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Preventing Cardiovascular Disease

“Exercise can be used as a vaccine to prevent disease and a medication to treat disease. If there were a drug with the same benefits as exercise, it would instantly be the standard of care.”

Robert Sallis

Objectives

▶ Define cardiovascular disease and coronary heart disease.
▶ Explain the importance of a healthy lifestyle in preventing cardiovascular disease.
▶ Become familiar with the major risk factors that lead to the development of coronary heart disease, including physical inactivity, an abnormal cholesterol profile, hypertension, homocysteine, C-reactive protein, diabetes, and smoking.
▶ Assess your own risk for developing coronary heart disease.
▶ Outline a comprehensive program for reducing the risk for coronary heart disease and managing the overall risk for cardiovascular disease.

Determine your risk for heart disease.

Visit www.cengagebrain.com to access course materials and companion resources for this text including quiz questions designed to check your understanding of the chapter contents. See the preface on page xv for more information.
As a young college student, why should I have to worry about heart disease? Young people should not think that heart disease will not affect them. The process begins early in life, as shown in American soldiers who died during the Korean and Vietnam conflicts. Autopsies conducted on soldiers killed at 22 years of age and younger revealed that approximately 70 percent had early stages of atherosclerosis. Other studies found elevated blood cholesterol levels in children as young as 10 years old. Overall risk factor management and positive lifestyle habits are the best ways to prevent disease. The choices you make today will affect your health and well-being in middle age and later.

Trans fats have been debated extensively lately. What foods are most likely to contain trans fats? With extensive media coverage of their possible harmfulness, the amount of trans fats in foods is decreasing significantly. Trans fats are found primarily in fried foods such as French fries, doughnuts, and apple fritters, but they are also found in baked foods, including pastries, biscuits, crackers, pie crusts, and pizza crust. Stick margarine and shortenings also contain trans fats. Trans fats increase the risk for heart disease and stroke not only by increasing the LDL (“bad”) cholesterol, but also by decreasing the cardioprotective HDL (“good”) cholesterol. To decrease consumption of trans fats, always read the food label for trans fat content and look for “hydrogenated fat/oil” or “partially hydrogenated fat/oil” (i.e., trans fats) on the list of ingredients. The FDA does not require food companies to list trans fat content on the label if it is less than .5 gram per serving. The American Heart Association recommends that on average we keep trans fat intake below 2 grams per day. Four servings of a product that contains .49 gram of partially hydrogenated oil, not listed on the food label, provide almost the entire daily allowance of trans fats.

Is resveratrol the “super” nutrient that prevents heart disease? Resveratrol is a compound found naturally in plant foods, particularly in red and purple grapes (and thus red wine), Japanese knotweed, peanuts, deep blue/red/purple berries, some juices, and soy. The nutrient is believed to provide many health benefits, including a decreased risk for heart disease. Most of the research, however, has been conducted in animal studies and there is no definite evidence for health benefits in humans. The media has capitalized on the idea that red wine is good for the heart because of its resveratrol content. There may be other nutrients found in red wine that either alone or in synergy with resveratrol provide benefits. Also, the amount of resveratrol obtained in red wine, juice, or other natural foods is too low in comparison to the therapeutic dose used in the research studies. It is practically impossible, if not foolish, to drink the amount of red wine necessary to approach the therapeutic dose used in the animal studies. More research in humans is clearly needed before definitive claims can be made.

Is dark chocolate heart healthy? Scientists believe that dark chocolate is heart healthy because of its rich content of cocoa antioxidant compounds called polyphenols. Dark chocolate has a higher concentration of polyphenols than milk chocolate and white chocolate has none. These compounds appear to enhance activity of special proteins called sterol regulatory element-binding proteins (SREBPs), which are involved in cholesterol metabolism. Activated SREBPs bind to genes on DNA that increase a protein called apolipoprotein A1 (ApoA1) in the liver, which is the major protein component of the “good” HDL cholesterol. Polyphenols also decrease liver production of another protein, apolipoprotein B (ApoB), which is the major protein component of the “bad” LDL cholesterol and increase activity of LDL receptors that induce more cholesterol for removal from the bloodstream. Polyphenols may also fight plaque buildup in the arteries by decreasing the amount of oxidized LDL cholesterol, a major contributor to atherosclerosis (plaque buildup). Other research has shown modest reductions in blood pressure (two to three points on both systolic and diastolic). Even such small decreases in blood pressure significantly lower coronary artery disease and stroke mortality. High-quality dark chocolate is not a food to be eaten liberally, but it’s a health food to be enjoyed in moderation. Keep in mind that chocolate has a lot of calories, fat, saturated fat, and sugar; and overweight and obesity are major problems in the United States, with corresponding negative effects on morbidity and mortality. As little as one-quarter ounce of daily dark chocolate (about 30 calories worth) has been shown to provide health benefits.

Prevalence of Cardiovascular Disease

About 30 percent of all deaths in the United States are attributable to cardiovascular disease (CVD), the most prevalent degenerative condition in the United States.1 More than a third of the adult population has some form of these diseases of the heart and blood vessels. According to the Centers for Disease Control and Prevention (CDC), about 60 percent of deaths from heart disease are sudden and unexpected, with no previous symptoms of the disease. Almost half of these deaths occur outside of the hospital, most likely because the individuals failed to recognize early warning symptoms of a heart attack.
I never thought that I would be at risk for cardiovascular disease. For one thing, I’m still young—only 20. For another, I’ve always been pretty healthy. When colds and flu go around, I don’t usually catch them. I have never been a smoker. And also, because I used to play sports in high school, I still thought of myself as active and athletic. But the truth is that after I came to college I wasn’t involved in sports anymore and I didn’t really get any exercise. Once in a great while some friends and I would toss around a Frisbee. For one of my classes, I had to climb a couple flights of stairs to get to the classroom and I would find that I was really out of breath, which told me I was not in very good shape anymore. During a physical exam, when my doctor did a blood test, I was surprised to learn that I had high cholesterol. I had also gained 11 pounds since high school. Along with my lack of exercise, the fact that I ate pepperoni pizza regularly, ate fruits and vegetables only once in a blue moon, and my grandfather having had a heart attack when he was only 50; put me in the high-risk category for coronary heart disease. Getting those results was really a wake-up call for me. I took the time when I was taking the Lifetime Wellness class to really focus on trying to reduce my risk. I began working out and tried to reverse my eating habits—pizza and fast food only once in a while, and fruits, vegetables, fish, and other healthy foods often. Now, a year later, my cholesterol levels are just about normal. I have lost weight, exercise regularly, and eat pretty healthy most of the time. The risk analysis now shows that I am at a low risk for heart disease. I know these changes have made me healthier and most likely I have added years to my life.

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**PERSONAL PROFILE**

**My Cardiovascular Risk Profile**

I. Do you try to incorporate as much physical activity as possible and avoid excessive sitting on a daily basis?  
Yes ☐  No ☐

II. Does your diet have ample amounts of grains, fruits, and vegetables, and do you limit the intake of red meats, whole milk products, simple carbohydrates, refined sugars, and processed foods in your diet?  
Yes ☐  No ☐

III. Are you aware of the most significant risk factors that lead to coronary heart disease and the factors that you have control over by the way you choose to live your life?  
Yes ☐  No ☐

IV. Have you ever had a blood lipid analysis test done and what do the results tell you about your current lifestyle, genetics, and potential risk for cardiovascular disease?  
Yes ☐  No ☐

V. Are you familiar with the effects of low-grade inflammation on heart disease and lifestyle factors that increase C-reactive protein levels?  
Yes ☐  No ☐

Some examples of CVD are coronary heart disease, stroke, **Peripheral vascular disease**, congenital heart disease, rheumatic heart disease, atherosclerosis, high blood pressure, and congestive heart failure. According to CDC estimates, if all deaths from major CVDs were eliminated, life expectancy in the United States would increase by about 7 years.

The American Heart Association estimated the cost of heart and blood vessel disease in the United States at $286 billion per year. About 1.26 million people have new or recurrent heart attacks each year, and over 45 percent of them will die as a result. More than half of these deaths occur within 1 hour of the onset of symptoms, before the person reaches the hospital.

**Key Terms**

- **Cardiovascular disease (CVD)** The array of conditions that affect the heart and the blood vessels.
- **Peripheral vascular disease** Narrowing of the peripheral blood vessels.
Stroke

When CVDs are separated by categories, stroke becomes the third leading cause of death in the United States, accounting for approximately 143,600 deaths each year. About 800,000 new or recurrent strokes are reported each year, and of these, more than a third are left with permanent disabilities. About 20 percent of those who survive require institutional care.

Stroke is the most significant contributor to mental and physical disability in the United States, yet it does not draw the same attention as coronary heart disease, high blood pressure, diabetes, or cancer. Similar to those for coronary heart disease, most risk factors for stroke are preventable. Table 10.1 lists the major risk factors; the first four factors are beyond a person’s control, whereas the latter seven are fully manageable.

Although heart and blood vessel disease is still the number-one health problem in the United States, the incidence declined by 28 percent between 1960 and 2000 (see Figure 10.1), in large part because of health education. People now are aware of the risk factors for CVD and are changing their lifestyle to lower their potential risk for these diseases.

Coronary Heart Disease

The heart and the coronary arteries are illustrated in Figure 10.2. The major form of CVD is coronary heart disease (CHD), in which the arteries that supply the heart muscle with oxygen and nutrients are narrowed by fatty deposits, such as cholesterol and triglycerides. Narrowing of the coronary arteries diminishes the blood supply to the heart muscle, which can precipitate a heart attack.

CHD is the single leading cause of death in the United States, accounting for about 20 percent of all deaths and approximately half of all deaths from CVD. Approximately 80 percent of deaths from CHD in people under age 65 occur during the first heart attack. CHD is the

### Table 10.1 Stroke Risk Factors

<table>
<thead>
<tr>
<th>Unchangeable factors</th>
<th>Manageable factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age: Increased risk after age 55</td>
<td>Tobacco use: Stop!</td>
</tr>
<tr>
<td>Gender: Higher risk in men</td>
<td>Blood pressure: Maintain in normal range</td>
</tr>
<tr>
<td>Race: African Americans are at greater risk</td>
<td>Diet: Decrease fat and sodium consumption and increase intake of potassium, fruits, and vegetables</td>
</tr>
<tr>
<td>Family history</td>
<td>Activity level: Increase frequency and intensity</td>
</tr>
<tr>
<td></td>
<td>Weight: Maintain within recommended range</td>
</tr>
<tr>
<td></td>
<td>Cholesterol: Maintain normal levels</td>
</tr>
<tr>
<td></td>
<td>Diabetes: Prevent or manage condition</td>
</tr>
</tbody>
</table>

*Estimated figures for 2010.

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**Figure 10.1** Incidence of cardiovascular disease in the United States for selected years: 1900–2010.

**Figure 10.2** The heart and its blood vessels.
Preventing Cardiovascular Disease

Chapter 10

Leading cause of sudden cardiac deaths. The risk of death is also greater in the least-educated segment of the population. Each year, more than 500,000 coronary bypass operations and more than 1 million coronary angioplasty procedures are performed in the United States.

Coronary Heart Disease Risk Profile

Although genetic inheritance plays a role in CHD, the most important determinant is personal lifestyle. Most of the major risk factors for CHD are preventable and reversible. CHD risk factor analyses are administered to evaluate the impact of a person’s lifestyle and genetic endowment as potential contributors to the development of coronary disease. The specific objectives of a CHD risk factor analysis follow:

- Screen individuals who may be at high risk for the disease
- Educate people regarding the leading risk factors for developing CHD
- Implement programs aimed at reducing the risks
- Use the analysis as a starting point from which to compare changes induced by the intervention program

Table 10.2

<table>
<thead>
<tr>
<th>Risk Factors</th>
<th>Maximal Risk Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abnormal cholesterol profile</td>
<td>12</td>
</tr>
<tr>
<td>Low HDL cholesterol</td>
<td>6</td>
</tr>
<tr>
<td>High LDL cholesterol</td>
<td>6</td>
</tr>
<tr>
<td>High-sensitivity C-reactive protein</td>
<td>8</td>
</tr>
<tr>
<td>Physical inactivity</td>
<td>8</td>
</tr>
<tr>
<td>Smoking</td>
<td>8</td>
</tr>
<tr>
<td>Body mass index</td>
<td>8</td>
</tr>
<tr>
<td>Hypertension</td>
<td>8</td>
</tr>
<tr>
<td>Systolic blood pressure</td>
<td>4</td>
</tr>
<tr>
<td>Diastolic blood pressure</td>
<td>4</td>
</tr>
<tr>
<td>Personal history of heart disease</td>
<td>8</td>
</tr>
<tr>
<td>Abnormal stress electrocardiogram</td>
<td>8</td>
</tr>
<tr>
<td>Diabetes</td>
<td>6</td>
</tr>
<tr>
<td>High blood glucose</td>
<td>3</td>
</tr>
<tr>
<td>Known diabetes</td>
<td>3</td>
</tr>
<tr>
<td>Family history of heart disease</td>
<td>8</td>
</tr>
<tr>
<td>Elevated homocysteine</td>
<td>4</td>
</tr>
<tr>
<td>Age</td>
<td>4</td>
</tr>
<tr>
<td>Tension and stress</td>
<td>3</td>
</tr>
<tr>
<td>Abnormal resting electrocardiogram</td>
<td>3</td>
</tr>
<tr>
<td>Elevated triglycerides</td>
<td>2</td>
</tr>
</tbody>
</table>

Leading Risk Factors for CHD

The leading risk factors contributing to CHD are listed in Table 10.2. A self-assessment of risk factors for CHD is given in Activity 10.1. This analysis can be done by people who have little or no medical information about their cardiovascular health, as well as those who have had a thorough medical examination. The guidelines for zero risk are outlined for each factor, making this self-analysis a valuable tool for managing the risk factors for CHD.

Key Terms

- **Stroke**  Condition in which a blood vessel that feeds the brain ruptures or is clogged, leading to blood flow disruption to the brain.
- **Coronary heart disease (CHD)** Condition in which the arteries that supply the heart muscle with oxygen and nutrients are narrowed by fatty deposits, such as cholesterol and triglycerides.
- **Angioplasty** A procedure in which a balloon-tipped catheter is inserted, then inflated, to widen the inner lumen of the artery.
- **Risk factors** Lifestyle and genetic variables that may lead to disease.
# Self-Assessment Coronary Heart Disease Risk Factor Analysis

Name: __________________________  Date: __________

Course: ________________  Section: __________  Gender: _______  Age: _______

## Instructions

The disease process for cardiovascular disease starts early in life, primarily as a result of poor lifestyle habits. Studies have shown beginning stages of atherosclerosis and elevated blood lipids in children as young as 10 years old. Consequently, the purpose of this activity is to establish a baseline CHD risk profile and to point out the “zero-risk” level for each coronary risk factor.

