate that stretching for 15 to 60 seconds is better to increase range of motion than stretching for shorter periods of time and is just as effective as stretching for longer durations.6 Individuals who are susceptible to flexibility injuries should limit each stretch to 20 seconds. Pilates exercises are recommended for these individuals, as they increase joint stability (also see Chapter 7, pages 245–246).

Key Terms

Static stretching (slow-sustained stretching) Exercising in which the muscles are lengthened gradually through a joint’s complete range of motion.

Passive stretching Stretching exercises performed with the aid of an external force applied by either another individual or an external apparatus.

Ballistic (dynamic) stretching Stretching exercises performed with jerky, rapid, and bouncy movements.

Dynamic stretching Stretching exercises that require speed of movement, momentum, and active muscular effort to help increase the range of motion about a joint or group of joints.

Controlled ballistic stretching Exercises done with slow, short, gentle, and sustained movements.

Proprioceptive neuromuscular facilitation (PNF) Mode of stretching that uses reflexes and neuromuscular principles to relax the muscles being stretched.

Intensity

The intensity, or degree of stretch, when doing flexibility exercises should be to only a point of mild discomfort or tightness at the end of the range of motion. Undue pain does not have to be part of the stretching routine.

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Exercises that are not recommended during warm-up can lead to a temporary short-term decrease in strength and power. Thus, intense stretching conducted prior to participating in athletic events that rely on force and power for peak performance is not recommended.\(^7\)

In terms of whether stretching before or after exercise is more effective for preventing injuries, the best time to stretch is controversial. In limited studies on athletic populations, the evidence is unclear. Additional research is necessary to clarify this issue.

In general, unless the activity requires extensive range of motion, a good time to stretch is after an aerobic workout. Higher body temperature in itself helps to increase the joint range of motion. Muscles also are fatigued following exercise, and a fatigued muscle tends to shorten, which can lead to soreness and spasms. Stretching exercises help fatigued muscles reestablish their normal resting length and prevent unnecessary pain.

### Frequency of Exercise

Flexibility exercises should be conducted a minimum of two or three days per week, but ideally five to seven days per week. After six to eight weeks of almost daily stretching, flexibility can be maintained with two or three sessions per week, involving the major muscle/tendon groups of the body and doing four repetitions of 15 to 60 seconds for each exercise performed. Figure 8.4 summarizes the guidelines for flexibility development.

Over the years, people who lack adequate flexibility, and those who neglect stretching, can expect to see a decline in functional capacity and become more susceptible to injuries. Regular stretching increases not only range of motion by increasing muscular elongation but also by enhancing a person's level of stretch tolerance.

### When to Stretch?

Many people do not differentiate a warm-up from stretching. Warming up means starting a workout slowly with walking, cycling, or slow jogging, followed by gentle stretching (not through the entire range of motion). Stretching implies movement of joints through their full range of motion and holding the final degree of stretch according to recommended guidelines.

A warm-up that progressively increases muscle temperature and mimics movement that will occur during training enhances performance. For some activities, gentle stretching is recommended in conjunction with warm-up routines. Before steady activities (walking, jogging, cycling), a warm-up of 3 to 5 minutes is recommended. The recommendation is up to 10 minutes before stop-and-go activities (e.g., racquet sports, basketball, and soccer) and athletic participation in general (e.g., football and gymnastics). Activities that require abrupt changes in direction are more likely to cause muscle strains if they are performed without proper warm-up that includes mild stretching.

Sports-specific/pre-exercise stretching can improve performance in sports that require a greater-than-average range of motion, such as gymnastics, dance, diving, and figure skating. A few studies suggest that intense stretching during warm-up can lead to a temporary short-term (up to 60 minutes) decrease in strength and power. Thus, intense stretching conducted prior to participating in athletic events that rely on force and power for peak performance is not recommended.\(^7\)

In terms of whether stretching before or after exercise is more effective for preventing injuries, the best time to stretch is controversial. In limited studies on athletic populations, the evidence is unclear. Additional research is necessary to clarify this issue.

In general, unless the activity requires extensive range of motion, a good time to stretch is after an aerobic workout. Higher body temperature in itself helps to increase the joint range of motion. Muscles also are fatigued following exercise, and a fatigued muscle tends to shorten, which can lead to soreness and spasms. Stretching exercises help fatigued muscles reestablish their normal resting length and prevent unnecessary pain.

### Flexibility Exercises

To improve body flexibility, each major muscle group should be subjected to at least one stretching exercise. A complete set of exercises for developing muscular flexibility is presented on pages 292–294.

Although you may not be able to hold a final stretched position with some of these exercises (such as lateral head tilts and arm circles), you still should perform the exercise through the joint’s full range of motion. Depending on the number and length of repetitions, a complete workout will last between 15 and 30 minutes.

### Contraindicated Exercises

Most strength and flexibility exercises are relatively safe to perform, but even safe exercises can be hazardous if they are performed incorrectly. Some exercises may be safe to perform occasionally but, when executed repeatedly, may cause trauma and injury. Pre-existing muscle or joint conditions (old sprains or injuries) can further increase the risk of harm during certain exercises. As you develop your exercise program, you are encouraged to follow the exercise descriptions and guidelines given in this book.

A few exercises, however, are not recommended because of the potential high risk for injury. These exercises sometimes are done in videotaped workouts and some fitness classes. **Contraindicated exercises** may cause harm because of the excessive strain they place on muscles and joints, in particular the spine, lower back, knees, neck, or shoulders.

