


Chapter 14

Fitness: Physical Activity, Nutrients, and Body Adaptations



A healthy body contains enough lean tissue to support health and the right amount of fat to meet body needs.

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Physical Activity vs. Fitness

Physical activity: any muscle movement that increases energy expenditure.

Leisure time physical activity: any activity unrelated to a person's occupation.

- For example – hiking, walking, biking
- Includes **exercise** – purposeful, planned physical activity

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Physical Activity vs. Fitness

Physical fitness: state of being created by the interaction between nutrition and physical activity

Physical fitness includes

- **Cardiorespiratory fitness**
- **Musculoskeletal fitness**
- **Flexibility**
- **Body composition**

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Physical Activity vs. Fitness


Fitness Component	Examples of Activities One Can Do to Achieve Fitness in Each Component
Cardiorespiratory	Aerobic-type activities such as walking, running, swimming, cross-country skiing
Musculoskeletal fitness	Resistance training, weightlifting, calisthenics, sit-ups, push-ups
Muscular strength	Weightlifting or related activities using heavier weights with few repetitions
Muscular endurance	Weightlifting or related activities using lighter weights with greater number of repetitions
Flexibility	Stretching exercises, yoga
Body composition	Aerobic, anaerobic and resistance training can help optimize body composition

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Physical Activity

Make it a part of a daily routine
Duration and regularity are important
Regular physical activity and obesity:

- ↑ energy expenditure
- ↑ metabolism
- Improves body composition
- Improves appetite control
- Psychological benefits
 - Combats depression
 - Improves self esteem



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Benefits of Physical Activity

Regular physical activity:


- Reduces the risk of heart disease, stroke, high blood pressure
- Reduces the risk for obesity
- Reduces the risk for type 2 diabetes
- Reduces the risk for osteoporosis
- May reduce the risk of colon cancer

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Benefits of Physical Activity

Despite the clear benefits of regular physical activity,

- more than half of all US adults do not do sufficient physical activity
- 26% of US adults admit to doing no leisure time physical activity at all
- less than 30% of high school students participate in daily physical education



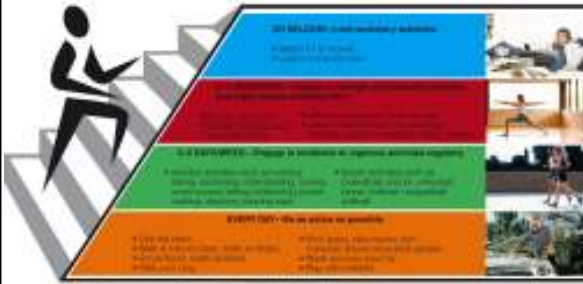
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Fitness

Benefits of Fitness

- Restful sleep
- Nutritional health
- Optimal body composition
- Optimal bone density
- Resistance to colds and other infectious diseases
- Low risks of some types of cancer
- Strong circulation and lung function
- Low risk of cardiovascular disease
- Low risk of type 2 diabetes
- Reduced risk of gallbladder disease in women
- Low incidence and severity of anxiety and depression
- Long life and high quality of life in the later years

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Fitness

The *2005 Dietary Guidelines for Americans* state that people need to participate in 30 minutes of physical activity most days of the week for health benefits and 60 minutes to maintain a healthy body weight.

Developing Fitness

- Guidelines for conditioning that are achieved through training.
 - Cardiorespiratory Endurance
 - Frequency – 3-5 days per week
 - Intensity – 55-90% maximum heart rate
 - Duration – 20-60 minutes

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Fitness

Guidelines for conditioning

- Strength
 - Frequency – 2-3 days per week
 - Intensity – enough to enhance muscle strength, muscle endurance, and improve body composition
 - Duration – 8 to 12 repetitions of 8 to 10 different exercises
- Flexibility
 - Frequency – 2-3 days per week
 - Intensity – enough to develop and maintain a full range of motion
 - Duration – 4 repetitions of 10-30 seconds per muscle group