You may want to repeat the blood pressure test to obtain current values for this activity. If you have had a blood chemistry analysis performed recently that included total cholesterol, HDL cholesterol, triglycerides, and glucose levels, you may use the results for this activity.

## 1. Physical Activity

Do you get 30 or more minutes of moderate-intensity physical activity:

- Fewer than 3 times per week ........ 8
- Between 3 and 4 times per week .... 3
- 5 or more times per week ............. 0

## 2. Resting and Stress

Electrocardiograms (ECG)

Add scores for both ECGs

<table>
<thead>
<tr>
<th>ECG</th>
<th>Resting</th>
<th>Stress</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Equivocal</td>
<td>4</td>
<td>1–5</td>
</tr>
<tr>
<td>Abnormal</td>
<td>8</td>
<td>3–11</td>
</tr>
</tbody>
</table>

## 3. HDL Cholesterol (if unknown, answer Question 8)

- ≥40 ............................................. 0
- <40 ................................................. 6

## 4. LDL Cholesterol

(If unknown, answer Question 8)

- <100 ............................................ 0
- 100–159 ........................................ 3
- 160 ............................................. 6

## 5. Triglycerides (if unknown, answer Question 8)

- <150 mg/dL ............................... 0
- 150–199 mg/dL .......................... .5
- ≥200 mg/dL ................................... 2

## 6. Homocysteine (if unknown, answer Question 8)

Does your daily diet include:

- 2 and 3 servings (or more) of fruits and vegetables respectively............................ 0
- Fewer than 2 and 3 servings of fruits and vegetables respectively........................ 4

## 7. Inflammation (as measured by High-Sensitivity C-Reactive Protein or hs-CRP) (if unknown, answer Question 8)

- <1 mg/L ....................................... 0
- 1–3 mg/L ................................. 2
- >3 mg/L .................................... 8

## 8. Diet (Do not answer if Questions 3, 4, 5, 6, and 7 have been answered)

Does your regular diet include (high score if all apply): 1 or more daily servings of red meat; 7 or more eggs/week; daily butter, cheese, whole milk, refined carbohydrates, alcohol, processed foods, and frequent grilling or cooking meat and poultry at high temperatures.........10–14

4 to 6 servings of red meat/week; 4–6 eggs per week; 1% or 2% milk; some cheese, refined carbohydrates, and alcohol ................. 4–10

Red meat fewer than three times/week; fewer than 3 eggs/week; skim milk and skim milk products; moderate refined carbohydrates and alcohol ...... 0–3

## 9. Diabetes/Glucose

- ≤100 mg/dL................................. 0
- 101–110 mg/dL......................... 1
- 111–125 mg/dL......................... 2
- ≥126 mg/dL............................. 3

Diabetics add another 3 points ........3

## 10. Blood Pressure

Add scores for both readings (e.g., 144/88 score = 4)

<table>
<thead>
<tr>
<th>Systolic</th>
<th>Diastolic</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;120 ....... (0)</td>
<td>&lt;80 ....... (0)</td>
</tr>
<tr>
<td>121–139 ....... (1)</td>
<td>81–89 ....... (1)</td>
</tr>
<tr>
<td>140–159 ....... (3)</td>
<td>90–99 ....... (3)</td>
</tr>
<tr>
<td>≥160 ........... (4)</td>
<td>≥100 ........... (4)</td>
</tr>
</tbody>
</table>
### Self-Assessment Coronary Heart Disease Risk Factor Analysis (continued)

<table>
<thead>
<tr>
<th>11. Body Mass Index (BMI)</th>
<th>≤25.0............................................... 0</th>
<th>25.0–29.99........................................2</th>
<th>≥30.0–39.99......................................... 4</th>
<th>≥40.0............................................... 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>12. Smoking</td>
<td>Lifetime non-smoker .................0</td>
<td>Ex-smoker more than 1 year ............0</td>
<td>Ex-smoker less than 1 year ............1</td>
<td>Non-smoker, but live or work in smoking environment .........................2</td>
</tr>
<tr>
<td></td>
<td>Smoke 1–9 cigarettes/day .................3</td>
<td>Smoke 10–19 cigarettes/day ............4</td>
<td>Smoke 20–29 cigarettes/day ............5</td>
<td>Smoke 30–39 cigarettes/day ............6</td>
</tr>
<tr>
<td></td>
<td>Smoke 40 or more cigarettes/day .....8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13. Tension and Stress</td>
<td>Sometimes tense......................1</td>
<td>Always tense...............................3</td>
<td>Often tense.................................2</td>
<td></td>
</tr>
<tr>
<td>Are you:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14. Personal History</td>
<td>Have you ever had a heart attack, stroke, coronary disease, or any known heart problem:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>During the last year....................8</td>
<td>2–5 years ago.................................3</td>
<td>1–2 years ago.................................5</td>
<td>More than 5 years ago...............2</td>
</tr>
<tr>
<td>15. Family History</td>
<td>Have any of your blood relatives (parents, uncles, brothers, sisters, grandparents) suffered from cardiovascular disease:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>One or more before age 51 .........8</td>
<td>One or more after age 60 ..............2</td>
<td>One or more between 51 and 60 ......4</td>
<td>None had cardiovascular disease ......0</td>
</tr>
<tr>
<td>16. Age</td>
<td>29 or younger...........................0</td>
<td>≥60...............................................3</td>
<td>30–39.........................................1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>40–49.........................................2</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### How to Score

<table>
<thead>
<tr>
<th>Risk Category</th>
<th>Total Risk Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Low</td>
<td>5 or fewer points</td>
</tr>
<tr>
<td>Low</td>
<td>Between 6 and 15 points</td>
</tr>
<tr>
<td>Moderate</td>
<td>Between 16 and 25 points</td>
</tr>
<tr>
<td>High</td>
<td>Between 26 and 35 points</td>
</tr>
<tr>
<td>Very High</td>
<td>36 or more points</td>
</tr>
</tbody>
</table>

#### II. Stage of Change for Cardiovascular Disease Prevention

Using Figure 2.5 (page 61) and Table 2.3 (page 60), identify your current stage of change for participation in a cardiovascular disease risk-reduction program:

#### III. In a few sentences, using a separate sheet of paper, discuss your family and personal risk for cardiovascular disease. Also, discuss lifestyle changes that you have already implemented in this course, as well as additional changes that you can make to decrease your own risk for cardiovascular disease.

#### IV. Physical Activity Rating

Number of daily steps at the beginning of the term: [ ]

Current number of daily steps: [ ]

Current physical activity rating (use Table 1.2, page 12): [ ]
For example, a person who fills out the form learns that recommended blood pressure is less than 120/80, that risk is reduced by smoking less or quitting altogether, that high-density lipoprotein (HDL) cholesterol should be 40 mg/dL (milligrams per deciliter) or higher, and that low-density lipoprotein (LDL) cholesterol should be less than 100 mg/dL (if unknown, basic nutritional guidelines are also given). (The respective roles of HDL and LDL cholesterol in protecting against and causing heart disease are discussed later in this chapter.)

To provide a meaningful score for CHD risk, a weighing system was developed to show the impact of each risk factor on developing the disease (see Table 10.2 and Activity 10.1). This system is based on current research and on the work done at leading preventive medical facilities in the United States. The most significant risk factors are given the heaviest numerical weight.

For example, a poor cholesterol profile seems to be one of the best predictors for developing CHD. Up to 12 risk points are assigned to individuals with very high LDL cholesterol and low HDL cholesterol levels. The least heavily weighted risk factor is triglycerides, with a maximum of only 2 risk points assigned to this factor. Each risk factor is also assigned a zero risk level—the level at which it apparently does not increase the risk for disease at all.

Based on actual test results, a person receives a score anywhere from zero to the maximum number of points for each factor. When the risk points from all of the risk factors are totaled, the final number is used to place an individual in one of five overall risk categories for potential development of CHD (see Activity 10.1).

The “Very Low” CHD risk category designates the group at lowest risk for developing heart disease based on age and gender. “Low” CHD suggests that even though people in this category are taking good care of their cardiovascular health, they can improve it (unless all of the risk points come from age and family history). “Moderate” CHD risk means that the person can definitely improve his or her lifestyle to lower the risk for disease, or medical treatment may be required. A score in the “High” or “Very High” CHD risk category points to a strong probability of developing heart disease within the next few years and calls for immediate implementation of a personal risk-reduction program, including professional medical, nutritional, and physical activity intervention.

The leading risk factors for CHD are discussed next, along with the general recommendations for risk reduction.

**Critical Thinking**

What do you think of your own risk for diseases of the cardiovascular system? • Is this something you need to concern yourself with at this point in your life? Why or why not?

**Physical Inactivity**

Physical inactivity is responsible for low levels of cardiorespiratory endurance (the ability of the heart, lungs, and blood vessels to deliver enough oxygen to the cells to meet the demands of prolonged physical activity). The level of cardiorespiratory endurance (or fitness) is given most commonly by the maximal amount of oxygen (in milliliters) that every kilogram (2.2 pounds) of body weight is able to utilize per minute of physical activity (mL/kg/min). As maximal oxygen uptake (VO2max) increases, so does efficiency of the cardiorespiratory system.

Even though physical inactivity has not been assigned the most risk points (8 points for a poor level of fitness versus 12 for a poor cholesterol profile; see Table 10.2), improving cardiorespiratory endurance through daily physical activity and aerobic exercise greatly reduces the overall risk for heart disease.

Although specific recommendations can be followed to improve each risk factor, daily physical activity and a regular aerobic exercise program help to control most of the major risk factors that lead to heart disease. Physical activity and aerobic exercise will:

- Increase cardiorespiratory endurance
- Decrease and control blood pressure
- Reduce body fat
- Lower blood lipids (cholesterol and triglycerides)
- Improve HDL cholesterol
- Prevent and help control diabetes
- Decrease low-grade (hidden) inflammation in the body
- Increase and maintain good heart function, sometimes improving certain electrocardiogram abnormalities

Regular physical activity helps to control most of the major risk factors that lead to heart disease.
• Motivate toward smoking cessation
• Alleviate tension and stress
• Counteract a personal history of heart disease

Data from the research summarized in Figure 1.11 in Chapter 1 clearly show the tie between physical activity and mortality, regardless of age and other risk factors.\textsuperscript{3} A

**Key Terms**

**High-density lipoproteins (HDLs)** Cholesterol-transporting molecules in the blood ("good" cholesterol) that help clear cholesterol from the blood.

**Low-density lipoproteins (LDLs)** Cholesterol-transporting molecules in the blood ("bad" cholesterol) that tend to increase blood cholesterol.

Lifetime participation in physical activity is one of the most important factors in the prevention of cardiovascular disease.
higher level of physical fitness benefits even those who exhibit other risk factors, such as high blood pressure and serum cholesterol, cigarette smoking, and a family history of heart disease. In most cases, less fit people in the study without these risk factors had higher death rates than highly fit people with these same risk factors.

The findings show that the higher the level of cardiorespiratory fitness, the longer the life, but the largest drop in premature death is seen between the “unfit” and the “moderately fit” groups. Even small improvements in cardiorespiratory endurance greatly decrease the risk for cardiovascular mortality. Most adults who engage in a moderate exercise program can attain these fitness levels easily. A 2-mile walk in 30 to 40 minutes, five to seven days a week, is adequate to decrease risk.

Subsequent research published in the *New England Journal of Medicine* substantiated the importance of exercise in preventing CHD. The benefits to previously inactive adults of starting a moderate to vigorous physical activity program were as important as quitting smoking, managing blood pressure, or controlling cholesterol. In relative risk for death from CHD, the increase in physical activity led to the same decrease as giving up cigarette smoking.

The scientific data are quite clear that moderate-intensity physical activity provides substantial benefits in terms of overall cardiovascular risk reduction. The exact amount of aerobic exercise required to decrease the risk for cardiovascular disease is difficult to establish and most likely varies due to genetics, age, gender, body composition, health status, and personal lifestyle, among other factors. What may be sufficient for a low-risk individual may not be enough for someone else with disease risk factors. For example, an apparently healthy individual at recommended body weight may not need more than 30 daily minutes of accumulated moderate-intensity physical activity. Another person with a weight problem and other risk factors such as high blood pressure, cholesterol abnormalities, and borderline high blood sugar may need a much greater amount of activity to counteract these risk factors.

Although research may never indicate the exact amount of aerobic exercise required to lower the risk for cardiovascular disease, pioneer research in this area conducted in the 1980s showed that expending 2,000 calories per week as a result of physical activity yielded the same decrease as giving up cigarette smoking. The findings show that the higher the level of cardiorespiratory fitness, the longer the life, but the largest drop in premature death is seen between the “unfit” and the “moderately fit” groups. Even small improvements in cardiorespiratory endurance greatly decrease the risk for cardiovascular mortality. Most adults who engage in a moderate exercise program can attain these fitness levels easily. A 2-mile walk in 30 to 40 minutes, five to seven days a week, is adequate to decrease risk.

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Although research may never indicate the exact amount of aerobic exercise required to lower the risk for cardiovascular disease, pioneer research in this area conducted in the 1980s showed that expending 2,000 calories per week as a result of physical activity yielded the lowest risk for cardiovascular disease among a group of almost 17,000 Harvard alumni. Expending 2,000 calories per week represents about 300 calories per daily exercise session or the equivalent of jogging 3 miles in 30 minutes or walking 3 miles in about 45 minutes.

When feasible, scientific studies indicate that vigorous-intensity activity is preferable because of greater improvements in aerobic fitness, blood pressure, glucose control, and a larger reduction in CHD risk. A note of caution: do not engage in vigorous exercise without proper clearance and a minimum of six weeks of proper conditioning through moderate-intensity activity.

Also, try to minimize total daily sitting time. Research data indicate that excessive daily sitting (at a desk, commuting to and from work, eating meals, and watching television) increases the risk for cardiovascular disease, obesity, some chronic disorders, and premature mortality. The risk is increased even among people who meet the 30 minutes of moderate-intensity physical activity on most days of the week but still spend a large part of the day sitting. If your job (as most nowadays do) requires that a large portion of the day be spent in a sitting position, at least make yourself get up and take frequent breaks. Small creative lifestyle changes make a difference, such as always answering the phone standing; walking to the office next door instead of texting, emailing, IMing, or using the phone; and using stairs instead of elevators and escalators. When watching television, make it a point to get up and walk around during each commercial break. Even better, do dips at the edge of the couch or stand up and sit down 20 times to strengthen your thigh muscles.