Illustrations of contraindicated exercises are presented in Figure 8.5. Safe alternative exercises are listed...
Figure 8.5 Contraindicated exercises.

- **Double-Leg Lift**
  - All three of these exercises cause excessive strain on the spine and may harm intervertebral discs.
  - **Alternatives:** Strength Exercises 4 and 17, pages 255 and 259

- **Upright Double-Leg Lifts**
  - **Alterations:** Flexibility Exercises 20 and 8, pages 295 and 293

- **V-Sits**
  - **Alterations:** Flexibility Exercises 12, 15, 16, 17, and 19, pages 294 and 295

- **Staring Toe Touch**
  - Excessive strain on the knee and lower back.
  - **Alterations:** Flexibility Exercise 12, page 294

- **Swan Stretch**
  - Excessive strain on the spine; may harm intervertebral discs.
  - **Alteration:** Flexibility Exercise 20, page 295

- **Knee to Chest**
  - (with hands over the shin)
  - Excessive strain on the knee.
  - **Alternative:** Flexibility Exercises 15 and 16, page 294

- **Sit-Ups with Hands Behind the Head**
  - Excessive strain on the neck.
  - **Alternatives:** Strength Exercises 4 and 17, pages 256 and 259

- **Cradle**
  - Excessive strain on the spine, knees, and shoulders.
  - **Alternatives:** Flexibility Exercises 20 and 8, pages 295 and 293

- **Full Squat**
  - Excessive strain on the knees.
  - **Alternatives:** Strength Exercises 1, 16, 28A and 28B, pages 254, 259, and 263

- **Yoga Plow**
  - Excessive strain on the spine, neck, and shoulders.
  - **Alternatives:** Flexibility Exercises 12, 15, 16, 17, and 19, pages 294 and 295

- **Donkey Kicks**
  - Excessive strain on the back, shoulders, and neck.
  - **Alternatives:** Flexibility Exercises 8 and 14, pages 293 and 294

- **Standing Toe Touch**
  - Excessive strain on the knee and lower back.
  - **Alterations:** Flexibility Exercise 12, page 294

- **Knee to Chest**
  - Excessive strain on the knee.
  - **Alternative:** Flexibility Exercise 8 and 12, pages 293 and 294

- **The Hero**
  - Excessive strain on the knees.
  - **Alternatives:** Flexibility Exercises 12 and 19, pages 294 and 295

- **Swan Stretch**
  - Excessive strain on the spine; may harm intervertebral discs.
  - **Alternative:** Flexibility Exercise 20, page 295

- **Standing Toe Touch**
  - Excessive strain on the knee and lower back.
  - **Alternatives:** Strength Exercises 4 and 17, pages 255 and 259

- **Knee to Chest**
  - (with hands over the shin)
  - Excessive strain on the knee.
  - **Alternative:** Flexibility Exercises 15 and 16, page 294

- **Sit-Ups with Hands Behind the Head**
  - Excessive strain on the neck.
  - **Alternatives:** Strength Exercises 4 and 17, pages 256 and 259
below each contraindicated exercise and are illustrated in the exercises for strength (pages 254–258) and flexibility (pages 292–295). In isolated instances, a qualified physical therapist may select one or a few of the contraindicated exercises to treat a specific injury or disability in a carefully supervised setting. Unless you are specifically instructed to use one of these exercises, it is best that you select safe exercises from this book.

Preventing and Rehabilitating Low-Back Pain

Few people make it through life without having low-back pain at some point. An estimated 60 to 80 percent of the population has been afflicted by back pain or injury. Estimates indicate that more than 75 million Americans suffer from chronic back pain. Each year more than $86 billion are spent in the United States to care for back pain, with limited evidence that increased spending really helps people. When it comes to back pain, prevention and treatment through physical exercise are by far the best medicine.

It has been determined that backache syndrome is preventable more than 80 percent of the time, and is caused by (a) physical inactivity, (b) poor postural habits and body mechanics, (c) excessive body weight, and/or (d) psychological stress. Data also indicate that back injuries are more common among smokers because it reduces blood flow to the spine—increasing back pain susceptibility.

More than 95 percent of all back pain is related to muscle/tendon injury, and only 1 to 5 percent is related to intervertebral disc damage. Usually, back pain is the result of repeated micro-injuries that occur over an extended time (sometimes years) until a certain movement, activity, or excessive overload causes a significant injury to the tissues.

People tend to think of back pain as a problem with the skeleton. Actually, the spine’s curvature, alignment, and movement are controlled by surrounding muscles. The most common reason for chronic low-back pain is a lack of physical activity. In particular, a major contributor to back pain is excessive sitting, which causes back muscles to shorten, stiffen, and become weaker.

Deterioration or weakening of the abdominal and gluteal muscles, along with tightening of the lower back (erector spinae) muscles, brings about an unnatural forward tilt of the pelvis (Figure 8.6). This tilt puts extra pressure on the spinal vertebrae, causing pain in the lower back. Accumulation of fat around the midsection of the body contributes to the forward tilt of the pelvis, which further aggravates the condition.

Low-back pain frequently is associated with faulty posture and improper body mechanics, or body positions. Incorrect posture and poor mechanics, such as prolonged static postures, repetitive bending and pushing, twisting a loaded spine, and prolonged (more than an hour) sitting with little movement increase strain on the lower back and many other bones, joints, muscles, and ligaments. Figure 8.7 provides a summary of proper body mechanics that promote back health.