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TABLE 1a Guidelines for Physical Activity

	Cardiorespiratory	Strength	Flexibility
Type of Activity	Aerobic activity that uses large muscle groups and can be sustained over time.	Resistance activity that is performed at a controlled speed and through a full range of motion.	Stretching activity that uses the major muscle groups.
Frequency	2 to 3 days per week	2 to 3 days per week	2 to 7 days per week
Intensity	30 to 60% of maximum heart rate	Enough to enhance muscle strength and improve body composition.	Enough to develop and maintain a full range of motion.
Duration	20 to 60 minutes	8 to 12 repetitions of 8 to 16 different exercises (sets)	2 to 4 repetitions of 15 to 30 seconds per stretch (sets)
Examples	Swimming, cycling, water skiing, walking, tennis, jogging, rowing, aerobic dancing, ballroom dancing, jumping rope, group activities such as basketball, soccer, volleyball, tennis, volleyball	Push-ups, pull-ups, weight lifting, sit-ups	Yoga

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Sound Fitness Program

A sound physical fitness program

- Meets your personal goals
- Is fun
- Includes variety and consistency
- Appropriately overloads the body
- Includes a warm-up and cool-down period

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Sound Fitness Program

A sound physical fitness program meets your personal goals.

An individual's fitness program will be different if they are

- Training for athletic competition
- Working toward cardiorespiratory fitness
- Trying to maintain overall health

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Sound Fitness Program

A sound physical fitness program is fun.

An individual's fitness program should focus on what they enjoy.

- Outdoor activities
- Social recreation

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Sound Fitness Program

A sound physical fitness program includes variety and consistency.

A variety of activities prevents boredom.

The **Physical Activity Pyramid** highlights the variety of activities that constitute a fitness program.

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Sound Fitness Program

A sound physical fitness program appropriately overloads the body.

Overload principle: additional physical demands on the body to improve fitness

- Too much physical exertion is NOT recommended
- The **FIT principle** can be used to determine appropriate overload

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Sound Fitness Program

The FIT Principle

- **Frequency** – the frequency of physical activity varies with fitness goals
- **Intensity** – determining proper intensity may be based on maximal heart rate
- **Time of activity** – whether the total activity time is an accumulation of activities or completed all at once

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Fitness

Cardiorespiratory Endurance

- Cardiorespiratory conditioning is measured by maximum oxygen uptake ($VO_2\max$).
 - Increases cardiac output and oxygen delivery
 - Increases stroke volume
 - Slows resting pulse
 - Increases breathing efficiency
 - Improves circulation
 - Reduces blood pressure

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Fitness

Cardiorespiratory Endurance

- Muscle Conditioning
 - Muscles use oxygen efficiently.
 - Muscles can burn fat longer.
- A Balanced Fitness Program
 - Individualized
 - Cardiorespiratory
 - Muscle strength and endurance
 - Flexibility
 - Choose an activity you enjoy

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TABLE 14-2 A Sample Balanced Fitness Program

Monday, Tuesday, Wednesday, Thursday, Friday:

- 5 minutes of warm-up activity
- 45 minutes of aerobic activity
- 10 minutes of cool-down activity and stretching

Tuesday, Thursday, Saturday:

- 5 minutes of warm-up activity
- 30 minutes of weight training
- 10 minutes of cool-down activity and stretching

Saturday and/or Sunday:

- Sports, walking, hiking, biking, or swimming

Fitness

Weight Training

- Also called resistance training
- Increases muscle strength and endurance
- Prevents and manages cardiovascular disease
- Enhances psychological well-being
- Maximizes and maintains bone mass
- Enhances performance in other sports