While aerobically fit individuals have a lower incidence of cardiovascular disease, regular physical activity and aerobic exercise by themselves do not guarantee a lifetime free of cardiovascular problems. Poor lifestyle habits—such as smoking, eating too many fatty/salty/sweet foods, being overweight, and having high stress levels—increase cardiovascular risk, and their effects will not be eliminated completely through an active lifestyle.

Overall management of risk factors is the best guideline to lower the risk for CVD. Still, aerobic exercise is one of the most important factors in preventing and reducing cardiovascular problems. Based on the overwhelming amount of scientific data in this area, evidence of the benefits of aerobic exercise in reducing heart disease is far too impressive to be ignored. Low fitness is more dangerous than obesity, smoking, high cholesterol, or diabetes. The basic principles for cardiorespiratory exercise are given in Chapter 6.

As more research studies are conducted, the addition of strength training is increasingly recommended for good heart function. The American Heart Association (AHA) recommends strength training even for individuals who have had a heart attack or have high blood pressure, as long as they strength-train under a physician’s advice. Strength training helps control body weight and blood sugar and lowers cholesterol and blood pressure.

**Abnormal Electrocardiograms**

The electrocardiogram (ECG or EKG) is a valuable measure of the heart’s function. The ECG provides a record of the electrical impulses that stimulate the heart to contract (see Figure 10.3). In reading an ECG, doctors interpret five general areas: heart rate, heart rhythm, axis of the heart, enlargement or hypertrophy of the heart, and myocardial infarction.

During a standard 12-lead ECG, 10 electrodes are placed on the person’s chest. From these 10 electrodes, 12 tracings,
or “leads,” of the electrical impulses as they travel through the heart muscle, or myocardium, are studied from 12 different positions. By looking at ECG tracings, medical professionals can identify abnormalities in heart functioning (see Figure 10.4). Based on the findings, the ECG may be interpreted as normal, equivocal, or abnormal. An ECG will not always identify problems, so a normal tracing is not an absolute guarantee. Conversely, an abnormal tracing does not necessarily signal a serious condition.

ECGs are taken at rest, during the stress of exercise, and during recovery. A stress electrocardiogram is also known as a “graded exercise stress test” or a “maximal exercise tolerance test.” Similar to a high-speed test on a car, a stress ECG reveals the tolerance of the heart to increased physical activity. It is a much better test than a resting ECG to discover CHD.

Stress ECGs also are used to assess cardiorespiratory fitness levels, to screen individuals for preventive and cardiac rehabilitation programs, to detect abnormal blood pressure response during exercise, and to establish actual or functional maximal heart rate for exercise prescription. The recovery ECG is another important diagnostic tool to monitor the return of the heart’s activity to normal conditions.

Not every adult who wishes to start or continue an exercise program needs a stress ECG. Specifically, the test is recommended for:

1. Men over age 45 and women over age 55
2. Individuals with two or more CHD risk factors who wish to participate in a vigorous exercise program
3. Any person with symptoms or known cardiac, pulmonary, or metabolic disease who wish to participate in either moderate or vigorous exercise
4. People with a family history of CHD, syncope (brief loss of consciousness), or sudden death in father or first-degree male relative before age 55, or mother or first-degree female relative before age 65
5. People with an abnormal resting ECG
6. All individuals with symptoms of chest discomfort, dysrhythmias (abnormal heartbeat), syncope, or chronotropic incompetence (heart rate that increases slowly during exercise and never reaches maximum)

**Key Terms**

**Electrocardiogram (ECG or EKG)** A recording of the electrical activity of the heart.

**Myocardium** Heart muscle.

**Stress electrocardiogram** An exercise test during which the workload is increased gradually until the individual reaches maximal fatigue, with blood pressure and 12-lead electrocardiographic monitoring throughout the test.
At times, the stress ECG has been questioned as a reliable predictor of CHD. Nevertheless, it remains the most practical, inexpensive, noninvasive procedure available to diagnose latent (undiagnosed/unknown) CHD. The test is accurate in diagnosing CHD about 65 percent of the time. The sensitivity of the test increases along with the severity of the disease, and more accurate results are seen in people who are at high risk for CVD.

**Abnormal Cholesterol Profile**

**Cholesterol** receives much attention because of its direct relationship to heart disease. Blood lipids (cholesterol and triglycerides) are carried in the bloodstream by protein molecules of HDLs, LDLs, very low density lipoproteins (VLDLs), and chylomicrons. An increased risk for CHD has been established in individuals with high total cholesterol, high LDL cholesterol, and low HDL cholesterol.

An abnormal cholesterol profile contributes to atherosclerosis, the buildup of fatty tissue in the walls of the arteries (see Figures 10.5 and 10.6). As the plaque builds up, it blocks the blood vessels that supply the myocardium with oxygen and nutrients (the coronary arteries), and these obstructions can trigger a myocardial infarction, or heart attack.

Unfortunately, the heart disguises its problems quite well, and typical symptoms of heart disease, such as angina pectoris, do not start until the arteries are about 75 percent blocked. In many cases, the first symptom is sudden death.

The recommendation of the National Cholesterol Education Program (NCEP) is to keep total cholesterol levels below 200 mg/dL. Cholesterol levels between 200 and 239 mg/dL are borderline high, and levels of 240 mg/dL and above indicate high risk for disease (see Table 10.3). The risk for heart attack increases 2 percent for every 1 percent increase in total cholesterol. About one-half of U.S. adults have total cholesterol values of 200 mg/dL or higher.

Preventive medicine practitioners often recommend a range between 160 and 180 mg/dL as best for total cholesterol. Furthermore, in the Framingham Heart Study (a 60-year ongoing project in the community of Framingham, Massachusetts), not a single individual with a total cholesterol level of 150 mg/dL or lower has had a heart attack.

As important as it is, total cholesterol is not the best predictor for cardiovascular risk. Many heart attacks occur in people with only slightly elevated total cholesterol. More significant is the way in which cholesterol is carried in the bloodstream. Cholesterol is transported primarily in the form of LDL and HDL.

LDL (“bad”) cholesterol tends to release cholesterol, which then may penetrate the lining of the arteries and speed the process of atherosclerosis. The NCEP guidelines given in Table 10.3 state that an LDL cholesterol value below 100 mg/dL is optimal.
Even when more LDL cholesterol is present than the cells can use, cholesterol seems not to cause a problem until it is oxidized by free radicals (see discussion under “Antioxidants” in Chapter 3, pages 101–103). After cholesterol is oxidized, white blood cells invade the arterial wall, take up the cholesterol, and clog the arteries.

LDL cholesterol particles are of two types: large, or pattern A; and small, or pattern B. Small particles are thought to pass through the inner lining of the coronary arteries more readily, thereby increasing the risk for a heart attack. A predominance of small particles can lead to a sixfold increase in the risk for CHD.

A genetic variation of LDL cholesterol, known as lipoprotein-a or Lp(a), is also noteworthy because a high level of these particles promotes blood clots and earlier development of atherosclerosis. It is thought that certain substances in the arterial wall interact with Lp(a) and lead to premature formation of plaque. About 10 percent of the population has elevated levels of Lp(a). Only medications help decrease Lp(a), and drug options should be discussed with a physician.

Intermediate-density lipoprotein (IDL) is also of concern because these mid-sized particles are more likely to cause atherosclerosis than a similar amount of LDL cholesterol. For individuals at risk for heart disease, a comprehensive blood lipid profile that includes total cholesterol, HDL cholesterol, LDL cholesterol, Lp(a), IDL, and size pattern (A and B) is recommended.

In a process known as reverse cholesterol transport, HDLs act as “scavengers,” removing cholesterol from the body and preventing plaque from forming in the arterial wall. This process helps maintain cholesterol levels within a healthy range by removing excess cholesterol from the body via the liver.

### Table 10.3: Cholesterol Guidelines

<table>
<thead>
<tr>
<th>Amount</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Cholesterol</td>
<td></td>
</tr>
<tr>
<td>&lt;200 mg/dL</td>
<td>Desirable</td>
</tr>
<tr>
<td>200–239 mg/dL</td>
<td>Borderline high</td>
</tr>
<tr>
<td>≥240 mg/dL</td>
<td>High risk</td>
</tr>
<tr>
<td>LDL Cholesterol</td>
<td></td>
</tr>
<tr>
<td>&lt;100 mg/dL</td>
<td>Optimal</td>
</tr>
<tr>
<td>100–129 mg/dL</td>
<td>Near or above optimal</td>
</tr>
<tr>
<td>130–159 mg/dL</td>
<td>Borderline high</td>
</tr>
<tr>
<td>160–189 mg/dL</td>
<td>High</td>
</tr>
<tr>
<td>≥190 mg/dL</td>
<td>Very high</td>
</tr>
<tr>
<td>HDL Cholesterol</td>
<td></td>
</tr>
<tr>
<td>&lt;40 mg/dL</td>
<td>Low (high risk)</td>
</tr>
<tr>
<td>≥60 mg/dL</td>
<td>High (low risk)</td>
</tr>
</tbody>
</table>

From National Cholesterol Education Program.

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**Key Terms**

- **Cholesterol**: A waxy substance, technically a steroid alcohol, found only in animal fats and oil; used in making cell membranes, as a building block for some hormones, in the fatty sheath around nerve fibers, and other necessary substances.
- **Blood lipids (fat)**: Cholesterol and triglycerides.
- **Very low density lipoproteins (VLDLs)**: Triglyceride, cholesterol, and phospholipid-transporting molecules in the blood.
- **Chylomicrons**: Triglyceride-transporting molecules.
- **Atherosclerosis**: Fatty/cholesterol deposits in the walls of the arteries leading to formation of plaque.
- **Myocardial infarction**: Heart attack; damage to or death of an area of the heart muscle as a result of an obstructed artery to that area.
- **Angina pectoris**: Chest pain associated with coronary heart disease.
- **Reverse cholesterol transport**: A process in which HDL molecules attract cholesterol and carry it to the liver, where it is changed to bile and eventually excreted in the stool.
The strength of HDL is in the protein molecules found in its coating. When HDL comes in contact with cholesterol-filled cells, these protein molecules attach to the cells and take their cholesterol.

The more HDL (“good”) cholesterol, the better. HDL cholesterol offers some protection against heart disease. A low level of HDL cholesterol is one of the strongest predictors of CHD at all levels of total cholesterol, including levels below 200 mg/dL. Data suggest that for every 1 mg/dL increase in HDL cholesterol, the risk for CHD drops up to 3 percent in men and 5 percent in women.7 The recommended HDL cholesterol values to minimize the risk for CHD are at least 40 mg/dL. HDL cholesterol levels above 60 mg/dL help to lower the risk for CHD.

Similar to LDL, there are two known types of HDL particles, HDL2 and HDL3. HDL2 are larger particles that carry cholesterol from the arterial wall to the liver for disposal. These particles also have antioxidant and anti-inflammatory effects. HDL3 also transports cholesterol out of the arterial wall but may not be as effective as HDL2. HDL3, however, seems to protect against cholesterol oxidation that results in atherosclerosis.8

For the most part, HDL cholesterol is determined genetically. Generally, women have higher levels than men. Because the female sex hormone estrogen tends to raise HDL, premenopausal women have a much lower incidence of heart disease. African American children and adult men have higher HDL values than Caucasians. HDL cholesterol also decreases with age.

Increasing HDL cholesterol improves the cholesterol profile and lessens the risk for CHD. Habitual aerobic exercise, a diet high in omega-3 fatty acids, weight loss, nonsmoking, and modest alcohol intake help raise HDL cholesterol. Drug therapy may also promote higher HDL cholesterol levels. Niacin helps convert HDL3 to HDL2.

Improved HDL cholesterol is clearly related to a regular aerobic exercise program (preferably high intensity, or above 6 metabolic equivalents [METs], for at least 20 minutes three times per week—see Chapter 6). Individual responses to aerobic exercise differ, but generally, the more you exercise, the higher your HDL cholesterol level.

Counteracting Cholesterol

The average adult in the United States consumes between 400 and 600 mg of cholesterol daily. The body, however, manufactures more than that. Saturated and trans fats (trans fatty acids) raise cholesterol levels more than anything else in the diet. These fats produce approximately 1,000 mg of cholesterol per day. Because of individual differences, some people can have a higher-than-normal intake of saturated and trans fats and still maintain normal levels. Others, who have a lower intake, can have abnormally high levels.

Saturated fats are found mostly in meats and dairy products and seldom in foods of plant origin (see Table 10.4). Poultry and fish contain less saturated fat than