In the majority of back injuries, pain is present only with movement and physical activity. According to the National Institutes of Health (NIH), most back pain goes away on its own in a few weeks. A physician should be consulted if any of the following conditions are present:

- Numbness in the legs
- Trouble urinating
- Leg weakness
- Fever
- Unintentional weight loss
- Persistent severe pain even at rest

A physician can rule out any disc damage, arthritis, osteoporosis, a slipped vertebrae, spinal stenosis (narrowing of the spinal canal), or other serious condition. For common back pain, he may prescribe proper bed rest using several pillows under the knees for leg support (Figure 8.7). This position helps relieve muscle spasms by stretching the muscles involved. He may also prescribe a muscle relaxant or anti-inflammatory medication (or both) and some type of physical therapy.

In most cases, an x-ray and MRI is not required unless pain lingers for more than four to six weeks. In the early stages of back pain, tight muscles and muscle spasms tend to compress the vertebrae, squeezing the intervertebral disks and revealing apparent disk problems on an x-ray. In these cases, the real problem is the tight muscles and
Whatever the cause of low back pain, part of its treatment is the correction of faulty posture. But good posture is not simply a matter of “standing tall.” It refers to correct use of the body at all times. In fact, for the body to function in the best of health it must be so used that no strain is put upon the muscles, joints, bones, and ligaments. To prevent low back pain, avoiding strain must become a way of life, practiced while lying, sitting, standing, walking, working, and exercising. When body position is correct, internal organs have enough room to function normally and blood circulates more freely.

With the help of this guide, you can begin to correct the positions and movements that bring on or aggravate backache. Particular attention should be paid to the positions recommended for resting, since it is possible to strain the muscles of the back and neck even while lying in bed. By learning to live with good posture, under all circumstances, you will gradually develop the proper carriage and stronger muscles needed to protect and support your hard-working back.

### How to Stay on Your Feet Without Tiring Your Back

To prevent strain and pain in everyday activities, it is restful to change from one task to another before fatigue sets in. Housewives can lie down between chores; others should check body position frequently, drawing in the abdomen, flattening the back, bending the knees slightly.

#### Not this way

- Use of a footrest relieves swayback.

### How to Sit Correctly

A back’s best friend is a straight, hard chair. If you can’t get the chair you prefer, learn to sit properly on whatever chair you get. To correct sitting position from forward slump:

1. Throw head well back, then bend it forward to pull in the chin. This will straighten the back. Now tighten abdominal muscles to raise the chest. Check position frequently.

2. Use of footrest relieves swayback. Aim is to have knees higher than hips.

3. Correct way to sit while driving, close to pedals. Use seat belt or hard backrest, available commercially.

4. TV slump leads to “dowager’s hump,” strains neck and shoulders.

5. If chair is too high, swayback is increased.

6. Keep neck and back in as straight a line as possible with the spine. Bend forward from hips.

7. Driver’s seat too far from pedals emphasizes curve in lower back.


### Check Your Carriage Here

In correct, fully erect posture, a line dropped from the ear will go through the tip of the shoulder, middle of hip, back of kneecap, and front of anklebone.

#### Incorrect

- Lower back is arched or hollow.

#### Incorrect

- Upper back is stooped, lower back is arched, abdomen sags.

#### Correct

- In correct position, chin is in, head up, back flattened, pelvis held straight.

#### In correct position, chin is in, head up, back flattened, pelvis held straight.
How to Put Your Back to Bed
For proper bed posture, a firm mattress is essential. Bedboards, sold commercially, or devised at home, may be used with soft mattresses. Bedboards, preferably, should be made of 3/4-inch plywood. Faulty sleeping positions intensify swayback and result not only in backache but in numbness, tingling, and pain in arms and legs.

Correct:
Lying on side with knees bent effectively flattens the back. Flat pillow may be used to support neck, especially when shoulders are broad.

Incorrect:
Lying flat on back makes swayback worse.

Use of high pillow strains neck, arms, shoulders.

Sleeping face down exaggerates swayback, strains neck and shoulders.

Bending one hip and knee does not relieve swayback.

Proper arrangement of pillows for resting or reading in bed.

A straight-back chair used behind a pillow makes a serviceable backrest.

When Doing Nothing, Do it Right
- Rest is the first rule for the tired, painful back. The above positions relieve pain by taking all pressure and weight off the back and legs.
- Note pillows under knees to relieve strain on spine.
- For complete relief and relaxing effect, these positions should be maintained from 5 to 25 minutes.

Exercise Without Getting Out of Bed
Exercises to be performed while lying in bed are aimed not so much at strengthening muscles as at teaching correct positioning. But muscles used correctly become stronger and in time are able to support the body with the least amount of effort.

Do all exercises in this position.
Legs should not be straightened.

Bring knee up to chest. Lower slowly but do not straighten leg. Relax. Repeat with each leg 10 times.

Exercise Without Attracting Attention
Use these inconspicuous exercises whenever you have a spare moment during the day, both to relax tension and improve the tone of important muscle groups.
1. Rotate shoulders, forward and backward.
2. Turn head slowly side to side.
3. Watch an imaginary plane take off, just below the right shoulder. Stretch neck, follow it slowly as it moves up, around and down, disappearing below the other shoulder. Repeat, starting on left side.
4. Slowly, slowly, touch left ear to left shoulder, right ear to right shoulder. Raise both shoulders to touch ears, drop them as far down as possible.
5. At any pause in the day—waiting for an elevator to arrive, for a specific traffic light to change—pull in abdominal muscles, tighten, hold it for the count of eight without breathing. Relax slowly. Increase the count gradually after the first week, practice breathing normally with the abdomen flat and contracted. Do this sitting, standing, and walking.

