CHAPTER

14 Nutrition and Physical Activity: Keys to Good Health

Chapter Summary

Physical activity is any movement produced by muscles that increases energy expenditure. Physical fitness is the ability to carry out daily tasks with vigor and alertness, without undue fatigue, and with ample energy to enjoy leisure-time pursuits and meet unforeseen emergencies. Physical activity provides a multitude of health benefits, including reducing risks for obesity and many chronic diseases, and relieving anxiety and stress. Despite these benefits, most Americans are inactive. A sound fitness program has many components. Personal fitness goals should be met, the fitness program should be fun, and it should include variety and consistency. To achieve the appropriate overload for fitness, the FIT principle should be followed (frequency, intensity, and time of activity). In addition, proper warm-up and cool-down activities should be performed.

Adenosine triphosphate, or ATP, is the common energy source for all cells. ATP can be regenerated anaerobically by breaking down creatine phosphate or breaking down glucose to pyruvate in the process of glycolysis. In this process, pyruvate is converted to lactic acid, which can also be used as muscle fuel. To support activities that last longer than two minutes, energy must be derived aerobically from the breakdown of carbohydrates and fats. Only a small amount of protein is used for energy. Vigorous exercise requires extra energy. General recommendations for athletes include consumption of 45–65% of total energy from carbohydrates, 20–25% from fat, and the remainder of energy from protein. Protein needs may be higher for athletes, but most already eat plenty of protein. Carbohydrate loading involves altering physical training and diet and may be effective for endurance competitions. Regular exercise increases fluid needs to help cool internal body temperature and prevent heat illnesses, which include heat syncope, heat cramps, heat exhaustion, and heat stroke.

Active people may need more B-vitamins than inactive people. Many women do not consume enough calcium. Some female athletes suffer from the female athlete triad, a condition that can lead to significant bone loss. Many active individuals require more iron. Ergogenic aids are substances used to improve exercise and athletic performance and may be used for other purposes. Many ergogenic aids are not effective, some are dangerous, and most are expensive.

Nutrition Myth of Fact addresses the question: Are ergogenic aids necessary for active people?

Learning Objectives

After studying this chapter, the student should be able to:

1. Discuss the health benefits of being physically active on a regular basis (pp. 554-556).
2. Identify the four components of fitness and the forms of exercise necessary to achieve them (pp. 554–555).
3. Compare national recommendations for frequency, intensity, and duration of physical activity (pp. 557–558).
4. Identify six strategies for developing a sound fitness program (pp. 558-564).
5. Describe the FITT principle, and calculate your maximal and training heart-rate range (pp. 560–562).
6. List and describe at least three metabolic processes cells use to fuel physical activity (pp. 564–570).
7. Explain how an increase in physical activity or athletic training can affect energy and macronutrient needs (pp. 571–578).
8. Define carbohydrate loading, and discuss situations in which this practice may enhance athletic performance (pp. 576–581).
9. Explain how an increase in physical activity or athletic training can affect fluid and micronutrient needs (pp. 578-581).
10. Compare heat syncope, heat cramps, heat exhaustion, and heat stroke (pp. 578–579).

Key Terms

aerobic exercise
anabolic
atrophy
carbohydrate loading
cool-down
creatine phosphate
ergogenic aids
evaporative cooling
exercise
FITT principle
frequency
grazing
heat cramps
heat exhaustion
heat syncope
heat stroke
hypertrophy
intensity
leisure-time physical activity
low-intensity activities
maximal heart rate
moderate-intensity activities
overload principle
physical activity
physical fitness
resistance training
stretching
time of activity
type of activity
vigorous-intensity activities
warm-up

Chapter Outline

I. Why Are the Benefits of Physical Activity?

A. Physical activity describes any movement produced by muscles that increases energy expenditure.

1. Leisure-time physical activity is any activity not related to occupation and includes competitive sports, planned exercise training, and recreational activities.

2. Exercise, a subcategory of leisure-time physical activity, refers to activity that is purposeful, planned, and structured.