<table>
<thead>
<tr>
<th>Food</th>
<th>Serving Size</th>
<th>Cholesterol (mg)</th>
<th>Sat. Fat (gr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avocado</td>
<td>³/₄ med.</td>
<td>—</td>
<td>3.2</td>
</tr>
<tr>
<td>Bacon</td>
<td>2 slices</td>
<td>30</td>
<td>2.7</td>
</tr>
<tr>
<td>Beans (all types)</td>
<td>any</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Beef—lean, fat trimmed off</td>
<td>3 oz</td>
<td>75</td>
<td>6.0</td>
</tr>
<tr>
<td>Beef heart (cooked)</td>
<td>3 oz</td>
<td>150</td>
<td>1.6</td>
</tr>
<tr>
<td>Beef liver (cooked)</td>
<td>3 oz</td>
<td>255</td>
<td>1.3</td>
</tr>
<tr>
<td>Butter</td>
<td>1 tsp</td>
<td>12</td>
<td>0.4</td>
</tr>
<tr>
<td>Caviar</td>
<td>1 oz</td>
<td>85</td>
<td>—</td>
</tr>
<tr>
<td>Cheese</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>American</td>
<td>2 oz</td>
<td>54</td>
<td>11.2</td>
</tr>
<tr>
<td>Cheddar</td>
<td>2 oz</td>
<td>60</td>
<td>12.0</td>
</tr>
<tr>
<td>Cottage (1% fat)</td>
<td>1 cup</td>
<td>10</td>
<td>0.4</td>
</tr>
<tr>
<td>Cottage (4% fat)</td>
<td>1 cup</td>
<td>31</td>
<td>6.0</td>
</tr>
<tr>
<td>Cream</td>
<td>2 oz</td>
<td>62</td>
<td>6.0</td>
</tr>
<tr>
<td>Muenster</td>
<td>2 oz</td>
<td>54</td>
<td>10.8</td>
</tr>
<tr>
<td>Parmesan</td>
<td>2 oz</td>
<td>38</td>
<td>9.3</td>
</tr>
<tr>
<td>Swiss</td>
<td>2 oz</td>
<td>52</td>
<td>10.0</td>
</tr>
<tr>
<td>Chicken (no skin)</td>
<td>3 oz</td>
<td>45</td>
<td>0.4</td>
</tr>
<tr>
<td>Chicken liver</td>
<td>3 oz</td>
<td>472</td>
<td>1.1</td>
</tr>
<tr>
<td>Chicken thigh, wing</td>
<td>3 oz</td>
<td>69</td>
<td>3.3</td>
</tr>
<tr>
<td>Egg (yolk)</td>
<td>1 lrg</td>
<td>218</td>
<td>1.6</td>
</tr>
<tr>
<td>Frankfurter</td>
<td>2</td>
<td>90</td>
<td>11.2</td>
</tr>
<tr>
<td>Fruits</td>
<td>any</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Grains (all types)</td>
<td>any</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Halibut, flounder</td>
<td>3 oz</td>
<td>43</td>
<td>0.7</td>
</tr>
<tr>
<td>Ice cream</td>
<td>¹/₂ cup</td>
<td>27</td>
<td>4.4</td>
</tr>
<tr>
<td>Lamb</td>
<td>3 oz</td>
<td>60</td>
<td>7.2</td>
</tr>
<tr>
<td>Lard</td>
<td>1 tsp</td>
<td>5</td>
<td>1.9</td>
</tr>
<tr>
<td>Lobster</td>
<td>3 oz</td>
<td>170</td>
<td>0.5</td>
</tr>
<tr>
<td>Margarine (all vegetable)</td>
<td>1 tsp</td>
<td>—</td>
<td>0.7</td>
</tr>
<tr>
<td>Mayonnaise</td>
<td>1 tbsp</td>
<td>10</td>
<td>2.1</td>
</tr>
<tr>
<td>Milk</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Skim</td>
<td>1 cup</td>
<td>5</td>
<td>0.3</td>
</tr>
<tr>
<td>Low fat (2%)</td>
<td>1 cup</td>
<td>18</td>
<td>2.9</td>
</tr>
<tr>
<td>Whole</td>
<td>1 cup</td>
<td>34</td>
<td>5.1</td>
</tr>
<tr>
<td>Nuts</td>
<td>1 oz</td>
<td>—</td>
<td>1.0</td>
</tr>
<tr>
<td>Oysters</td>
<td>3 oz</td>
<td>42</td>
<td>—</td>
</tr>
<tr>
<td>Salmon</td>
<td>3 oz</td>
<td>30</td>
<td>0.8</td>
</tr>
<tr>
<td>Scallops</td>
<td>3 oz</td>
<td>29</td>
<td>—</td>
</tr>
<tr>
<td>Sherbet</td>
<td>¹/₂ cup</td>
<td>7</td>
<td>1.2</td>
</tr>
<tr>
<td>Shrimp</td>
<td>3 oz</td>
<td>128</td>
<td>0.1</td>
</tr>
<tr>
<td>Trout</td>
<td>3 oz</td>
<td>45</td>
<td>2.1</td>
</tr>
<tr>
<td>Tuna (canned—drained)</td>
<td>3 oz</td>
<td>55</td>
<td>—</td>
</tr>
<tr>
<td>Turkey dark meat</td>
<td>3 oz</td>
<td>60</td>
<td>0.6</td>
</tr>
<tr>
<td>Turkey light meat</td>
<td>3 oz</td>
<td>50</td>
<td>0.4</td>
</tr>
<tr>
<td>Vegetables (except avocado)</td>
<td>any</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

Table 10.4 Cholesterol and Saturated Fat Content of Selected Foods

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beef does, but should be eaten in moderation (about 3 to 6 ounces per day—see Chapter 3). In a 10-year study of more than 500,000 men and women over the age of 50, those who ate the most red meat (an average of 4.5 ounces per day), had a much higher risk of dying from heart disease and cancer. Of the highest red meat eaters, men had a 31 percent higher risk of dying during the study period, whereas women had a 50 percent higher risk of dying from heart disease during this time. Cancer risk was about 20 percent higher among men and women who consumed the most red meat.

Unsaturated fats are mainly of plant origin and cannot be converted to cholesterol. Omega-3-rich fish meals (found in salmon, tuna, and mackerel) also help lower triglycerides and increase HDL cholesterol. Because of the cardioprotective benefits of omega-3 fatty acids, the American Heart Association recommends eating oily fish at least twice per week. As illustrated in Figure 10.7, baseline blood levels of omega-3 fatty acids are inversely related to the risk of sudden cardiac death. Individuals in the highest quartile of omega-3 fatty acids (mean = 6.87% of total fatty acids) have a 90-percent reduction in sudden cardiac death risk as compared with those in the lowest quartile (mean = 3.58% of total fatty acids).

The antioxidant effect of vitamins C and E may provide benefits. Data suggest that a single unstable free radical (an oxygen compound produced during metabolism—see Chapter 3) can damage LDL particles, accelerating the atherosclerotic process. Vitamin C may inactivate free radicals and slow the oxidation of LDL cholesterol. Vitamin E may protect LDL from oxidation, preventing heart disease, but studies suggest that it does not seem to be helpful in reversing damage once it has taken place.

Trans Fats
Foods that contain trans fatty acids, hydrogenated fat, or partially hydrogenated vegetable oil should be avoided. Studies indicate that these foods elevate LDL cholesterol as much as saturated fats do, but even worse, they lower HDL cholesterol. Trans fats also increase triglycerides. These changes contribute not only to heart disease, but also to gallstone formation. Trans fats are found primarily in processed foods.

Food companies have used trans fats because they are inexpensive to produce, easy to use, last a long time, and add taste and texture to food. Restaurants and fast-food chains choose oils with trans fats because they can be used repeatedly in commercial fryers. Hydrogen frequently is added to monounsaturated and polyunsaturated fats to increase shelf life and to solidify them so they are more spreadable. Hydrogenation can change the position of hydrogen atoms along the carbon chain, transforming the fat into a trans fatty acid. Margarine and spreads, chips, commercially produced crackers and cookies, and fast foods often contain trans fatty acids. Small amounts of trans fats are also found naturally in some meats, dairy products, and other animal-based foods.

Habitual aerobic exercise helps increase HDL cholesterol (“good” cholesterol).

**Figure 10.7** Relative risk and sudden cardiac death by baseline omega-3 fatty acid level of quartiles.

**Key Terms**

- **Triglycerides** Fats formed by glycerol and three fatty acids; also called free fatty acids.
- **Processed foods** A food which has been chemically altered from its natural state through additives such as flavors, flavor enhancers, colors, binders, preservatives, stabilizers, emulsifiers, fillers, and so on, or which has been manufactured through combination or other methods.
The American Heart Association (AHA) has issued dietary guidelines for trans fat intake, recommending that people limit trans fat intake to less than 1 percent of the total daily caloric intake. This amount represents about 1.5 grams of trans fats a day for a 1,500 calorie diet, 2 grams for 2,000 calories, and 3 grams for 3,000 calories. Because the FDA now requires that all food labels list the trans fat content, you can keep better track of your daily trans fat intake by paying attention to food labels. Additional information on trans fats is found under the “Trans Fatty Acids” section in Chapter 3 (see page 78).

The U.S. Food and Drug Administration (FDA) allows food manufacturers to label any product that has less than half a gram of trans fat per serving as zero. Be aware that if you eat three or four servings of a particular food near a half a gram of trans fat, you may be getting your maximum daily allowance (1 gram per 1,000 calories of daily caloric intake). Thus, you are encouraged to look at the list of ingredients and search for the words “partially hydrogenated” as an indicator of hidden trans fats.

The labels “partially hydrogenated” and “trans fatty acids” indicate that the product carries a health risk just as high as that of saturated fat. Now that trans fats are listed on food labels, companies are looking to reformulate their products to reduce or eliminate these fats. Some products that once had a high trans fat content now have none. As a consumer, you are encouraged to check food labels often to obtain current information. Table 10.5 lists the average trans fat content of some foods. These values may vary among brands according to food formulation and ingredients and may change in the near future as manufacturers alter food formulations to decrease or eliminate trans fat content.

### Table 10.5: Average Trans Fat Content of Selected Foods

<table>
<thead>
<tr>
<th>Food Item</th>
<th>Amount</th>
<th>Grams</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fats/Oils</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Margarine, stick</td>
<td>1 tbsp</td>
<td>2.0</td>
</tr>
<tr>
<td>Margarine, tub</td>
<td>1 tbsp</td>
<td>0.5</td>
</tr>
<tr>
<td>Butter</td>
<td>1 tbsp</td>
<td>0.3</td>
</tr>
<tr>
<td>Shortening</td>
<td>1 tsp</td>
<td>4.0</td>
</tr>
<tr>
<td>Mayonnaise</td>
<td>1 tbsp</td>
<td>0.0</td>
</tr>
<tr>
<td><strong>Snacks</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oreo cookies</td>
<td>3</td>
<td>2.5</td>
</tr>
<tr>
<td>Chips Ahoy Chocolate Chip Cookies</td>
<td>3</td>
<td>1.5</td>
</tr>
<tr>
<td>Ritz crackers</td>
<td>5</td>
<td>1.5</td>
</tr>
<tr>
<td>Flavorite Honey Maid Grahams</td>
<td>8</td>
<td>1.5</td>
</tr>
<tr>
<td>Fig Newtons</td>
<td>2</td>
<td>1.0</td>
</tr>
<tr>
<td>Potato chips</td>
<td>2 oz</td>
<td>3.0</td>
</tr>
<tr>
<td>Cake, pound</td>
<td>1 slice (3 oz)</td>
<td>4.5</td>
</tr>
<tr>
<td>Candy bar</td>
<td>1</td>
<td>3.0</td>
</tr>
<tr>
<td><strong>Fast Foods</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dunkin’ Donuts Apple Fritter</td>
<td>1</td>
<td>2.5</td>
</tr>
<tr>
<td>Krispy Kreme Apple Fritter</td>
<td>1</td>
<td>7.0</td>
</tr>
<tr>
<td>Krispy Kreme Doughnut, glazed</td>
<td>1</td>
<td>4.0</td>
</tr>
<tr>
<td>McDonald’s Biscuit</td>
<td>1</td>
<td>5.0</td>
</tr>
<tr>
<td>McDonald’s Cinnamon Roll</td>
<td>1</td>
<td>4.5</td>
</tr>
<tr>
<td>McDonald’s Baked Apple Pie</td>
<td>1</td>
<td>4.0</td>
</tr>
<tr>
<td>McDonald’s Chicken McNuggets</td>
<td>10 pieces</td>
<td>2.5</td>
</tr>
<tr>
<td>Burger King French Toast Sticks</td>
<td>5 pieces</td>
<td>4.5</td>
</tr>
<tr>
<td>Burger King Chicken Tenders</td>
<td>5 pieces</td>
<td>2.5</td>
</tr>
<tr>
<td>Burger King Big Fish Sandwich</td>
<td>1</td>
<td>1.5</td>
</tr>
<tr>
<td>KFC Extra Crispy Breast</td>
<td>6 oz</td>
<td>4.5</td>
</tr>
<tr>
<td>KFC Breast, original recipe</td>
<td>6 oz</td>
<td>2.5</td>
</tr>
<tr>
<td>French fries</td>
<td>1 med (4 oz)</td>
<td>5.0</td>
</tr>
<tr>
<td>Taco Bell, Taco</td>
<td>1</td>
<td>0.5</td>
</tr>
<tr>
<td>Taco Bell, Taco Supreme</td>
<td>1</td>
<td>1.0</td>
</tr>
<tr>
<td>Taco Bell, Burrito</td>
<td>1</td>
<td>2.0</td>
</tr>
<tr>
<td>Taco Bell, Burrito Supreme, beef</td>
<td>1</td>
<td>2.0</td>
</tr>
</tbody>
</table>

NOTE: Trans fat intake should be limited to no more than 1 percent of total daily caloric intake or the equivalent of 1 gram per 1,000 calories of energy intake.

*Trans fat content in food items may decrease significantly in the near future as food manufacturers are looking to lower the amount in their products because of FDA regulations that require trans fats to be listed on food labels. Trans fat content also varies between different brands based on food formulation and ingredients. Check food labels regularly to obtain current information.

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Lowering LDL Cholesterol

LDL cholesterol levels higher than ideal can be lowered through dietary changes, by losing body fat, by taking medication, and by participating in a regular aerobic exercise program. Research conducted at the Aerobics Research Institute in Dallas, Texas, showed a higher relative risk of mortality in unfit individuals with low cholesterol than fit people with high cholesterol. The lowest mortality rate, of course, is seen in fit people with low total cholesterol levels.

In terms of dietary modifications, a diet lower in saturated fat, trans fats, and cholesterol and high in fiber is recommended. Saturated fat should be replaced with polyunsaturated and monounsaturated fats because the latter tend to decrease LDL cholesterol and increase HDL cholesterol (see the discussion of “Simple Fats” in Chapter 3, pages 77–79). Total saturated fat intake should be less than 7 percent of the total daily caloric intake, preferably much lower while on a cholesterol-lowering diet. Trans fat intake should be less than 1 percent of daily caloric intake. Exercise is important because dietary manipulation by itself is not as effective in lowering LDL cholesterol as a combination of diet plus aerobic exercise.

To lower LDL cholesterol significantly, total daily fiber intake must be in the range of 25 to 38 grams per day (see “Fiber” in Chapter 3), and total fat consumption can be in the range of 30 percent of total daily caloric intake—as long as most of the fat is unsaturated fat and the average cholesterol consumption is lower than 300 mg per day (preferably less than 200 mg). Increasing consumption of...
Soluble fiber dissolves in water and forms a gel-like substance that encloses food particles. This property helps bind and excrete fats from the body. Soluble fibers also bind intestinal bile acids that could be recycled into additional cholesterol. Soluble fibers are found primarily in oats, fruits, barley, legumes, and psyllium.

Psyllium, a grain that is added to some multigrain breakfast cereals, also helps lower LDL cholesterol. As little as 3 daily grams of psyllium can lower LDL cholesterol by 20 percent. Commercially available fiber supplements that contain psyllium (such as Metamucil) can be used to increase soluble fiber intake. Three tablespoons daily will add about 10 grams of soluble fiber to the diet.