Bring both knees slowly up to chest (place your hands on the lower thigh behind the other knee). Tighten muscles of abdomen, press back flat against bed. Hold knees to chest 20 seconds, then lower slowly. Relax. Repeat 5 times. This exercise gently stretches the shortened muscles of the lower back, while strengthening abdominal muscles.

Rules to Live By—From Now On
1. Never bend from the waist only; bend the hips and knees.
2. Never lift a heavy object higher than your waist.
3. Always turn and face the object you wish to lift.
4. Avoid carrying unbalanced loads; hold heavy objects close to your body.
5. Never carry anything heavier than you can manage with ease.
6. Never lift or move heavy furniture. Wait for someone to do it who knows the principles of leverage.
7. Avoid sudden movements, sudden “overloading” of muscles. Learn to move deliberately, swinging the legs from the hips.
8. Learn to keep the head in line with the spine, when standing, sitting, lying in bed.
9. Put soft chairs and deep couches on your “don’t sit” list. During prolonged sitting, cross your legs to rest your back.
10. Your doctor is the only one who can determine when low back pain is due to faulty posture and he is the best judge of when you may do general exercises for physical fitness. When you do, omit any exercise that arches or overstrains the lower back: backward bends, or forward bends, touching the toes with the knees straight.
11. Wear shoes with moderate heels, all about the same height. Avoid changing from high to low heels.
12. Put a footrest under the desk and a footrest under the crib.
13. Diaper the baby sitting next to him or her on the bed.
14. Don’t stoop and stretch to hang the wash; raise the clothesbasket and lower the washline.
15. Beg or buy a rocking chair. Rocking rests the back by changing the muscle groups used.
16. Train yourself vigorously to use your abdominal muscles to flatten your lower abdomen. In time, this muscle contraction will become habitual, making you the envied possessor of a youthful body profile!
17. Don’t strain to open windows or doors.
18. For good posture, concentrate on strengthening “nature’s corset”—the abdominal and buttock muscles. The pelvic roll exercise is especially recommended to correct the postural relation between the pelvis and the spine.
subsequent muscle spasms. A daily physical activity and stretching program helps to decompress the spine, stretch tight muscles, strengthen weak muscles, and increases blood flow (promoting healing) to the back muscles.

Time is often the best treatment approach. Even with severe pain, most people feel better within days or weeks without being treated by health care professionals. Up to 90 percent of people will heal on their own. To relieve symptoms, you may use over-the-counter pain relievers and hot or cold packs. You also should stay active to avoid further weakening of the back muscles. Low-impact activities such as walking, swimming, water aerobics, and cycling are recommended. Once you are pain free in the resting state, you need to start correcting the muscular imbalance by stretching the tight muscles and strengthening the weak ones. Stretching exercises always are performed first.

If there is no indication of disease or injury (such as leg numbness or pain), a herniated disc, or fractures, spinal manipulation by a chiropractor or other health care professional can provide pain relief. Spinal manipulation as a treatment modality for low back pain has been endorsed by the federal Agency for Health Care Policy and Research. The guidelines suggest that spinal manipulation may help to alleviate discomfort and pain during the first few weeks of an acute episode of low-back pain. Generally, benefits are seen in fewer than 10 treatments. People who have had chronic pain for more than 6 months should avoid spinal manipulation until they have been thoroughly examined by a physician.

Back pain is considered chronic if it persists longer than three months. Surgery is seldom the best option, as it often weakens the spine. Scar tissue and surgical alterations also decrease the success rate of a subsequent surgery. Only about 10 percent of people with chronic pain are candidates for surgery. If surgery is recommended, always seek a second opinion. And consider all other options. In many cases, pushing beyond the pain and participating in aggressive physical therapy (“exercise boot camps” for back pain) aimed at strengthening the muscles that support the spine are what’s needed to overcome the condition. Data from the Physician’s Neck & Back Clinic in Minneapolis showed that only 3 in 38 patients recommended for surgery needed such upon completion of a 10-week aggressive physical therapy program.

Back pain can be reduced greatly through aerobic exercise, muscular flexibility exercise, and muscular strength and endurance training that includes specific exercises to strengthen the spine-stabilizing muscles. Exercise requires effort by the patient, and it may create discomfort initially, but exercise promotes circulation, healing, muscle size, and muscle strength and endurance. Many patients abstain from aggressive physical therapy because they are unwilling to commit the time required for the program.

In terms of alleviating back pain, exercise is medicine, but it needs to be the right type of exercise. Aerobic exercise is beneficial because it helps decrease body fat and psychological stress. During an episode of back pain, however, people often avoid activity and cope by getting more rest. Rest is recommended if the pain is associated with a herniated disc, but if your physician rules out a serious problem, exercise is a better choice of treatment. Exercise helps restore physical function, and individuals who start and maintain an aerobic exercise program have back pain less frequently. Individuals who exercise also are less likely to require surgery or other invasive treatments.

Regular stretching exercises that help the hip and trunk go through a functional range of motion, rather than increasing the range of motion, are recommended. That is, for proper back care, stretching exercises should not be performed to the extreme range of motion. Individuals with a greater spinal range of motion also have a higher incidence of back injury. Spinal stability, instead of mobility, is desirable for back health.