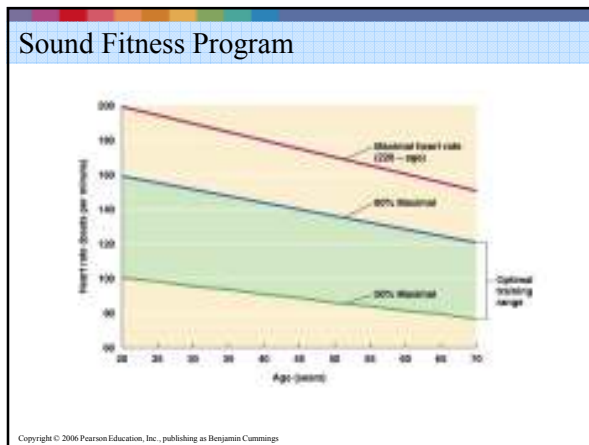
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Sound Fitness Program

	Cardiorespiratory Fitness	Muscular Fitness
Frequency:	3–5 days per week	2–3 days per week
Intensity:	55 to 85% of maximal heart rate (or an RPE ¹ of 12–15 [Somewhat Hard to Hard])	70 to 85% of maximal weight you can lift (or an RPE ¹ of 13–16 [Somewhat Hard to Very Hard])
Time:	At least 20 consecutive minutes	1–3 sets of 8–12 lifts ² for each set

¹RPE stands for rating of perceived exertion, defined in the text.
 A minimum of 8 to 10 exercises involving the major muscle groups such as arms, shoulders, chest, abdomen, back, legs, and legs is recommended.
²Source: Adapted from American College of Sports Medicine Position Stand: The recommended quantity and quality of exercise for developing and maintaining cardiorespiratory and muscular fitness, and flexibility in healthy adults, *Med. Sci. Sports Exerc.* 30 (1998): 975–991. Used with permission.

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Sound Fitness Program

Rating of Perceived Exertion (RPE)

Scale	Perceived Exertion	Physical Signs
6	Very, very light	No perceptible sign
7		
8	Very light	No perceptible sign
9		
10	Fairly light	Feeling of motion
12	Somewhat hard	Warmth on cold day, slight sweat on warm days
13		
14	Hard	Sweating but can still talk without difficulty
15		
16	Very hard	Heavy sweating, difficulty talking
17	Very, very hard	Feeling of near exhaustion
18		
19		
20		

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Sound Fitness Program

	Health	Physical Fitness
Frequency:	Daily	2–5 days per week (1–5 days for cardiorespiratory fitness, 2–3 days for muscular fitness and flexibility)
Intensity:	Any level	50–85% of maximal heart rate or an RPE ¹ of 12–16
Time:	Accumulation of a minimum of 30 minutes each day	20–40 minutes of continuous or interrupted activity
Type:	Any activity	Aerobic-type activities, resistance exercises to enhance muscular strength and endurance, and flexibility exercises

¹RPE is rating of perceived exertion.
 Source: Adapted from American College of Sports Medicine Position Stand: The recommended quantity and quality of exercise for developing and maintaining cardiorespiratory and muscular fitness, and flexibility in healthy adults, *Med. Sci. Sports Exerc.* 30 (1998): 975–991. U.S. Department of Health and Human Services, *Physical Activity and Health: A Report of the Surgeon General* (Atlanta, GA: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, 1996).

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Sound Fitness Program

A sound physical fitness program includes a warm-up and a cool-down period.

- Includes stretching and calisthenics
- Helps prevent injuries
- May reduce muscle soreness

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Fuel for Physical Activity

Adenosine triphosphate (ATP) – the energy carrying molecule in the body

ATP must be generated continuously since muscles store only enough ATP for 1 – 3 seconds of activity.

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Fuel for Physical Activity



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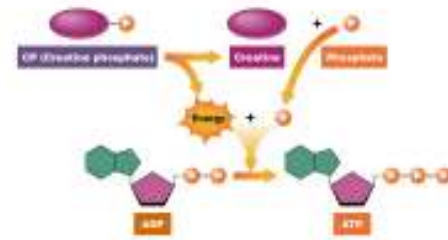
Fuel for Physical Activity

After depleting ATP stores, muscles turn to other sources:

- **Creatine phosphate (CR)** stores some energy that can be used to make ATP
- Creatine phosphate stores enough energy for 3 to 15 seconds of maximal physical effort

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Fuel for Physical Activity



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Fuel for Physical Activity

After creatine phosphate, carbohydrates are the next source of energy for the production of ATP.