The incidence of heart disease is very low in populations in which daily fiber intake exceeds 30 grams per day. Further, a Harvard University Medical School study of 43,000 middle-aged men who were followed for more than 6 years showed that increasing fiber intake to 30 daily grams resulted in a 41 percent reduction in heart attacks.14

When attempting to lower LDL cholesterol, moderate fat consumption is still encouraged. A drawback of very low-fat diets (less than 25 percent fat) is that they tend to lower HDL cholesterol and increase triglycerides. If HDL cholesterol is already low, monounsaturated and polyunsaturated fats should be added to the diet. Examples of food items that are high in monounsaturated fats and polyunsaturated fats are nuts, olive, canola, corn, and soybean oils. The table of nutritive values in Appendix A can be used to determine food items that are high in monounsaturated and polyunsaturated fats (see also Figure 3.9, page 91).
NCEP Guidelines
The NCEP guidelines for people who are trying to decrease LDL cholesterol allow for a diet with up to 35 percent of calories from fat, including 10 percent from polyunsaturated fats and 20 percent from monounsaturated fats. If you are attempting to lower LDL cholesterol, saturated fats should be kept to an absolute minimum.

Margarines and salad dressings that contain stanol ester, a plant-derived compound that interferes with cholesterol absorption in the intestine, are now also on the market. Over the course of several weeks, daily intake of about 3 grams of margarine or 6 tablespoons of salad dressing containing stanol ester lowers LDL cholesterol by 14 percent. Dietary guidelines to lower LDL cholesterol levels are provided in the accompanying box.

The best prescription for controlling blood lipids is the combination of a healthy diet, a sound aerobic exercise program, and weight control. If this does not work, a physician can recommend appropriate drug therapies based upon a blood test to analyze the various subcategories of lipoproteins.

The NCEP guidelines recommend that people consider drug therapy if, after 6 months on a diet low in cholesterol and trans fat and saturated fat, cholesterol remains unacceptably high. An unacceptable level is an LDL cholesterol above 190 mg/dL for individuals with fewer than two risk factors and no signs of heart disease. For individuals with more than two risk factors and with a history of heart disease, LDL cholesterol above 160 mg/dL is unacceptable.

Saturated Fat Replacement in the Diet
Although for years we have known that saturated fat raises LDL cholesterol, a 2010 review of 21 observational research studies involving almost 350,000 people failed to prove a significant association between saturated fat intake and risk of CHD, stroke, or CVD. Researchers are focusing on the foods consumed in the American diet that have replaced saturated fat.

Once people learned that saturated fats were unhealthy, instead of consuming more fruits, vegetables, legumes, and grains, many increased consumption of “low-fat” simple carbohydrates and refined sugars (low-fat varieties of breads, rolls, cereals, cookies, ice cream, cakes, and desserts). Although low in fat, simple carbohydrates and refined sugars are high in calories that lead to weight gain. The data show that exchanging refined carbohydrates for saturated fat exacerbates blood lipid problems, including a higher LDL cholesterol, a reduction in HDL cholesterol, and higher triglycerides.

Behavior Modification Planning

Dietary Guidelines to Lower LDL Cholesterol

- Consume between 25 and 38 grams of fiber daily, including a minimum of 10 grams of soluble fiber (good sources are oats, fruits, barley, legumes, and psyllium).
- Increase consumption of vegetables, fruits, whole grains, and beans.
- Do not consume more than 200 mg of dietary cholesterol a day.
- Consume red meats (3 ounces per serving) fewer than 3 times per week and no organ meats (such as liver and kidneys).
- Do not eat commercially baked foods.
- Avoid foods that contain trans fatty acids, hydrogenated fat, or partially hydrogenated vegetable oil.
- Increase intake of omega-3 fatty acids (see Chapter 3) by eating two to three omega-3-rich fish meals per week.

- Consume 25 grams of soy protein a day.
- Drink low-fat milk (1 percent or less fat, preferably) and use low-fat dairy products.
- Do not use coconut oil, palm oil, or cocoa butter.
- Limit egg consumption to fewer than three eggs per week (this is for people with high cholesterol only; others may consume eggs in moderation).
- Use margarines and salad dressings that contain stanol ester instead of butter and regular margarine.
- Bake, broil, grill, poach, or steam food instead of frying.
- Refrigerate cooked meat before adding to other dishes. Remove fat hardened in the refrigerator before mixing the meat with other foods.
- Avoid fatty sauces made with butter, cream, or cheese.
- Maintain recommended body weight.

Try It
Dietary guidelines for health and wellness were thoroughly discussed in Chapter 3, “Nutrition for Wellness.” How have your dietary habits changed since studying these guidelines, and how well do they support the above recommendations to lower LDL cholesterol?
Experts instead recommend replacing saturated fat with monounsaturated and polyunsaturated fats. The latter are preferable because they provide greater cardiovascular benefits. The recommendation is not to limit fat consumption in the diet to an absolute minimum, but to maintain total fat intake around 25 to 35 percent of total calories, with a primary shift toward polyunsaturated fats. To do so, choose fish, nuts, seeds, and vegetable oils that are liquid at room temperature (with the exception of tropical oils including coconut, palm, and palm kernel oils).

At present, it is unknown whether the cardioprotective benefits are the result of limiting saturated fat intake or increasing polyunsaturated fat consumption. Another 2010 review found that consumption of polyunsaturated fat in place of saturated fat reduced the incidence of heart attacks and cardiac deaths. Thus, moderate fat intake (not low fat), along with decreased refined carbohydrates, and decreased caloric intake in most cases, are encouraged. The issue merits further research involving clinical trials (rather than observational studies) before clear answers can be obtained.

Elevated Triglycerides

Triglycerides, also known as free fatty acids, make up most of the fat in our diet and most of the fat that circulates in the blood. In combination with cholesterol, triglycerides speed up formation of plaque in the arteries. Triglycerides are carried in the bloodstream primarily by VLDLs and chylomicrons.

Although they are found in poultry skin, lunch meats, and shellfish, these fatty acids are manufactured mainly in the liver from refined sugars, starches, and alcohol. High intake of alcohol and sugars (honey and fruit juices included) significantly raises triglyceride levels.

To lower triglycerides, avoid pastries, candies, soft drinks, fruit juices, white bread, pasta, and alcohol. In addition, cutting down on overall fat consumption, quitting smoking, reducing weight (if overweight), and doing aerobic exercise are helpful measures. Omega-3 fatty acids also help, but doses higher than those found in fish are required. The American Heart Association recommends two to four daily grams of fish oil under a physician’s supervision.

The desirable blood triglyceride level is less than 150 mg/dL (see Table 10.6). For people with cardiovascular problems, this level should be below 100 mg/dL. Levels above 1,000 mg/dL pose an immediate risk for potentially fatal sudden inflammation of the pancreas.

**LDL Phenotype B**

Some people consistently have slightly elevated triglyceride levels (above 140 mg/dL) and HDL cholesterol levels below 35 mg/dL. About 80 percent of these people have a genetic condition called LDL phenotype B. Although the blood lipids may not be notably high, these people are at higher risk for atherosclerosis and CHD.

**Critical Thinking**

Are you aware of your blood lipid profile? • If not, what is keeping you from getting a blood chemistry test? • What are the benefits of having it done now rather than later in life?

**Table 10.6 Triglycerides Guidelines**

<table>
<thead>
<tr>
<th>Amount</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;150 mg/dL</td>
<td>Desirable</td>
</tr>
<tr>
<td>150–199 mg/dL</td>
<td>Borderline-high</td>
</tr>
<tr>
<td>200–499 mg/dL</td>
<td>High</td>
</tr>
<tr>
<td>≥500 mg/dL</td>
<td>Very high</td>
</tr>
</tbody>
</table>

SOURCE: National Heart, Lung and Blood Institute.

Cholesterol-Lowering Medications

Effective medications are available to treat elevated cholesterol and triglycerides. Most notable among them are the statins group (Lipitor®, Mevacor®, Pravachol®, Lescol®, and Zocor®), which can lower cholesterol by up to 60 percent in 2 to 3 months. Statins slow down cholesterol production and increase the liver’s ability to remove blood cholesterol. They also decrease triglycerides and produce a small increase in HDL levels. The drug Tricor® is commonly used to lower triglycerides.

In general, it is better to lower LDL cholesterol without medication, because drugs often cause undesirable side effects. Many people with heart disease must take cholesterol-lowering medication, but medication is best combined with lifestyle changes to augment the
cholesterol-lowering effect. For example, when Zocor was taken alone over 3 months, LDL cholesterol decreased by 30 percent; but when a Mediterranean diet was adopted in combination with Zocor therapy, LDL cholesterol decreased by 41 percent.\textsuperscript{19}

Other drugs effective in reducing LDL cholesterol are bile acid sequestrants, which bind the cholesterol found in bile acids. Cholesterol subsequently is excreted in the stools. These drugs often are used in combination with statin drugs.

High dosages (1.5 to 3 grams per day) of nicotinic acid or niacin (a B vitamin) also help lower LDL cholesterol, Lp(a), and triglycerides and increase HDL cholesterol (change HDL3 to HDL2). Niacin in combination with some of the aforementioned drugs also exerts positive effects on IDL and pattern size. A fourth group of drugs, known as fibrates, is used primarily to lower triglycerides.

### Elevated Homocysteine

Clinical data indicating that many heart attack and stroke victims have normal cholesterol levels have led researchers to look for other risk factors that may contribute to atherosclerosis. Although it is not a blood lipid, one of these factors is a high concentration of the amino acid homocysteine in the blood. It is thought to enhance the formation of plaque and the subsequent blockage of arteries.

The body uses homocysteine to help build proteins and carry out cellular metabolism. It is an intermediate amino acid in the interconversion of two other amino acids—methionine and cysteine. This interconversion requires the B vitamin folate (folic acid) and vitamins B\textsubscript{6} and B\textsubscript{12}. Typically, homocysteine is metabolized rapidly, so it does not accumulate in the blood or damage the arteries. Still, many people have high blood levels of homocysteine. This might result from either a genetic inability to metabolize homocysteine or a deficiency in the vitamins required for its conversion.

Homocysteine typically is measured in micromoles per liter (µmol/L). Guidelines to interpret homocysteine levels are provided in Table 10.7. A 10-year follow-up study of people with high homocysteine levels showed that those individuals with a level above 14.25 µmol/L had almost twice the risk of stroke compared with individuals whose level was below 9.25 µmol/L.\textsuperscript{20} Homocysteine accumulation is theorized to be toxic because it may:

1. Cause damage to the inner lining of the arteries (the initial step in the process of atherosclerosis)
2. Stimulate the proliferation of cells that contribute to plaque formation
3. Encourage clotting, which could completely obstruct an artery and lead to a heart attack or stroke

Keeping homocysteine from accumulating in the blood seems to be as simple as eating the recommended daily servings of vegetables, fruits, grains, and some meat and legumes. Five servings of fruits and vegetables daily can provide sufficient levels of folate and vitamin B\textsubscript{6} to remove and clear homocysteine from the blood. Vitamin B\textsubscript{12} is found primarily in animal flesh and animal products. Vitamin B\textsubscript{12} deficiency is rarely a problem because 1 cup of milk or an egg provides the daily requirement. The body also recycles most of this vitamin; therefore, a deficiency takes years to develop. People who consume five servings of fruits and vegetables daily are unlikely to derive extra benefits from a vitamin-B-complex supplement.

Increasing evidence that folate can prevent heart attacks has led to the recommendation that people consume 400 micrograms (mcg) per day—obtainable from five daily servings of fruits and vegetables. Unfortu-
nately, estimates indicate that more than 80 percent of Americans do not get 400 mcg of folate per day (adequate folate intake also is critical for women of child-bearing age to prevent birth defects).

**Inflammation**

In addition to homocysteine, scientists are looking at inflammation as a major risk factor for heart attacks. Low-grade inflammation can occur in a variety of places throughout the body. For years it has been known that inflammation plays a role in CHD and that inflammation hidden deep in the body is a common trigger of heart attacks, even when cholesterol levels are normal or low and arterial plaque is minimal.

To evaluate ongoing inflammation in the body, physicians have turned to **C-reactive protein (CRP)**, a protein whose levels in the blood increase with inflammation. Individuals with elevated CRP are more prone to cardiovascular events, even in the absence of elevated LDL cholesterol. The evidence shows that CRP blood levels elevate years before a first heart attack or stroke, and that individuals with elevated CRP have twice the risk of a heart attack. The risk of a heart attack is even higher in people with both elevated CRP and cholesterol, resulting in an almost ninefold increase in risk (see Figure 10.8).

Because high CRP levels might be a better predictor of future heart attacks than high cholesterol alone, a test known as high-sensitivity CRP (hs-CRP), which measures inflammation in the blood vessels, has been approved by the FDA. The term “high sensitivity” was derived from the test’s capability to detect small amounts of CRP in the blood.

**Figure 10.8** Relationships between C-reactive protein, cholesterol, and risk of cardiovascular disease.

Results of the hs-CRP test provide a good measure of the probability of plaque rupturing within the arterial wall. The two main types of plaque are soft and hard. Soft plaque is the most likely to rupture. Ruptured plaque releases clots into the bloodstream that can lead to a heart attack or a stroke. Other evidence has linked high CRP levels to high blood pressure and colon cancer.

Excessive intake of alcohol and high-protein diets also increase CRP. Evidence further indicates that high-fat fast food increases CRP levels for several hours following the meal. And cooking meat and poultry at high temperatures creates damaged proteins called advanced glycosylation end products (AGEs), which trigger inflammation. Several studies have also indicated that high intake of omega-6 fatty acids causes inflammation (also see Chapter 3, page 78). The current American diet is too high in omega-6 foods. Obesity increases inflammation. With weight loss, CRP levels decrease proportional to the amount of fat lost.

An hs-CRP test is relatively inexpensive and it is highly recommended for individuals at risk for heart attack. A level above 2 mg/L appears to be a better predictor of a heart attack than an LDL cholesterol level above 130 mg/dL. General guidelines for hs-CRP levels are given in Table 10.8.

<table>
<thead>
<tr>
<th>Rating</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low risk</td>
<td>&lt;1 mg/L</td>
</tr>
<tr>
<td>Average risk</td>
<td>1–3 mg/L</td>
</tr>
<tr>
<td>High risk</td>
<td>&gt;3 mg/L</td>
</tr>
</tbody>
</table>

Results of the hs-CRP test provide a good measure of the probability of plaque rupturing within the arterial wall. The two main types of plaque are soft and hard. Soft plaque is the most likely to rupture. Ruptured plaque releases clots into the bloodstream that can lead to a heart attack or a stroke. Other evidence has linked high CRP levels to high blood pressure and colon cancer.

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A weakness of the hs-CRP test is that it does not detect differences between acute and chronic inflammation, and results may not be stable from day to day. An acute inflammation, for example, could be the result of a pulled muscle or a passing cold. It is chronic inflammation that increases heart disease risk. Thus, a new test that specifically detects chronic inflammation, lipoprotein phospholipase A2 (PAL2), may soon replace the hs-CRP test.