Yoga exercises are particularly beneficial to enhance flexibility; and Iyengar yoga in particular, has been shown to relieve chronic low back pain. In fact yoga may help relieve chronic back pain better than conventional medicine. Following 24 weeks of biweekly classes, yoga participants had greater improvement in functional disability along with a decrease in pain intensity and low back pain–related depression. These benefits were still present six months after the end of class participation.

A strengthening program for a healthy back should be conducted around the endurance threshold—15 or more repetitions to near fatigue. Muscular endurance of the muscles that support the spine is more important than absolute strength because these muscles perform their work during the course of an entire day.

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**Critical Thinking**

Consider your own low back health. Have you ever had episodes of low back pain? • If so, how long did it take you to recover, and what helped you recover from this condition?

Several exercises for preventing and rehabilitating the backache syndrome are given on pages 295–296. These exercises can be done twice or more daily when a person has back pain. Under normal circumstances, doing these exercises three or four times a week is enough to prevent the syndrome. Using some of the additional core exercises listed in Chapter 7 (“Core Strength Training,” page 244) will further enhance your low-back management program. Back pain recurs more often in people who rely solely on medication, compared with people who use both medication and exercise therapy to recover.

---

**Key Terms**

- **Iyengar yoga** Form of yoga that aims to develop flexibility, strength, balance, and stamina using props (belts, blocks, blankets, and chairs) to aid in the correct performance of asanas or yoga postures.
Effects of Posture

Good posture enhances personal appearance, self-image, confidence, improves balance and endurance, protects against misalignment-related pains and aches, prevents falls, and enhances your overall sense of well-being.\(^{15}\) The relationship between different body parts is the essence of posture.

Poor posture is a risk factor for musculoskeletal problems of the neck, shoulders, and lower back. Incorrect posture also strains hips and knees. Faulty posture and weak and inelastic muscles are also a leading cause of chronic low-back problems.

Adequate body mechanics also aid in reducing chronic low back pain. Proper body mechanics means using correct positions in all the activities of daily life, including sleeping, sitting, standing, walking, driving, working, and exercising. Because of the high incidence of low back pain, illustrations of proper body mechanics and a series of corrective and preventive exercises are shown in Figure 8.7 and Activity 8.2. Besides engaging in the recommended exercises you need to continually strive to maintain good posture. As posture improves, you frequently become motivated to change other aspects, such as muscular strength and flexibility and decreasing body fat.

Effects of Stress

Psychological stress, too, may lead to back pain.\(^{16}\) The brain is “hardwired” to the back muscles. Excessive stress causes muscles to contract. Frequent tightening of the back muscles can throw the back out of alignment and constrict blood vessels that supply oxygen and nutrients to the back. Chronic stress also increases the release of hormones that have been linked to muscle and tendon injuries. Furthermore, people under stress tend to forget proper body mechanics, placing themselves at unnecessary risk for injury. If you are undergoing excessive stress and back pain at the same time, proper stress management (see Chapter 12) should be a part of your comprehensive back-care program.

Personal Flexibility and Low Back Conditioning Program

Activity 8.2 allows you to develop your own flexibility and low-back conditioning programs. Some of the exercises that help increase spinal stability and muscular strength endurance require isometric contractions. The recommendation calls for these contractions to be held for 2 to 20 seconds. The length of the hold will depend on your current fitness level and the difficulty of each exercise. For most exercises, you may start with a 2- to 5-second hold. Over the course of several weeks, you can increase the length of the hold up to 20 seconds.
Muscular Flexibility Assessment

Name: ___________________________ Date: ____________
Course: ___________________________ Section: ____________ Gender: _______ Age: _______

<table>
<thead>
<tr>
<th>Test</th>
<th>Score</th>
<th>Fitness Category</th>
<th>Point</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modified Sit-and-Reach</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Total Body Rotation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Right</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Left</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Shoulder Rotation</td>
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</tr>
</tbody>
</table>

Total Points: ___________________________

Overall Flexibility Category: ___________________________

Flexibility Development and Low Back Conditioning Programs

I. Stage of Change for Flexibility Training

Using Figure 2.5 (page 61) and Table 2.3 (page 60), identify your current stage of change for participation in a muscular stretching program:

II. Instruction

Perform all of the recommended flexibility exercises given on pages 292–294. Use a combination of slow-sustained and proprioceptive neuromuscular facilitation stretching techniques. Indicate the technique(s) used for each exercise and, where applicable, the number of repetitions performed and the length of time that the final degree of stretch was held.

<table>
<thead>
<tr>
<th>Stretching Exercises Exercise</th>
<th>Stretching Technique</th>
<th>Repetitions</th>
<th>Length of Final Stretch</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lateral head tilt</td>
<td></td>
<td></td>
<td>NA*</td>
</tr>
<tr>
<td>Arm circles</td>
<td></td>
<td></td>
<td>NA</td>
</tr>
<tr>
<td>Side stretch</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Body rotation</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Chest stretch</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Shoulder hyperextension stretch</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Shoulder rotation stretch</td>
<td></td>
<td></td>
<td>NA</td>
</tr>
<tr>
<td>Quad stretch</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heel cord stretch</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Adductor stretch</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sitting adductor stretch</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sit-and-reach stretch</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Triceps stretch</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Not Applicable
Flexibility Development and Low Back Conditioning Programs (continued)

**Stretching Schedule** (Indicate days, time, and place where you will stretch):

Flexibility-training days:  M  T  W  Th  F  Sa  Su  
Time of day:  
Place:  

**Low Back Conditioning Program**

Perform all of the recommended exercises for the prevention and rehabilitation of low back pain given on pages 294–296. Indicate the number of repetitions performed for each exercise.