B. Physical activity increases our physical fitness, which is the ability to carry out daily tasks with vigor and alertness, without undue fatigue, and with ample energy to enjoy leisure-time pursuits and meet unforeseen emergencies.

1. The four components of physical fitness include:

a. Cardiorespiratory fitness

b. Musculoskeletal fitness

c. Flexibility

d. Body composition

2. These are achieved through three types of exercise:

a. Aerobic activity

b. Resistance training

c. Stretching

C. Physical activity reduces our risk for chronic disease.

1. Physical activity reduces risk for and complications of chronic diseases such as heart disease, stroke, and high blood pressure.

2. Physical activity reduces risk for obesity.

3. Physical activity reduces risk for type 2 diabetes.

4. Physical activity may reduce risk for colon cancer.

5. Physical activity reduces risk for osteoporosis.

6. Physical activity improves sleep patterns, reduces the risk for upper respiratory infections, and relieves anxiety and stress.

D. Over half of U.S. adults do not meet national recommendations for physical activity, and level of physical activity in young people is also inadequate.

Key Terms: physical activity, leisure-time physical activity, exercise, physical fitness, aerobic exercise, resistance training, stretching

Figure and Table:

Figure 14.1: Health benefits of regular physical activity.

Figure 14.2: Rates of physical inactivity in the United States.

Table 14.1: The Components of Fitness

II. How Much Physical Activity is Enough?

A. Over the years there have been varying recommendations relating to how much physical activity we should get.

1. 1996 Surgeon General's report recommended Americans engage in at least 30 minutes of physical activity on most days of the week.

2. 2002 Institute of Medicine recommended Americans should be active 60 minutes per day to optimize health.

a. The IOM recommendation was derived from metabolic studies.

b. The IOM recommendation was not based on a wider range of evidence.

3. In 2008, the U.S. Department of Health and Human Services released the *Physical Activity Guidelines for Americans*, which included guidelines for children, adolescents, older adults, and information for pregnant women and people with disabilities, diabetes, osteoarthritis, and cancer survivors.

a. The 2008 Guidelines incorporate a range of available evidence and promote a minimum of 150 minutes per week of moderate-intensity aerobic activity, with added encouragement to increase both intensity and duration for greater benefits.

III. How Can You Improve Your Fitness?

A. Assess your current level of fitness.

B. Identify your personal fitness goals.

1. Understand the specificity principle.

2. Training should be specific to your activity or goal.

C. Make your program varied, consistent, and fun.

1. People who engage in regular physical activity tend to be more motivated by intrinsic factors.

2. An important motivator for in maintaining regular physical activity is enjoyment.

3. Variety in activity prevents boredom.

D. A sound fitness program appropriately overloads the body.

1. The overload principle advocates appropriate additional demand be placed on the body to improve fitness.

a. A gain in muscle strength and size that results from repeated work that overloads the muscle is hypertrophy.

b. Atrophy is when the muscles are not adequately worked and they decrease in size and strength.

2. The FITT principle is applied to design a general fitness program or a performance-based program and includes four factors: frequency, intensity, time, and type of activity.

3. Frequency refers to the number of activity sessions per week.

a. Three to five days a week for a total of 150 minutes to achieve cardiorespiratory fitness.

b. Two days per week to achieve muscular fitness.

4. Intensity refers to the amount of effort expended, or how difficult the activity is to perform.

a. The intensity of the activity can be described as low, moderate, or vigorous.

b. Exercise intensity can be calculated by estimating your maximal heart rate.

5. Time of activity refers to how long each session lasts, and recommendations depend on goals.

6. Type of activity refers to the range of activities a person can engage in promote physical fitness.

E. A sound fitness plan includes a warm-up and a cool-down period.

1. Warming up properly prepares muscles for exertion by increasing blood flow and body temperature.

2. Cooling down after exercise reduces the risk of injury and muscle soreness.

F. Keep it simple and take it slow if you have been inactive for a while.

1. Initiation phase: incorporate brief bouts of physical activity and reduce sedentary time as you gradually build up to 30 minutes a day.