CRP levels decrease with statin drugs, which also lower cholesterol and reduce inflammation. A 2008 study on 17,802 apparently healthy men and women with LDL

**Table 10.8** High-Sensitivity CRP Guidelines

<table>
<thead>
<tr>
<th>Amount</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;1 mg/L</td>
<td>Low risk</td>
</tr>
<tr>
<td>1–3 mg/L</td>
<td>Average risk</td>
</tr>
<tr>
<td>&gt;3 mg/L</td>
<td>High risk</td>
</tr>
</tbody>
</table>

**Key Terms**

**Homocysteine** An amino acid that, when allowed to accumulate in the blood, may lead to plaque formation and blockage of arteries.

**C-reactive protein (CRP)** A protein whose blood levels increase with inflammation, at times hidden deep in the body; elevation of this protein is an indicator of potential cardiovascular events.
cholesterol below 130 mg/dL, but CRP levels above 2.0 mg/L showed that a daily dose of the statin drug Crestor® reduced LDL cholesterol by 50 percent, CRP by 37 percent, and the risk of heart attack, stroke, and death by 54 percent, 48 percent, and 47 percent, respectively. The results were so impressive, that researchers stopped the trial halfway through the study.

Exercise, weight loss, proper nutrition, and quitting smoking are helpful in reducing hs-CRP. Omega-3 fatty acids inhibit proteins that cause inflammation. Aspirin therapy also helps by controlling inflammation.

Types of Diabetes

Diabetes mellitus is of two types: type 1, or insulin-dependent diabetes mellitus (IDDM), and type 2, or non-insulin-dependent diabetes mellitus (NIDDM). Type 1 also has been called “juvenile diabetes,” because it is found mainly in young people. With type 1, the pancreas produces little or no insulin. With type 2, either the pancreas does not produce sufficient insulin, or it produces adequate amounts but the cells become insulin-resistant, thereby keeping glucose from entering the cell. Type 2 accounts for 90 to 95 percent of all cases of diabetes.

Presently, more than 1 in 10 American adults have diabetes. Although diabetes has a genetic predisposition, 60 to 80 percent of type 2 diabetes is related closely to overeating, obesity, and lack of physical activity. Type 2 diabetes, once limited primarily to overweight adults, now accounts for almost half of the new cases diagnosed in children. According to the CDC, 1 in 3 children born in the United States today will develop diabetes.

More than 80 percent of all people with type 2 diabetes are overweight or have a history of excessive weight. In most cases, this condition can be corrected through regular exercise, a special diet, and weight loss.

Aerobic exercise helps prevent type 2 diabetes. The protective effect is even greater in those with risk factors such as obesity, high blood pressure, and family propensity. The preventive effect is attributed to less body fat result in severe infection and gangrene, which can even lead to an amputation.

An 8-hour fasting blood glucose level above 125 mg/dL on two separate tests confirms a diagnosis of diabetes (see Table 10.9). A level of 126 or higher should be brought to the attention of a physician.

**Table 10.9 Blood Glucose Guidelines**

<table>
<thead>
<tr>
<th>Amount</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤100 mg/dL</td>
<td>Normal</td>
</tr>
<tr>
<td>101–125 mg/dL</td>
<td>Pre-diabetes</td>
</tr>
<tr>
<td>≥126 mg/dL</td>
<td>Diabetes*</td>
</tr>
</tbody>
</table>

*Confirmed by two tests on different days.

Regular physical activity increases insulin sensitivity and decreases the risk for diabetes.
and to better sugar and fat metabolism resulting from the regular exercise program. At 3,500 calories of energy expenditure per week through exercise, the risk is cut in half versus that of a sedentary lifestyle.

Both moderate- and vigorous-intensity physical activity are associated with increased insulin sensitivity and decreased risk for diabetes. The key to increase and maintain proper insulin sensitivity is regularity of the exercise program. Failing to maintain habitual physical activity voids these benefits. Thus, a simple aerobic exercise program (walking, cycling, or swimming four or five times per week) often is prescribed because it increases the body’s sensitivity to insulin. Exercise guidelines for diabetic patients are discussed in detail in Chapter 9.

In fact, accumulating evidence indicates that increasing physical activity, losing excess weight, and improving nutrition is more effective to control diabetes and lower CVD risk than relying on drugs to manage the disease. Furthermore, research suggests that diabetic patients are worse off when medications are used to decrease blood sugar levels and blood pressure to normal or below normal levels. Accordingly, diabetic patients are strongly encouraged to adopt healthy lifestyle factors even if glucose levels are controlled with medication. Medications are recommended for diabetic patients with a systolic blood pressure above 140 mm Hg, but it is only necessary to drive it down to about 130 mm Hg.

A diet high in complex carbohydrates (unrefined whole grains and whole foods) and water-soluble fibers (found in fruits, vegetables, oats, beans, and psyllium), low in saturated fat, low in sugar, and a small amount of lean protein with meals is helpful in treating diabetes. Weight loss, even if only a 5 to 10 percent reduction in weight, can make a notable difference in controlling blood sugar. These lifestyle changes (proper nutrition, physical activity, and weight loss) often allow diabetic patients to normalize their blood sugar level without the use of medication.

Finally, evidence also suggests that consumption of low-fat dairy products lowers the risk for type 2 diabetes. Research on more than 41,000 men showed that those who consumed the most dairy products had a 23 percent lower incidence of the disease. Furthermore, each additional daily serving of dairy products was associated with a 9 percent decrease in type 2 diabetes risk.

Glycemic Index
Although complex carbohydrates are recommended in the diet, people with diabetes need to pay careful attention to the glycemic index (explained in Chapter 5 and detailed in Table 5.1, pages 147–149). Refined and starchy foods (small-particle carbohydrates, which are quickly digested) rank high in the glycemic index, whereas grains, fruits, and vegetables are low-glycemic foods.

Foods high in the glycemic index cause a rapid increase in blood sugar. A diet that includes many high-glycemic foods increases the risk for CVD in people with high insulin resistance and glucose intolerance. Com-

### Behavior Modification Planning

#### Guidelines to Prevent and Manage Type 2 Diabetes

Experts agree that the following healthy lifestyle strategies are effective in type 2 diabetes management:

**I PLAN TO**

- □ Follow an overall healthful dietary pattern that includes
  - □ A minimum of five daily servings of fruits and vegetables
    - At least three daily servings of whole grains
    - Consumption of at least two 3-oz servings of fatty fish per week
    - A few small portions of nuts each week
    - Skim milk and low-fat dairy products in your daily diet
- □ Maintain recommended body weight
- □ Increase daily physical activity (to at least 30 minutes of daily moderate-intensity activity and strength training two to three times per week)

**I DID IT**

- Review your Behavior Change Plan and your Online Journal or class notebook. Are you following these guidelines? Are there changes you need to make to your Behavior Change Plan to bring yourself into closer compliance?

### Key Terms

- **Diabetes mellitus** A disease in which the body doesn’t produce or utilize insulin properly.
- **Insulin** A hormone secreted by the pancreas; essential for proper metabolism of blood glucose (sugar) and maintenance of blood glucose level.
- **Insulin resistance** Inability of the cells to respond appropriately to insulin.
- **Type 1 diabetes** Insulin-dependent diabetes mellitus (IDDM), a condition in which the pancreas produces little or no insulin; also known as juvenile diabetes.
- **Type 2 diabetes** Non–insulin-dependent diabetes mellitus (NIDDM), a condition in which insulin is not processed properly; also known as adult-onset diabetes.
- **Glucose intolerance** A condition characterized by slightly elevated blood glucose levels.
bining a moderate amount of high-glycemic foods with low-glycemic foods or with some fat and protein, however, can bring down the average index.

A1C Test
Individuals who have high blood glucose levels should consult a physician to decide on the best treatment. They also might obtain information about the hemoglobin A1c test (also called HbA1c), which measures the amount of glucose that has been in a person’s blood over the last 3 months. Blood glucose can become attached to hemoglobin in the red blood cells. Once attached, it remains there for the life of the red blood cell, which is about 3 months. The higher the blood glucose, the higher is the concentration of glucose in the red blood cells. Results of this test are given in percentages.

The HbA1c goal for diabetic patients is to keep it under 7 percent. At this level and below, diabetic patients have a lower risk of developing diabetes-related problems of the eyes, kidneys, and nerves. Because the test tells a person how well blood glucose has been controlled over the last 3 months, a change in treatment is almost always recommended if the HbA1c results are above 8 percent. All people with type 2 diabetes should have an HbA1c test twice per year.

Metabolic Syndrome
As the cells resist the actions of insulin, the pancreas releases even more insulin in an attempt to keep blood glucose from rising. A chronic rise in insulin seems to trigger a series of abnormalities referred to as the metabolic syndrome. These abnormal conditions include abdominal obesity, elevated blood pressure, high blood glucose, low HDL cholesterol, high triglycerides, and an increased blood-clotting mechanism. All of these conditions increase the risk for CHD and other diabetes-related conditions (blindness, infection, nerve damage, kidney failure). Approximately 50 million Americans are afflicted with this condition.

People with metabolic syndrome have an abnormal insulin response to carbohydrates, in particular high-glycemic foods. Research on metabolic syndrome indicates that a low-fat, high-carbohydrate diet may not be the best for preventing CHD and actually could increase the risk for the disease in individuals with high insulin resistance and glucose intolerance. It might be best for these people to distribute daily caloric intake so that 45 percent of the calories are derived from carbohydrates (primarily low-glycemic carbohydrates), 40 percent from fat, and 15 percent from protein.28 Of the 40 percent fat calories, most of the fat should come from mono- and poly-unsaturated fats and less than 7 percent from saturated fat.

Individuals with metabolic syndrome also benefit from weight loss (if overweight), exercise, and smoking cessation. Insulin resistance drops by about 40 percent in overweight people who lose 20 pounds. A total of 45 minutes of daily aerobic exercise enhances insulin efficiency by 25 percent. Quitting smoking also decreases insulin resistance.

Hypertension
Some 60,000 miles of blood vessels run through the human body. As the heart forces the blood through these vessels, the fluid is under pressure. Blood pressure is measured in milliliters of mercury (mm Hg), usually expressed in two numbers—systolic blood pressure is the higher number, and diastolic blood pressure is the lower number. Ideal blood pressure is 120/80 or lower.

Standards
Statistical evidence indicates that damage to the arteries starts at blood pressures above 120/80. The risk for CVD doubles with each increment of 20/10, starting with a blood pressure of 115/75.29 All blood pressures above 140/90 are considered to be hypertension (see Table 10.10). Blood pressures ranging from 120/80 to 139/89 are referred to as prehypertension.

Based on estimates, approximately 1 in every 3 adults is hypertensive. The incidence is higher among African Americans—in fact, it is among the highest in the world. Approximately 30 percent and 20 percent of all deaths in African American men and women, respectively, may be caused by high blood pressure.
Although the threshold for hypertension has been set at 140/90, many experts believe that the lower the blood pressure, the better. Even if the pressure is around 90/50, as long as that person does not have any symptoms of hypotension, he or she need not be concerned. Typical symptoms of hypotension are dizziness, lightheadedness, and fainting.

Blood pressure also may fluctuate during a regular day. Many factors affect blood pressure, and one single reading may not be a true indicator of the real pressure. For example, physical activity and stress increase blood pressure, and rest and relaxation decrease blood pressure. Consequently, several measurements should be taken before diagnosing high pressure.

Incidence and Pathology

Based on estimates by the American Heart Association, about 74 million Americans are hypertensive, and more than 57,000 Americans die each year as a result of high blood pressure. The dramatic increase in hypertension seems to be linked to the growing obesity epidemic and the aging of the U.S. population. Unless appropriate, healthy lifestyle strategies are implemented, people who do not have high blood pressure at age 55 have a 90 percent chance of developing it at some point in their lives.30

Hypertension has been referred to as "the silent killer." It does not hurt, it does not make you feel sick, and unless you check it, years may go by before you even realize you have a problem. High blood pressure is a risk factor for CHD, congestive heart failure, stroke, kidney failure, and osteoporosis.

All inner walls of arteries are lined by a layer of smooth endothelial cells. Blood lipids cannot penetrate the healthy lining and start to build up on the walls unless the cells are damaged. High blood pressure is thought to be a leading contributor to destruction of this lining. As blood pressure rises, so does the risk for atherosclerosis. The higher the pressure, the greater the damage to the arterial wall, making the vessels susceptible to fat deposits, especially if serum cholesterol is also high. Blockage of the coronary vessels decreases blood supply to the heart muscle and can lead to heart attacks. When brain arteries are involved, a stroke may follow.

A clear example of the connection between high blood pressure and atherosclerosis can be seen by comparing blood vessels in the human body. Even when atherosclerosis is present throughout major arteries, fatty plaques rarely are seen in the pulmonary artery, which goes from the right part of the heart to the lungs. The pressure in this artery normally is below 40 mm Hg, and at such a low pressure, significant deposits do not occur. This is one of the reasons that people with low blood pressure have a lower incidence of CVD.

Constantly elevated blood pressure also causes the heart to work much harder. At first the heart does well, but in time this continual strain produces an enlarged heart, followed by congestive heart failure. Furthermore, high blood pressure damages blood vessels to the kidneys and eyes, which can result in kidney failure and loss of vision.

Treatment

Of all hypertension, 90 percent has no definite cause. Called "essential hypertension," it is treatable. Aerobic exercise, weight reduction, a low-salt/low-fat and high-potassium/high-calcium diet, lower alcohol and caffeine intake, smoking cessation, stress management, and anti-hypertensive medication all have been used effectively to treat essential hypertension.

The remaining 10 percent of hypertensive cases are caused by pathological conditions, such as narrowing of the kidney arteries, glomerulonephritis (a kidney disease), tumors of the adrenal glands, and narrowing of the aortic artery. With this type of hypertension, the pathological cause has to be treated before the blood pressure problem can be corrected.

Key Terms

**Metabolic syndrome** An array of metabolic abnormalities that contribute to the development of atherosclerosis triggered by insulin resistance. These conditions include low HDL-cholesterol, high triglycerides, high blood pressure, and an increased blood-clotting mechanism.

**Blood pressure** A measure of the force exerted against the walls of the vessels by the blood flowing through them.

**Systolic blood pressure** Pressure exerted by blood against walls of arteries during forceful contraction (systole) of the heart; higher of the two numbers in blood pressure readings.

**Diastolic blood pressure** Pressure exerted by blood against walls of arteries during relaxation phase (diastole) of the heart; lower of the two numbers in blood pressure readings.