<table>
<thead>
<tr>
<th>Flexibility Exercises</th>
<th>Repetitions</th>
<th>Strength/Endurance Exercises</th>
<th>Repetitions</th>
<th>Seconds Held</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hip flexors stretch</td>
<td></td>
<td>Pelvic tilt</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single-knee-to-chest stretch</td>
<td></td>
<td>The cat</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Double-knee-to-chest stretch</td>
<td></td>
<td>Abdominal crunch or abdominal curl-up</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Upper and lower back stretch</td>
<td></td>
<td>Reverse crunch</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sit-and-reach stretch</td>
<td></td>
<td>Supine bridge</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gluteal stretch</td>
<td></td>
<td>Pelvic clock</td>
<td></td>
<td></td>
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<td>Back extension stretch</td>
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<td>Lateral bridge</td>
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<td>Trunk rotation and lower back stretch</td>
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<td>Prone bridge</td>
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<td>Leg press</td>
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<td>Lat pull-down</td>
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<td>Back extension</td>
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**Proper Body Mechanics**

Perform the following tasks using the proper body mechanics given in Figure 8.7 (pages 285–286). Check off each item as you perform the task:

- Standing (carriage) position
- Sitting position
- Bed posture
- Resting position for tired and painful back
- Lifting an object

**“Rules to Live By—From Now On”**

Read the 18 “Rules to Live By—From Now On” given in Figure 8.7 (page 286) and indicate below those rules that you need to work on to improve posture and body mechanics and prevent low back pain.
Assess Your Behavior

1. Do you give flexibility exercises the same priority in your fitness program as you do aerobic and strength training?

2. Are stretching exercises a part of your fitness program at least two times per week?

3. Do you include exercises to strengthen and enhance body alignment in your regular strength and flexibility program?

Assess Your Knowledge

Evaluate how well you understand the concepts presented in this chapter using the chapter-specific quizzing available in the online materials at www.cengagebrain.com.

1. Muscular flexibility is defined as
   a. the capacity of joints and muscles to work in a synchronized manner.
   b. the achievable range of motion at a joint or group of joints without causing injury.
   c. the capability of muscles to stretch beyond their normal resting length without injury to the muscles.
   d. the capacity of muscles to return to their proper length following the application of a stretching force.
   e. the limitations placed on muscles as the joints move through their normal planes.

2. Good flexibility
   a. promotes healthy muscles and joints.
   b. decreases the risk of injury.
   c. improves posture.
   d. decreases the risk of chronic back pain.
   e. All are correct choices.

3. Plastic elongation is a term used in reference to
   a. permanent lengthening of soft tissue.
   b. increased flexibility achieved through dynamic stretching.
   c. temporary elongation of muscles.
   d. the ability of a muscle to achieve a complete degree of stretch.
   e. lengthening of a muscle against resistance.

4. The most significant contributors to loss of flexibility are
   a. sedentary living and lack of physical activity.
   b. weight and power training.
   c. age and injury.
   d. muscular strength and endurance.
   e. excessive body fat and low lean tissue.

5. Which of the following is not a mode of stretching?
   a. proprioceptive neuromuscular facilitation
   b. elastic elongation
   c. ballistic stretching
   d. slow-sustained stretching
   e. All are modes of stretching.

6. PNF can help increase
   a. muscular strength.
   b. muscular flexibility.
   c. muscular endurance.
   d. range of motion.
   e. All are correct choices.

7. When performing stretching exercises, the degree of stretch should be
   a. through the entire arc of movement.
   b. to about 80 percent of capacity.
   c. to mild tension at the end of the range of motion.
   d. applied until the muscle(s) start shaking.
   e. progressively increased until the desired stretch is attained.

8. When stretching, the final stretch should be held for
   a. 1 to 10 seconds.
   b. 15 to 60 seconds.
   c. 30 to 90 seconds.
   d. 1 to 3 minutes.
   e. as long as the person is able to sustain the stretch.

9. Low back pain is associated primarily with
   a. physical inactivity.
   b. faulty posture.
   c. excessive body weight.
   d. improper body mechanics.
   e. All are correct choices.

10. The following exercise helps stretch the lower back and hamstring muscles:
    a. adductor stretch.
    b. cat stretch.
    c. back extension stretch.
    d. single-knee-to-chest stretch.
    e. quad stretch.

Correct answers can be found at the back of the book.
EXERCISE 1 NECK STRETCHES

**Action:** Gently tilt the head laterally (a). You may increase the degree of stretch by gently pulling with one hand (b). You may also stretch the neck by raising your head toward the ceiling (c—do not extend your head backward; look straight forward). You may also turn your head 30° and gradually bring the head forward until you feel an adequate stretch in the muscles on the back of the neck (d). The degree of stretch can again be increased by gently pulling forward with the hand (e). Perform the exercises on both the right and left sides. Repeat each exercise several times, and hold the final stretched position for several seconds.

**Areas Stretched:** Neck flexors and extensors; ligaments of the cervical spine

EXERCISE 3 SIDE STRETCH

**Action:** Stand straight up, feet separated to shoulder-width, and place your hands on your waist. Now move the upper body to one side and hold the final stretch for a few seconds. Repeat on the other side.