2. Improvement phase: increase intensity and duration of activities.

3. Maintenance phase: maintain current activity level or reevaluate goals and alter training accordingly.

Key Terms: overload principle, hypertrophy, atrophy, FITT principle, frequency, intensity, low-intensity activities, moderate-intensity activities, vigorous-intensity activities, maximal heart rate, time of activity, type of activity, warm-up, cool-down

Figures:

Figure 14.3: Using the FITT principle to achieve cardiorespiratory and musculoskeletal fitness and flexibility.

Figure 14.4: This heart rate training chart can be used to estimate aerobic exercise intensity.

IV. What Fuels Physical Activity?

A. The common currency of energy for virtually all body cells is ATP.

1. Muscle stores of ATP are limited; ATP can be generated by the breakdown of carbohydrate, fat, and protein.

2. The primary systems for providing energy for physical activities are the ATP energy system and the anaerobic and aerobic breakdown of carbohydrates.

a. The amount of ATP needed determines which energy system is used.

B. The ATP-CP energy system uses creatine phosphate to regenerate ATP.

1. Creatine phosphate (CP) is broken down in an anaerobic environment.

2. CP will fuel muscular activity for very short bouts of activity.

a. Stores of ATP and CP can only support a maximal physical effort for about 3 to 15 seconds.

C. The breakdown of carbohydrates provides energy for brief and long-term exercise.

1. Other than the ATP-CP system, glycolysis is the fastest way to regenerate ATP.

2. In the absence of oxygen, pyruvate is converted to lactic acid, another fuel source for the muscle.

a. This is used for activities that last 30 seconds to 3 minutes.

3. To generate large amounts of ATP, oxygen is required for aerobic metabolism of pyruvate.

4. Aerobic metabolism of glucose supplies 18 times more energy than anaerobic metabolism and prevents muscle fatigue associated with acid production.

a. Primary fuel source for muscles during activities lasting from 3 minutes to 4 hours.

5. Glycogen stores are limited even in the trained athlete.

D. Aerobic breakdown of fats supports exercise of low intensity and long duration.

1. Fat is an abundant energy source, providing 9 kcal of energy per gram.

2. Fat breakdown is a relatively slow process, which makes it the preferred energy source in low- to moderate-intensity exercise and endurance activities.
3. The body relies on a mixture of carbohydrate and fat for most of its activity.

E. Amino acids are not major sources of fuel during exercise.

1. Amino acids contribute 3–6% of energy needed during exercise.
2. Protein is necessary to support activity and recovery, but higher amounts do not provide added benefits.

Key Terms: creatine phosphate (CP)

Nutrition Animation: The Cori Cycle (located in IR-DVD folder).

Figures:

Figure 14.5: An overview of the metabolic pathways the result in ATP production during exercise.

Figure 14.6: When the compound creatine phosphate (CP) is broken down into a molecule of creatine and an independent phosphate molecule, energy is released.

Figure 14.7: What Fuels Our Activities?

Figure 14.8: The Cori cycle is the metabolic pathway by which excess lactic acid can be converted into glucose in the liver.

Figure 14.9 For most daily activities, including exercise, we use a mixture of carbohydrate and fat for energy.

V. How Does Physical Activity Affect Energy and Macronutrient Needs?

A. Vigorous exercise increases energy needs.

1. To meet energy demands, athletes may need to graze or add energy-dense snack foods and meal replacements to their training diet.
2. Weight is an indicator of appropriate Caloric intake.
3. Athletes who reduce Caloric intake to maintain a lower weight or leaner figure put themselves at risk of health consequences and poor performance.