**Hypertension** Chronically elevated blood pressure.

**Hypotension** Low blood pressure.
Antihypertensive medicines often are the first choice of treatment, but they produce many side effects. These include lethargy, sleepiness, sexual difficulties, higher blood cholesterol and glucose levels, lower potassium levels, and elevated uric acid levels. A physician may end up treating these side effects as much as the hypertension itself. Because of the many side effects, about half of the patients stop taking the medication within the first year of treatment.

Another factor contributing to elevated blood pressure is too much sodium in the diet (salt, or sodium chloride, contains approximately 40 percent sodium). With a high sodium intake, the body retains more water, which increases the blood volume and, in turn, drives up the pressure. High intake of potassium seems to regulate water retention and lower the pressure slightly. According to the Institute of Medicine of the National Academy of Sciences, we need to consume at least 4,700 mg of potassium per day. Most Americans get only half that amount. Foods high in potassium include vegetables (especially leafy green), citrus fruit, dairy products, fish, beans, and nuts.

Critical Thinking

Do you know what your most recent blood pressure reading was, and did you know at the time what the numbers meant? • How would you react if your doctor were to instruct you to take blood pressure medication?

Although sodium is essential for normal body functions, the body can function with as little as 200 mg, or a tenth of a teaspoon, daily. Even under strenuous conditions in jobs and sports that incite heavy perspiration, the amount of sodium required is seldom more than 3,000 mg per day. Yet, sodium intake in the typical U.S. diet is about 4,000 mg per day.31 The upper limit (UL) of sodium intake has been set at 2,300 mg per day and the new 2010 Dietary Guidelines for Americans recommend a daily sodium intake of less than 2,300 mg. Adults over 51, African Americans, and all individuals with high blood pressure, diabetes, and chronic kidney disease are encouraged to keep daily intake below 1,500 mg. Among Americans, about 95 percent of men and 75 percent of women exceed these guidelines.

Salt-sensitive people, even in the absence of high blood pressure, are encouraged to decrease sodium intake because they have death rates similar to people with hypertension. The American Heart Association has issued guidelines calling for everyone to reduce daily sodium intake to less than 1,500 mg. Estimates indicate that if Americans were to follow these guidelines, heart attacks and strokes would decrease by 155,000 cases each year.

Two new studies corroborate previous concerns. First, a review of 13 sodium consumption-related studies shows that decreasing sodium intake by about 2,000 mg per day are associated with a 23 percent and 17 percent reduction in the risk of strokes and CVD, respectively.32 A second large study projected that reducing sodium intake by 1,200 mg per day, would prevent as many as 92,000 deaths a year in the United States.33 To either prevent or postpone the onset of hypertension and to help some hypertensives control their blood pressure, we should consume even less sodium than previously recommended.34 Lower sodium intake may also reduce the risk of left ventricular hypertrophy, congestive heart failure, gastric cancer, end-stage kidney disease, osteoporosis, and bloating. Research data support the notion that daily sodium intake should be reduced as much as possible.

Where does all the sodium come from? Part of the answer is given in Table 10.11 (the list in Table 10.11 does not include salt added at the table). Most of the sodium that people consume comes from packaged and prepared foods, over whose ingredients the consumer has no control.

When treating high blood pressure (unless it is extremely high), before recommending medication, many sports medicine physicians suggest a combination of aerobic exercise, weight loss, and less sodium in the diet. In most instances, this treatment brings blood pressure under control.

The relative risk for mortality based on blood pressure and fitness levels is similar to that of physical fitness and cholesterol. In men and women alike, the relative risk for early mortality is lower in fit people with high systolic blood pressure (140 mm Hg or higher) than in unfit people with a healthy systolic blood pressure (120 mm Hg or lower).35

The link between hypertension and obesity seems to be quite strong. Blood volume increases with excess body fat, and each additional pound of fat requires an estimated extra mile of blood vessels to feed this tissue. Furthermore, blood capillaries are constricted by the adipose tissues because these vessels run through them. As a result, the heart muscle must work harder to pump the blood through a longer, constricted network of blood vessels.

Regular physical activity plays a large role in managing blood pressure. On the average, fit individuals have lower blood pressure than unfit people. Aerobic exercise of moderate intensity supplemented by strength training is recommended for individuals with high blood pressure.36

Comprehensive reviews of the effects of aerobic exercise on blood pressure have found that in general, an individual can expect exercise-induced reductions of approximately 4 to 5 mm Hg in resting systolic blood pressure and 3 to 4 mm Hg in resting diastolic blood pressure.37 Although these reductions do not seem large, a decrease of about 5 mm Hg in resting diastolic blood pressure has been associated with a 40 percent decrease in the risk for stroke and a 15 percent reduction in the risk for CHD.38 Even in the absence of any decrease in
resting blood pressure, hypertensive individuals who exercise have a lower risk for all-cause mortality compared with hypertensive/sedentary individuals. Research data also show that exercise, not weight loss, is the major contributor to the lower blood pressure of exercisers. If they discontinue aerobic exercise, they do not maintain these changes.

### Guidelines to Stop Hypertension

- Participate in a moderate-intensity aerobic exercise program (50% intensity) for 30 to 45 minutes 5 to 7 times per week.
- Participate in a moderate-resistance strength-training program (use 12 to 15 repetitions to near-fatigue on each set) 2 times per week (seek your physician’s approval and advice for this program).
- Lose weight if you are above recommended body weight.
- Limit sodium intake to less than 1,500 mg/day.
- Do not smoke cigarettes or use tobacco in any other form.
- Practice stress management.
- Do not consume more than two alcoholic beverages a day if you are a man or one if you are a woman.
- Consume more potassium-rich foods.
- Follow the Dietary Approach to Stop Hypertension (DASH) diet:

  - **Whole grains:** 7–8 per day
  - **Fruits and vegetables:** 8–10 per day
  - **Low-fat or fat-free dairy foods:** 2–3 per day
  - **Meat, poultry, or fish:** less than 3 ounces per serving
  - **Beans, peas, nuts, or seeds:** 4–5 per week
  - **Fats and oils:** 2–3 servings per day
  - **Snacks and sweets:** 4–5 per week

### Table 10.11: Sodium and Potassium Levels of Selected Foods

<table>
<thead>
<tr>
<th>Food</th>
<th>Serving Size</th>
<th>Sodium (mg)</th>
<th>Potassium (mg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apple</td>
<td>1 med</td>
<td>1</td>
<td>182</td>
</tr>
<tr>
<td>Asparagus</td>
<td>1 cup</td>
<td>2</td>
<td>330</td>
</tr>
<tr>
<td>Avocado</td>
<td>½</td>
<td>4</td>
<td>680</td>
</tr>
<tr>
<td>Banana</td>
<td>1 med</td>
<td>1</td>
<td>440</td>
</tr>
<tr>
<td>Beans</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kidney (canned)</td>
<td>½ cup</td>
<td>436</td>
<td>330</td>
</tr>
<tr>
<td>Lima (cooked)</td>
<td>½ cup</td>
<td>2</td>
<td>478</td>
</tr>
<tr>
<td>Pinto (cooked)</td>
<td>½ cup</td>
<td>2</td>
<td>398</td>
</tr>
<tr>
<td>Refried (canned)</td>
<td>½ cup</td>
<td>377</td>
<td>336</td>
</tr>
<tr>
<td>Bologna</td>
<td>3 oz</td>
<td>1,107</td>
<td>133</td>
</tr>
<tr>
<td>Bouillon cube</td>
<td>1</td>
<td>960</td>
<td>4</td>
</tr>
<tr>
<td>Cantaloupe</td>
<td>¼</td>
<td>17</td>
<td>341</td>
</tr>
<tr>
<td>Carrot (raw)</td>
<td>1</td>
<td>34</td>
<td>225</td>
</tr>
<tr>
<td>Cheese</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>American</td>
<td>2 oz</td>
<td>614</td>
<td>93</td>
</tr>
<tr>
<td>Cheddar</td>
<td>2 oz</td>
<td>342</td>
<td>56</td>
</tr>
<tr>
<td>Muenster</td>
<td>2 oz</td>
<td>356</td>
<td>77</td>
</tr>
<tr>
<td>Parmesan</td>
<td>2 oz</td>
<td>1,056</td>
<td>53</td>
</tr>
<tr>
<td>Chicken (light meat)</td>
<td>6 oz</td>
<td>108</td>
<td>700</td>
</tr>
<tr>
<td>Frankfurter</td>
<td>1</td>
<td>627</td>
<td>136</td>
</tr>
<tr>
<td>Haddock</td>
<td>6 oz</td>
<td>300</td>
<td>594</td>
</tr>
<tr>
<td>Ham (honey/smoked)</td>
<td>2 oz</td>
<td>495</td>
<td>91</td>
</tr>
<tr>
<td>Hamburger (reg)</td>
<td>1</td>
<td>500</td>
<td>321</td>
</tr>
<tr>
<td>Marinara pasta sauce</td>
<td>½ cup</td>
<td>527</td>
<td>406</td>
</tr>
<tr>
<td>Milk (skim)</td>
<td>1 cup</td>
<td>126</td>
<td>406</td>
</tr>
<tr>
<td>Nuts</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brazil</td>
<td>1 nut</td>
<td>1</td>
<td>120</td>
</tr>
<tr>
<td>Walnuts</td>
<td>½ cup</td>
<td>1</td>
<td>327</td>
</tr>
<tr>
<td>Orange</td>
<td>1 med</td>
<td>1</td>
<td>263</td>
</tr>
<tr>
<td>Peach</td>
<td>1 med</td>
<td>2</td>
<td>308</td>
</tr>
<tr>
<td>Pickle (dill)</td>
<td>2 oz</td>
<td>550</td>
<td>26</td>
</tr>
<tr>
<td>Pizza (cheese—14″ diam.)</td>
<td>½</td>
<td>456</td>
<td>85</td>
</tr>
<tr>
<td>Potato</td>
<td>1 med</td>
<td>6</td>
<td>763</td>
</tr>
<tr>
<td>Salami</td>
<td>3 oz</td>
<td>1,047</td>
<td>170</td>
</tr>
<tr>
<td>Salmon (baked)</td>
<td>4 oz</td>
<td>75</td>
<td>424</td>
</tr>
<tr>
<td>Salmon (canned)</td>
<td>6 oz</td>
<td>198</td>
<td>756</td>
</tr>
<tr>
<td>Salt</td>
<td>1 tsp</td>
<td>2,132</td>
<td>0</td>
</tr>
<tr>
<td>Soups</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chicken Noodle</td>
<td>1 cup</td>
<td>979</td>
<td>55</td>
</tr>
<tr>
<td>Cream of Mushroom</td>
<td>1 cup</td>
<td>955</td>
<td>98</td>
</tr>
<tr>
<td>Vegetable Beef</td>
<td>1 cup</td>
<td>1,046</td>
<td>162</td>
</tr>
<tr>
<td>Soy sauce</td>
<td>1 tsp</td>
<td>1,123</td>
<td>22</td>
</tr>
<tr>
<td>Spaghetti (tomato sauce and cheese)</td>
<td>6 oz</td>
<td>648</td>
<td>276</td>
</tr>
<tr>
<td>Spinach (cooked, fresh)</td>
<td>1 cup</td>
<td>126</td>
<td>838</td>
</tr>
<tr>
<td>Strawberries</td>
<td>1 cup</td>
<td>1</td>
<td>244</td>
</tr>
<tr>
<td>Tomato (raw)</td>
<td>1 med</td>
<td>3</td>
<td>444</td>
</tr>
<tr>
<td>Tomato juice</td>
<td>1 cup</td>
<td>680</td>
<td>430</td>
</tr>
<tr>
<td>Tuna (drained)</td>
<td>3 oz</td>
<td>38</td>
<td>255</td>
</tr>
<tr>
<td>Whopper with cheese</td>
<td>1</td>
<td>1,432</td>
<td>534</td>
</tr>
</tbody>
</table>

*Less than 3 ounces per serving

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**Try It** In your Online Journal or class notebook, make a comparison of the goals of the DASH diet and Dietary Guidelines for Americans. How do they differ?
Another extensive review of research studies on the effects of at least 4 weeks of strength training on resting blood pressure yielded similar results. Both systolic and diastolic blood pressures decreased by an average of 3 mm Hg. Participants in these studies, however, were primarily individuals with normal blood pressure. Of greater significance, the results showed that strength training did not cause an increase in resting blood pressure. More research remains to be done on hypertensive subjects.

The effects of long-term participation in exercise are apparently much more remarkable. An 18-year follow-up study on exercising and nonexercising subjects showed much lower blood pressures in the active group. The exercise group had an average resting blood pressure of 120/78 compared with 150/90 for the nonexercise group (see Table 10.12).

Aerobic exercise programs for hypertensive patients should be of moderate intensity. Training at 40 to 60 percent intensity seems to have the same effect as training at 70 percent in lowering blood pressure. High-intensity training (above 70 percent) in hypertensive patients may not lower the blood pressure as much as moderate-intensity exercise. Even so, a person may be better off being highly fit and having high blood pressure than being unfit and having low blood pressure. The death rates for unfit individuals with low systolic blood pressure are much higher than for highly fit people with high systolic blood pressure. Strength training for hypertensive individuals calls for a minimum of one set of 10 to 15 repetitions that elicit a “somewhat hard” perceived exertion rating, using eight to ten multi-joint exercises two or three times per week.

Most important is a preventive approach. Keeping blood pressure under control is easier than trying to bring it down once it is high. Regardless of your blood pressure history, high or low, you should have it checked routinely. To keep your blood pressure as low as possible, exercise regularly, lose excess weight, eat less salt and sodium-containing foods, do not smoke, practice stress management, do not consume more than two alcoholic beverages a day if you are a man, or one if you are a woman, and consume more potassium-rich foods such as potatoes, bananas, orange juice, cantaloupe, tomatoes, and beans (see the box “Guidelines to Stop Hypertension” on the previous page). An alcoholic drink is defined as 5 ounces of wine, 12 ounces of beer, or 1.5 ounces of 80-proof liquor. The Dietary Approach to Stop Hypertension (DASH)—which emphasizes fruits, vegetables, grains, and dairy products—lowers systolic blood pressure by 11 points and diastolic pressure by 5.5 points.

Those who are taking medication for hypertension should not stop without the approval of the prescribing physician. If it is not treated properly, high blood pressure can kill. By combining medication with the other treatments, one might eventually reduce or eliminate the need for drug therapy.

## Excessive Body Fat

Excessive body fat is an independent risk factor for CHD, but disease risk may actually be augmented by other risk factors that usually accompany excessive body fat. Risk factors such as high blood lipids, hypertension, and diabetes typically are seen in conjunction with obesity. All of these risk factors usually improve with increased physical activity.