Glucose is the primary carbohydrate used to generate ATP.

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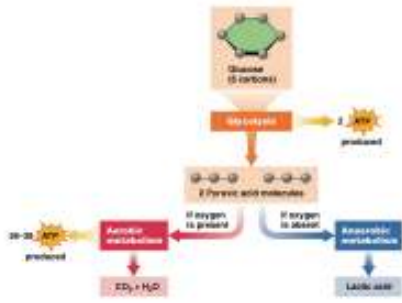
Fuel for Physical Activity

Metabolism of glucose

- **Anaerobic** breakdown of glucose yields 2 ATP molecules
- **Aerobic** breakdown of glucose yields 36 – 38 molecules of ATP

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Fuel for Physical Activity



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Fuel for Physical Activity

Triglycerides (fats) can be metabolized to generate ATP

- For low intensity exercise
- For exercise of long duration
- A very abundant energy source, even in lean people
- Provides 2x more energy per gram as carbohydrate

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Fuel for Physical Activity

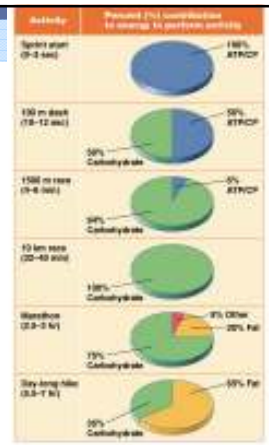
Carbohydrates and fats can both be used as energy sources for the production of ATP.

- Carbohydrates are mostly used for high intensity activity
- Fats are used for low intensity exercise

Proteins (amino acids) are not used as a fuel source for exercise.

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Fuel for Physical Activity



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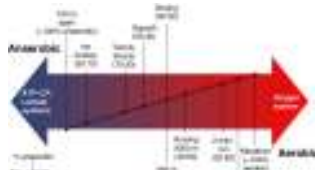
Energy Systems for Physical Performance

Teamwork in energy production

- Anaerobic systems for short duration activities, early part of endurance activities
- Aerobic systems for endurance activities

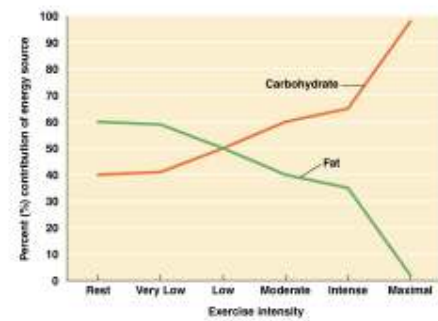
Training

- Decreases reliance on anaerobic systems
- Extends availability of glycogen



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Fuel for Physical Activity



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Nutrition for Physical Activity

Energy needs

- Energy needs may be higher for athletes
- Different energy needs for males and females
- Depends on body size
- Depends on the type of physical activity

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Optimal Nutrition for Athletic Performance

- Consume adequate energy and nutrients
- Maintain appropriate body composition
- Promote optimal recovery from training
- Maintain hydration status

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Diets for Physically Active People

Choosing a Diet to Support Fitness

- Water
 - Thirst mechanisms are not as reliable
 - Must be replenished
- Nutrient Density – consume nutrient-dense foods that are high in carbohydrate, moderate in fat, and adequate in protein

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Diets for Physically Active People

Choosing a Diet to Support Fitness

- Carbohydrate
 - 60-70% total energy intake
 - Avoid fiber-rich foods in the pre-game meal.
 - Added sugar and fat may be needed during intensive training.
 - Liquid supplements should not replace foods.
 - 8-10 g carbohydrate/kg body weight during heavy training
- Protein
 - Strength athletes: for males 112-119 g/day, females 88-94 g/day
 - Endurance athletes: for males 84-112 g/day, females 66-88 g/day
 - Foods: lean meats, fish, low-fat dairy, egg whites
 - Helps replenish glycogen