B. Carbohydrate needs increase for many active people.

1. Depending on the sport and training, an athlete should consume 45–65% of total energy as carbohydrates.
2. Carbohydrates should be consumed within a few hours of training if training bouts are only a few hours apart.
   - **a.** Adequate muscle glycogen can be restored with multiple, smaller intakes of carbohydrate or in larger, single amounts.
   - **b.** Some studies indicate enhanced muscle glycogen storage during the first 4 to 6 hours of recovery, with large carbohydrate intake every 15 to 30 minutes.
3. What food sources of carbohydrates are good for athletes?
   - **a.** Complex, less-processed carbohydrates are excellent sources of carbohydrates and other nutrients.
   - **b.** Athletes may need to consume more simple sugars to support training.
   - **c.** Consuming high glycemic-index foods during the immediate recovery period may increase glycogen storage.

d. Many beverages and snack bars are available to help the busy athlete meet carbohydrate demands.

4. Carbohydrate loading may improve performance of long-distance, endurance athletes.

a. Carbohydrate loading involves altering exercise duration and carbohydrate intake to maximize glycogen stores.

b. There may be side effects with carbohydrate loading, so athletes should try it during training first.

C. Moderate fat consumption is enough to support most activities.

1. Athletes and people who participate in regular aerobic exercise are able to burn more fat for energy.

2. Eating less than 15% of total energy as fat is inadequate for vigorous activity; fat intake of 20% to 35% is recommended for most athletes.

D. Many athletes have increased protein needs.

1. Competitive endurance athletes who train five to seven days per week require significantly more protein than the RDA.

2. Athletes who restrict energy intake, are vegan, or are adolescent may not be getting enough protein in their diets.

Key Term: grazing, carbohydrate loading

Figures and Tables:

Figure 14.10: Maximizing Carbohydrates to Support Activity

Figure 14.11: The effects of low-carbohydrate diet on muscle glycogen stores.

Table 14.2: Suggested Intakes of Nutrients to Support Vigorous Exercise

Table 14.3: Carbohydrate and Total Energy in Various Foods

Table 14.4: Recommended Carbohydrate Loading Guidelines for Endurance Athletes

VI. How Does Physical Activity Affect Fluid and Micronutrient Needs?

A. Heat production can increase by 15 to 20 times during heavy exercise.

1. The primary way the heat is dissipated is through sweating, or evaporative cooling.

2. Heat illnesses occur because when we exercise in the heat our muscles and skin compete for blood flow. Dehydration increases risk for heat illnesses.

a. Heat syncope is dizziness that occurs when people stand for too long in the heat.

b. Heat cramps are muscle spasms that occur during or several hours after strenuous exercise.

c. Heat exhaustion and head stroke occur on a continuum with heat exhaustion leading to heat stroke.

i. Early signs of heat exhaustion include symptoms of excessive sweating, weakness, nausea, dizziness, headache, and difficulty concentrating.

ii. Heat stroke symptoms include hot, dry skin; rapid heart rate; vomiting; diarrhea; an increase in body temperature to 104°F or higher; hallucinations; and coma.

B. Guidelines for proper fluid replacement are based on maintaining body weight.

1. Athletes should avoid losing more than 2–3% of body weight during exercise, and impairment can occur with as little as 1% weight loss.

2. Plain water is adequate to replace fluid losses for activities lasting less than one hour.

3. For longer activities and for people who do not consume enough water, sports beverages are recommended.

C. Inadequate intakes of micronutrients can diminish health and performance.

1. B-vitamins are directly involved in energy metabolism; however, most active people consume adequate amounts in food.

2. Calcium and the female athlete triad are concerns for some female athletes.

a. Calcium intakes are inadequate for most women in the United States.

b. Vigorous training does not increase the need for calcium.

c. Female athletes suffering from the female athlete triad are at risk hormonal disturbances that can lead to loss of bone mass.

d. Consuming adequate calcium or supplementing with calcium is critical for the female athlete.

3. Iron deficiency is a risk for physically active people.

a. Active people lose more iron than inactive people.

b. Female athletes, vegetarians, and some endurance athletes are at high risk for iron deficiency.

c. Because sports anemia is a transient condition, blood iron stores and dietary iron intake should be monitored regularly.

d. Athletes who cannot meet iron needs through diet may need supplemental iron.

Key Terms: evaporative cooling, heat syncope, heat cramps, heat exhaustion, heat stroke

Figures and Tables:

Figure 14.2: Symptoms of dehydration during heavy exercise.