**Areas Stretched:** Muscles and ligaments in the pelvic region

EXERCISE 2 ARM CIRCLES

**Action:** Gently circle your arms all the way around. Conduct the exercise in both directions.

**Areas Stretched:** Shoulder muscles and ligaments

EXERCISE 4 BODY ROTATION

**Action:** Place your arms slightly away from the body and rotate the trunk as far as possible, holding the final position for several seconds. Conduct the exercise for both the right and left sides of the body. You also can perform this exercise by standing about 2 feet away from the wall (back toward the wall) and then rotating the trunk, placing the hands against the wall.

**Areas Stretched:** Hip, abdominal, chest, back, neck, and shoulder muscles; hip and spinal ligaments

EXERCISE 5 CHEST STRETCH

**Action:** Place your hands on the shoulders of your partner, who in turn will push you down by your shoulders. Hold the final position for a few seconds.

**Areas Stretched:** Chest (pectoral) muscles and shoulder ligaments
EXERCISE 6 SHOULDER HYPEREXTENSION STRETCH

Action: Have a partner grasp your arms from behind by the wrists and slowly push them upward. Hold the final position for a few seconds.

Areas Stretched: Deltoid and pectoral muscles; ligaments of the shoulder joint

EXERCISE 7 SHOULDER ROTATION STRETCH

Action: With the aid of surgical tubing or an aluminum or wood stick, place the tubing or stick behind your back and grasp the two ends using a reverse (thumbs-out) grip. Slowly bring the tubing or stick over your head, keeping the elbows straight. Repeat several times (bring the hands closer together for additional stretch).

Areas Stretched: Deltoid, latissimus dorsi, and pectoral muscles; shoulder ligaments

EXERCISE 8 QUAD STRETCH

Action: Lie on your side and move one foot back by flexing the knee. Grasp the front of the ankle and pull the ankle toward the gluteal region. Hold for several seconds. Repeat with the other leg.

Areas Stretched: Quadriceps muscle; knee and ankle ligaments

EXERCISE 9 HEEL CORD STRETCH

Action: Stand against the wall or at the edge of a step and stretch the heel downward, alternating legs. Hold the stretched position for a few seconds.

Areas Stretched: Heel cord (Achilles tendon); gastrocnemius and soleus muscles

EXERCISE 10 ADDUCTOR STRETCH

Action: Stand with your feet about twice shoulder-width apart and place your hands slightly above the knees. Flex one knee and slowly go down as far as possible, holding the final position for a few seconds. Repeat with the other leg.

Areas Stretched: Hip adductor muscles

EXERCISE 11 SITTING ADDUCTOR STRETCH

Action: Sit on the floor and bring your feet in close to you, allowing the soles of the feet to touch each other. Now place your forearms (or elbows) on the inner part of the thigh and push the legs downward, holding the final stretch for several seconds.

Areas Stretched: Hip adductor muscles
EXERCISE 12 SIT-AND-REACH STRETCH

**Action:** Sit on the floor with legs together and gradually reach forward as far as possible. Hold the final position for a few seconds. This exercise also may be performed with the legs separated, reaching to each side as well as to the middle.

**Areas Stretched:** Hamstrings and lower back muscles; lumbar spine ligaments

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EXERCISE 13 TRICEPS STRETCH

**Action:** Place the right hand behind your neck. Grasp the right arm above the elbow with the left hand. Gently pull the elbow backward. Repeat the exercise with the opposite arm.

**Areas Stretched:** Back of upper arm (triceps muscle); shoulder joint

**Note:** Exercises 14 through 21 and 23 are also flexibility exercises and can be added to your stretching program.

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EXERCISE 14 HIP FLEXORS STRETCH

**Action:** Kneel down on an exercise mat or a soft surface, or place a towel under your knees. Raise the left knee off the floor and place the left foot about 3 feet in front of you. Place your left hand over your left knee and the right hand over the back of the right hip. Keeping the lower back flat, slowly move forward and downward as you apply gentle pressure over the right hip. Repeat the exercise with the opposite leg forward.

**Areas Stretched:** Flexor muscles in front of the hip joint

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EXERCISE 15 SINGLE-KNEE-TO-CHEST-STRETCH

**Action:** Lie down flat on the floor. Bend one leg at approximately 100° and gradually pull the opposite leg toward your chest. Hold the final stretch for a few seconds. Switch legs and repeat the exercise.

**Areas Stretched:** Lower back and hamstring muscles; lumbar spine ligaments

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EXERCISE 16 DOUBLE-KNEE-TO-CHEST STRETCH

**Action:** Lie flat on the floor and then curl up slowly into a fetal position. Hold for a few seconds.

**Areas Stretched:** Upper and lower back and hamstring muscles; spinal ligaments
**EXERCISE 17** UPPER AND LOWER BACK STRETCH  
**Action:** Sit on the floor and bring your feet in close to you, allowing the soles of the feet to touch each other. Holding on to your feet, bring your head and upper chest gently toward your feet.  
**Areas Stretched:** Upper and lower back muscles and ligaments

**EXERCISE 18** SIT-AND-REACH STRETCH  
(See Exercise 12 on page 294)

**EXERCISE 19** GLUTEAL STRETCH  
**Action:** Lie on the floor, bend the right leg, and place your right ankle slightly above the left knee. Grasp behind the left thigh with both hands and gently pull the leg toward the chest. Repeat the exercise with the opposite leg.  
**Areas Stretched:** Buttock area (gluteal muscles)