Attaining recommended body composition helps to improve several CHD risk factors and also helps to reach a better state of health and wellness. While data indicates that a 10 percent weight loss results in significant improvements in CHD risk factors, some studies have even shown reduction in chronic disease risk factors with only a two to three percent weight loss.

For years we have known that where people store fat affects risk for disease. People who store body fat in the abdominal area as opposed to in the hips and thighs are at higher risk for disease. Furthermore, when abdominal fat is stored primarily around internal organs (visceral fat)—also see Figure 4.6, page 138), disease risk is greater than when abdominal fat is stored subcutaneously or retroperitoneally.

The best approach to prevent increases in visceral fat is through regular exercise. Data on men and women who were followed for six months showed no visceral fat gains in groups that either walked (178 min/week) or jogged (120 min/week) an average of 12 miles per week. A sedentary group in this same study actually gained 8.6 percent visceral fat during the six months, while a 20-mile-per-week jogging group (173 min/week) lost seven percent visceral fat. Thus, it appears that 30 minutes of vigorous exercise six times per week is best to properly manage visceral fat. Of significant concern, just six months of inactivity further increased

### Table 10.12: Effects of Long-Term (14–18 years) Aerobic Exercise on Resting Blood Pressure

<table>
<thead>
<tr>
<th>Exercise Group</th>
<th>Initial</th>
<th>Final</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>44.6</td>
<td>68.0</td>
</tr>
<tr>
<td>Blood Pressure</td>
<td>120/79</td>
<td>120/78</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Nonexercise Group</th>
<th>Initial</th>
<th>Final</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>51.6</td>
<td>69.7</td>
</tr>
<tr>
<td>Blood Pressure</td>
<td>135/85</td>
<td>150/90</td>
</tr>
</tbody>
</table>

NOTE: The aerobic exercise program consisted of an average four training sessions per week, each 66 minutes long, at about 76 percent of heart rate reserve.

visceral fat and the concomitant increase in disease risk.

Data published in 2009 on 21,094 men followed for more than 20 years indicated that an elevated BMI (greater than 25) was associated with an increased risk of heart failure. Furthermore, the data showed that as BMI increased in both active and inactive men, so did the risk for heart failure. The increased risk for heart failure improved proportionally with increased BMI or decreased physical activity (see Table 10.13).

If you have a weight problem and want to get down to recommended weight, you must:

1. Increase daily physical activity up to 90 minutes a day, including aerobic and strength-training programs
2. Follow a diet lower in fat, refined sugars, and processed foods, and high in complex carbohydrates and fiber
3. Reduce total caloric intake moderately while getting the necessary nutrients to sustain normal body functions

A comprehensive weight reduction and weight control program is discussed in detail in Chapter 5.

### Table 10.13

<table>
<thead>
<tr>
<th>Body Weight and Activity Status</th>
<th>Percent Risk Increase*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lean** and inactive</td>
<td>19%</td>
</tr>
<tr>
<td>Overweight and active</td>
<td>49%</td>
</tr>
<tr>
<td>Overweight and inactive</td>
<td>78%</td>
</tr>
<tr>
<td>Obese and active</td>
<td>168%</td>
</tr>
<tr>
<td>Obese and inactive</td>
<td>293%</td>
</tr>
</tbody>
</table>

*As compared with lean and active men.

**Lean = BMI ≤25, Overweight = BMI >25 and <30, Obese = BMI ≥30.


Cigarette Smoking

More than 46 million adults and 3.5 million adolescents in the United States smoke cigarettes. Smoking is the single largest preventable cause of illness and premature death in the United States. It has been linked to CVD, cancer, bronchitis, emphysema, and peptic ulcers. In relation to coronary disease, smoking speeds the process of atherosclerosis and carries a threefold increase in the risk of sudden death after a myocardial infarction.

According to estimates, about 20 percent of all deaths from CVD are attributable to smoking. Smoking prompts the release of nicotine and another 1,200 toxic compounds into the bloodstream. Similar to hypertension, many of these substances are destructive to the inner membrane that protects the walls of the arteries. Once the lining is damaged, cholesterol and triglycerides can be deposited readily in the arterial wall. As the plaque builds up, it obstructs blood flow through the arteries.

Furthermore, smoking encourages the formation of blood clots, which can completely block an artery already narrowed by atherosclerosis. In addition, carbon monoxide, a byproduct of cigarette smoke, decreases the blood’s oxygen-carrying capacity. A combination of obstructed arteries, less oxygen, and nicotine in the heart muscle heightens the risk for a serious heart problem.

Smoking also increases heart rate, raises blood pressure, and irritates the heart, which can trigger fatal cardiac arrhythmias. Another harmful effect is a decrease in HDL cholesterol, the “good” type that helps control blood lipids. Smoking actually presents a much greater risk of death from heart disease than from lung disease.

Pipe and cigar smoking and tobacco chewing also increase the risk for heart disease. Even if the tobacco user inhales no smoke, he or she absorbs toxic substances through the membranes of the mouth, and these end up in the bloodstream. Individuals who use tobacco in any of these three forms also have a much greater risk for cancer of the oral cavity.

The risks for both CVD and cancer start to decrease the moment a person quits smoking. One year after quitting, the risk for CHD decreases by half, and within 15 years, the relative risk of dying from CVD and cancer approaches that of a lifetime nonsmoker. A more thorough discussion of the harmful effects of cigarette smoking, the benefits of quitting, and a complete program for quitting are detailed in Chapter 13.

### Tension and Stress

Tension and stress have become part of contemporary life. Everyone has to deal daily with goals, deadlines, responsibilities, and pressures. Almost everything in life (whether positive or negative) can be a source of stress. What creates the health hazard is not the stressor itself but, rather, the individual’s response to it.

The human body responds to stress by producing more catecholamines, which prepare the body for quick physical action—often called “fight or flight.” These hormones increase heart rate, blood pressure, and blood glucose levels, enabling the person to take action. If the person actually fights or flees, the higher levels of catecholamines are metabolized and the body can return to a normal state. If, however, a person is under constant stress and unable to take action (as in the death of a close relative or friend, loss of a job, trouble at work, or finan-

### Key Terms

- **Arrhythmias** Irregular heart rhythms.
- **Catecholamines** “Fight-or-flight” hormones, including epinephrine and norepinephrine.
are able to "burn up" the excess tension accumulated during the day and enjoy the evening hours. This has proved to be one of the best stress management techniques. More information on stress management techniques is presented in Chapter 12.

Personal and Family History

Individuals who have had cardiovascular problems are at higher risk than those who have never had a problem. People with this history should control other risk factors as much as they can. Many of the risk factors are reversible, so this will greatly decrease the risk for future problems. The more time that passes after the occurrence of the cardiovascular problem, the lower the risk for recurrence.

A genetic predisposition to heart disease has been demonstrated clearly. All other factors being equal, a person with blood relatives who now have or did have heart disease runs a greater risk than someone with no such history. Premature CHD is defined as a heart attack before age 55 in a close male relative or before age 65 in a close female relative. The younger the age at which the relative incurred the cardiovascular incident, the greater is the risk for the disease.

In some cases, there is no way of knowing whether the heart problem resulted from a person’s genetic predisposition or simply poor lifestyle habits. A person may have been physically inactive, been overweight, smoked, and had bad dietary habits—all of which contributed to a heart attack. Regardless, blood relatives fall in the “family history” category. Because we have no reliable way to differentiate all the factors contributing to CVD, a person with a family history should watch all other factors closely and maintain the lowest risk level possible. In addition, the person should have a blood chemistry analysis annually to make sure the body is handling blood lipids properly.

Age

Age is a risk factor because of the higher incidence of heart disease as people get older. This tendency may be induced partly by other factors stemming from changes in lifestyle as we get older—less physical activity, poorer nutrition, obesity, and so on. Young people should not think they are exempt from heart disease, though. The process begins early in life. Autopsies conducted on American soldiers killed at age 22 and younger revealed that approximately 70 percent had early stages of atherosclerosis. Other studies found elevated blood cholesterol levels in children as young as 10 years old.

Although the aging process cannot be stopped, it certainly can be slowed. Physiological age versus chronological age is important in preventing disease. Some individuals in their 60s and older have the body of a 30-year-old. And 30-year-olds often are in such poor condition and health that they almost seem to have the body of a 60-year-old. The best ways to slow the natural
flammation, formation of blood vessel plaque, blood clotting, and thus increase the risk for heart attack. Data on women who have periodontal disease indicate that these women also have higher blood levels of CRP and lower HDL cholesterol. Daily flossing, using an electric toothbrush, scraping the tongue, and irrigating the gums with water are all preventive measures that will help protect you from gum disease.

Another factor that has been linked to CVD is loud snoring. People who snore heavily may suffer from sleep apnea, a sleep disorder in which the throat closes for a brief moment, causing breathing to stop. Individuals who snore heavily may triple their risk of a heart attack and quadruple the risk of a stroke.

Low birth weight, considered to be under 5.5 pounds, also has been linked to heart disease, hypertension, and diabetes. Individuals with low birth weight should bring this information to the attention of their personal physician and regularly monitor the risk factors for CHD.

Aspirin therapy is recommended to prevent heart disease. For individuals at moderate risk or higher, an aspirin dosage of about 81 mg per day (the equivalent of a baby aspirin) can prevent or dissolve clots that cause heart attack or stroke. With such daily use, the incidence of nonfatal heart attack decreases by about a third.

American Heart Association Diet and Lifestyle Goals for Cardiovascular Risk Reduction

- Consume an overall healthy diet.
- Aim for a healthy body weight.
- Aim for recommended levels of LDL cholesterol, HDL cholesterol, and triglycerides.
- Aim for a normal blood pressure.
- Aim for normal blood glucose levels.
- Be physically active.
- Avoid use of and exposure to tobacco products.

Try It To significantly offset the risk of cardiovascular disease, you need to aim for all of the above goals. You are now aware of the necessary lifestyle and dietary guidelines to do so. In your Online Journal or class notebook, outline the lifestyle changes that are required for you to meet the above goals.

Cardiovascular Risk Reduction

Most of the risk factors are reversible and preventable. Having a family history of heart disease and some of the other risk factors because of neglect in lifestyle does not mean you are doomed. A healthier lifestyle—free of cardiovascular problems—is something over which you have extensive control. Be persistent! Willpower and commitment are required to develop patterns that eventually will turn into healthy habits and contribute to your total well-being and longevity.

Assess Your Behavior

Log on to www.cengagebrain.com to access CengageNOW and the Behavior Change Planner where you can modify your Behavior Change Plan to incorporate at least one new activity that is heart healthy.

1. Do you make a conscious effort to increase daily physical activity, and are you able to accumulate at least 30 minutes of moderate-intensity activity a minimum of 5 days per week?
2. Is your diet fundamentally low in saturated fat, trans fats, refined carbohydrates, processed foods, and do you meet the daily suggested amounts of fruits, vegetables, and fiber?
3. Have you recently had your blood pressure measured, and established your blood lipid profile? Do you know what the results mean, and are you aware of strategies to manage them effectively?
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. Coronary heart disease
   a. is the single leading cause of death in the United States.
   b. is the leading cause of sudden cardiac deaths.
   c. is a condition in which the arteries that supply the heart muscle with oxygen and nutrients are narrowed by fatty deposits.
   d. accounts for approximately 20 percent of all deaths in the United States.
   e. All of the above are correct.

2. The incidence of cardiovascular disease during the past 40 years in the United States has
   a. increased.
   b. decreased.
   c. remained constant.
   d. increased in some years and decreased in others.
   e. fluctuated according to medical technology.

3. Regular aerobic activity helps
   a. lower LDL cholesterol.
   b. lower HDL cholesterol.
   c. increase triglycerides.
   d. decrease insulin sensitivity.
   e. All of the above.

4. The risk of heart disease increases with
   a. high LDL cholesterol.
   b. low HDL cholesterol.
   c. high concentration of homocysteine.
   d. high levels of hs-CRP.
   e. All of the above factors.

5. An optimal level of LDL cholesterol is
   a. between 200 and 239 mg/dL.
   b. about 200 mg/dL.
   c. between 150 and 200 mg/dL.
   d. between 100 and 150 mg/dL.
   e. below 100 mg/dL.

6. As a part of a CHD prevention program, saturated fat intake should be kept below
   a. 35 percent.
   b. 30 percent.
   c. 22 percent.
   d. 15 percent.
   e. 7 percent.

7. Statin drugs
   a. increase the liver’s ability to remove blood cholesterol.
   b. decrease LDL cholesterol.
   c. slow cholesterol production.
   d. help reduce inflammation.
   e. accomplish all of the above.

8. Type 2 diabetes is related closely to
   a. overeating.
   b. obesity.
   c. lack of physical activity.
   d. insulin resistance.
   e. All of the above factors.

9. Metabolic syndrome is related to
   a. low HDL cholesterol.
   b. high triglycerides.
   c. increased blood-clotting mechanism.
   d. an abnormal insulin response to carbohydrates.
   e. All of the above.

10. Comprehensive reviews on the effects of aerobic exercise on blood pressure found that in general, an individual can expect exercise-induced reductions of approximately
   a. 3 to 5 mm Hg.
   b. 5 to 10 mm Hg.
   c. 10 to 15 mm Hg.
   d. over 15 mm Hg.
   e. There is no significant change in blood pressure with exercise.

Correct answers can be found at the back of the book.
Chapter 10:

Notes

13. See note 3.


21. “Inflammation May Be Key Cause of Heart Disease and More: Diet’s Role,” Environmental Nutrition 27, no. 7 (July 2004): 1, 4.


35. See note 3.


46. See note 45.

Suggested Readings


This page contains answers for this chapter only

Chapter 10

1. e  
2. b  
3. a  
4. e  
5. e  
6. e  
7. e  
8. e  
9. e  
10. a
I. Increase intake of phytonutrients, fiber, cruciferous vegetables and more antioxidants by:
   - Eating a predominantly vegetarian diet
   - Eating more fruits and vegetables every day (six to eight servings per day maximize anticancer benefits)
   - Increasing the consumption of broccoli, cauliflower, kale, turnips, cabbage, kohlrabi, Brussels sprouts, hot chili peppers, red and green peppers, carrots, sweet potatoes, winter squash, spinach, garlic, onions, strawberries, tomatoes, pineapple, and citrus fruits in your regular diet
   - Eating vegetables raw or quickly cooked by steaming or stir-frying
   - Substituting tea and fruit and vegetable juices for coffee and soda
   - Eating whole-grain breads
   - Including calcium in the diet (or from a supplement)
   - Including soy products in the diet
   - Using whole-wheat flour instead of refined white flour in baking
   - Using brown (unpolished) rice instead of white (polished) rice

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<td>Stage 2 hypertension</td>
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*Source: National High Blood Pressure Education Program.*