Table 14.5: Guidelines for Fluid Replacement

Activities

1. Have students take a poll of their peers with questions about their exercise habits. Ask students to note age and gender for each person polled. In class, make bar graphs for each age group and sex. Examples of questions that can be addressed include:

a. What type of exercise(s) does the person do?
b. How many minutes per day does each exercise take to complete?
c. How long has the person been exercising?
d. What benefits does the person receive from exercising?

2. Have students gather as much information as they can about dietary habits and supplement use among athletes on campus. Questions that should be considered include:

a. Which supplements are most popular?
b. What types of athletes are most likely to take supplements?
c. How much does the average athlete spend on supplements?
d. Where do they learn about ergogenic aids?

e. Which types of athletes choose high-protein diets, and what do athletes consider good sources of protein?
f. Which athletes follow strict diets to prevent weight gain, and what do they consider a strict diet?
g. What are typical pregame meals?
h. What are typical choices for recovery?
i. Water or sports drinks?

3. Using the information gathered above and what they have learned, have students work in groups to develop a healthy marketing campaign to educate the athletes on campus about nutrition and supplement use. This campaign could take the form of posters, pamphlets, Web messages, flyers, speakers, and so on. This could be viewed as community service if students initiate the campaign outside of class.

4. Divide students into small groups. Provide each group with a copy of the well-publicized diet of Olympic swimmer Michael Phelps (shown below). Ask each group to discuss whether or not this diet is a good choice for a competitive swimmer. Could he possibly maintain his physique and his competitive edge with this? What changes would you make to the diet if you were planning it based on the knowledge you have gained from the chapter? Note: Michael Phelps is 6'4" tall and weighs 185 lbs.

Breakfast: Three fried-egg sandwiches loaded with cheese, lettuce, tomatoes, fried onions, and mayonnaise. Two cups of coffee. One five-egg omelet. One bowl of grits. Three slices of French toast topped with powdered sugar. Three chocolate-chip pancakes.

Lunch: One pound of enriched pasta. Two large ham-and-cheese sandwiches with mayo on white bread. Energy drinks packing 1,000 Calories.

Dinner: One pound of pasta. An entire pizza. More energy drinks.

Diet Analysis Activity

5. Using the nutritional assessment previously completed, students should compare their nutrient intake with "Suggested Intakes of Nutrients to Support Vigorous Exercise" in Table 14.2 (page 571) in the textbook. Ask them to indicate what changes they could make in their diet to more closely meet the recommendations if they were/are participating in vigorous exercise.

Nutrition Debate Activity

6. Most athletes are ritualistic and anxious to believe the latest method for improving performance. If they eat a certain pregame meal and win a competition, they eat the same meal before every competition. The placebo effect is strong, and ergogenic aids with no valid support for effectiveness appear to be beneficial. Unfortunately, some of the nutritional and supplemental practices of athletes lead to harm. Considering this concern, the question is: How do we educate athletes on nutrition and ergogenic aids?

   Role playing can be useful for this chapter. Divide students into groups of three. Instruct them to take one of three roles: nutrition expert, athlete, or observer. The athlete should explain his/her unique dietary practices and use of one ergogenic aid (encourage creativity and unsound nutritional practices). For two minutes the nutrition expert will try to convince the athlete to make healthy changes while the athlete clings to ritual and

rejects research and reasoning. The observer will listen to both sides and then suggest ideas that might strengthen the expert's argument. Roles can then be rotated until each member of the group has played the expert. Discuss with the class the difficulties they encountered.

Web Resources

American Heart Association
www.heart.org

American College of Sports Medicine
www.acsm.org

U.S. Department of Health and Human Services
www.hhs.gov

Weight Control Information Network
www.win.niddk.nih.gov

NIH Office of Dietary Supplements
www.ods.od.nih.gov

Food and Nutrition Information Center
www.fnic.nal.usda.gov

The President's Challenge Adult Fitness Test
www.adultfitnesstest.org