**EXERCISE 20** BACK EXTENSION STRETCH  
**Action:** Lie face down on the floor with the elbows by the chest, forearms on the floor, and the hands beneath the chin. Gently raise the trunk by extending the elbows until you reach an approximate 90° angle at the elbow joint. Be sure the forearms remain in contact with the floor at all times. Do NOT extend the back beyond this point. Hyperextension of the lower back may lead to or aggravate an existing back problem. Hold the stretched position for about 10 seconds.  
**Areas Stretched:** Abdominal region  
**Additional Benefits:** Restore lower back curvature

**EXERCISE 21** TRUNK ROTATION AND LOWER BACK STRETCH  
**Action:** Sit on the floor and bend the left leg, placing the left foot on the outside of the right knee. Place the right elbow on the left knee and push against it. At the same time, try to rotate the trunk to the left (counterclockwise). Hold the final position for a few seconds. Repeat the exercise with the other side.  
**Areas Stretched:** Lateral side of the hip and thigh; trunk and lower back

**EXERCISE 22** PELVIC TILT  
(See Exercise 12 in Chapter 7, page 257) This is perhaps the most important exercise for the care of the lower back. It should be included as a part of your daily exercise routine and should be performed several times throughout the day when pain in the lower back is present as a result of muscle imbalance.

**EXERCISE 23** THE CAT  
**Action:** Kneel on the floor and place your hands in front of you (on the floor) about shoulder-width apart. Relax the trunk and lower back (a). Now arch the spine and pull in your abdomen as far as you can and hold this position for a few seconds (b). Repeat the exercise 4–5 times.  
**Areas Stretched:** Low back muscles and ligaments  
**Areas Strengthened:** Abdominal and gluteal muscles

**EXERCISE 24** ABDOMINAL CRUNCH OR ABDOMINAL CURL-UP  
(See Exercise 4 in Chapter 7, page 255) It is important that you do not stabilize your feet when performing either of these exercises, because doing so decreases the work of the abdominal muscles. Also, remember not to “swing up” but, rather, to curl up as you perform these exercises.
EXERCISE 25  REVERSE CRUNCH
(See Exercise 11 in Chapter 7, page 257)

EXERCISE 26  SUPINE BRIDGE
Action: Lie face up on the floor with the knees bent at about 120°. Do a
pelvic tilt (Exercise 12 in Chapter 7, page 257) and maintain the pelvic tilt
while you raise the hips off the floor until the upper body and upper
legs are in a straight line. Hold this position for several seconds.
Areas Strengthened: Gluteal and abdominal flexor muscles

EXERCISE 27  PELVIC CLOCK
Action: Lie face up on the floor with the knees bent at about 120°. Fully
extend the hips as in the supine bridge (Exercise 26). Now progressively
rotate the hips in a clockwise manner (2 o’clock, 4 o’clock, 6 o’clock,
8 o’clock, 10 o’clock, and 12 o’clock), holding each position in an isometric
contraction for about 1 second. Repeat the exercise counterclockwise.
Areas Strengthened: Gluteal, abdominal, and hip flexor muscles

EXERCISE 28  LATERAL BRIDGE
(See Exercise 13 in Chapter 7, page 257)

EXERCISE 29  PRONE BRIDGE
(See Exercise 14 in Chapter 7, page 258)

EXERCISE 30  LEG PRESS
(See Exercise 16 in Chapter 7, page 259)

EXERCISE 31  SEATED BACK
(See Exercise 20 in Chapter 7, page 260)

EXERCISE 32  LAT PULL-DOWN
(See Exercise 24 in Chapter 7, page 261)

EXERCISE 33  BACK EXTENSION
(See Exercise 36 in Chapter 7, page 267)

EXERCISE 34  LATERAL TRUNK FLEXION
(See Exercise 37 in Chapter 7, page 268)
Chapter 8: Notes


Chapter 8

1. b  2. e  3. a  4. a  5. b  6. e  7. c  8. b  9. e  10. d

This page contains answers for this chapter only
Flexibility Development Guidelines

Mode: Static, dynamic, or proprioceptive neuromuscular facilitation (PNF) stretching to include all major muscle/tendon groups of the body

Intensity: To the point of mild tension or limits of discomfort

Repetitions: Repeat each exercise 4 times, holding the final position between 15 and 30 seconds

Frequency: At least 2 or 3 days per week
Ideal, 5 to 7 days per week

Source: Adapted from American College of Sports Medicine, ACSM's Guidelines for Exercise Testing and Prescription (Baltimore: Williams & Wilkins, 2006).
Tips to Prevent Low Back Pain

- Be physically active.
- Maintain recommended body weight (excess weight strains the back).
- Stretch often using spinal exercises through a functional range of motion.
- Regularly strengthen the core of the body using sets of 10 to 12 repetitions to near fatigue with isometric contractions when applicable.
- Lift heavy objects by bending at the knees and carry them close to the body. Place one foot forward, and keep your knees slightly bent while standing.
- Avoid sitting (over 50 minutes) or standing in one position for lengthy periods of time.
- Maintain correct posture.
- Sleep on your back with a pillow under the knees or on your side with the knees drawn up and a small pillow between the knees.
- Try out different mattresses of firm consistency before selecting a mattress.
- Warm up properly using mild stretches before engaging in physical activity.
- Practice adequate stress management techniques.
- Don’t smoke (it reduces blood flow to the spine, increasing back pain risk).