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Diets for Physically Active People

Choosing a Diet to Support Fitness

Fat

- Major fuel source for endurance activities
- Moderate fat intake

A Performance Diet Example

- Total calories – 3000
- 63% kcal from carbohydrate
- 22% kcal from fat
- 15% kcal from protein
- All vitamin and mineral RDAs are met

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Meal	Calories	Carbohydrate (g)	Protein (g)	Fat (g)
Breakfast	375	55	15	15
Lunch	425	65	25	15
Dinner	1100	150	40	45
Dinner	1100	150	40	45
Total (4 meals)	3000	320	100	100

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Diets for Physically Active People

Meals Before and After Competition

- Pre-game Meals
 - Fluids
 - 300-800 kcalories
 - Carbohydrate-rich foods low in fat and fiber
 - Light and easy to digest
- Post-game Meals
 - High-carbohydrate meals
 - Liquids often preferred

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300-kcalorie meal

- 1 cup (20 ounces) fruit
- 4 whole crackers
- 1/2 cup reduced-fat peanut butter

500-kcalorie meal

- 1 large whole-wheat bagel
- 2 tsp jelly
- 1 L of low-fat milk

750-kcalorie meal

- 1 large baked (600B) sandwich
- 2 tsp margarine
- 1/2 cup steamed broccoli
- 1/2 cup carrots and green peas
- 2 vanilla sodas
- 1 L of 2000 or 1000 calorie juice

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Carbohydrate and Exercise

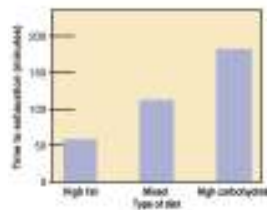
High carbohydrate diets

- Increase glycogen stores
- Extend endurance

Carbohydrate loading

Carbohydrate intake

- Before exercise
- During exercise
- After exercise



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Nutrition for Physical Activity

Maintaining water balance is critical for physically active people.

- Drink fluids before, during, and after exercise
- Consume enough water to maintain body weight
- Training in hot environments requires careful attention to water intake

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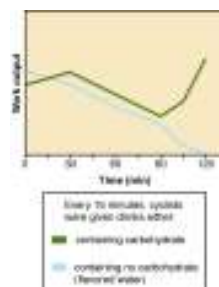
Fluid Needs During Exercise

Exercise and fluid loss

- Increased losses from sweat
- Increased with heat, humidity
- Risk for dehydration

Hydration

- Adequate fluids before, during, after exercise
- Water vs. sports drinks



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Energy Systems, Fuels, and Nutrients to Support Activity

Fluids and Electrolytes to Support Activity

- Hypothermia – a below-normal body temperature
 - Symptoms
 - Shivering and euphoria
 - Weakness, disorientation, and apathy
 - Prevention
 - Drink fluids
 - Wear appropriate clothing
 - Water Recommendations
 - 1.0 to 1.5 mL/kcal expended
 - ½ cup per 100 kcal expended

Energy Systems, Fuels, and Nutrients to Support Activity

Fluids and Electrolytes to Support Activity

- Fluid Replacement via Hydration
 - Full hydration is imperative for athletes.
 - Those who are aware of their hourly sweat rate can replace lost fluids.
 - Plain, cool water is recommended.
 - Endurance athletes may require carbohydrate-containing beverages.
 - Hydration schedule
 - Two hours before activity – 2-3 cups
 - 15 minutes before activity – 1-2 cups
 - Every 15 minutes during activity – ½-2 cups
 - After activity – 2 cups for every pound of body weight lost

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Energy Systems, Fuels, and Nutrients to Support Activity

Fluids and Electrolytes to Support Activity

- Electrolyte Losses and Replacement
 - Greater in the untrained
 - Training improves electrolyte retention.
 - Eat regular diet meeting energy and nutrient needs
 - Endurance athletes may need sports drinks.
 - Salt tablets worsen dehydration and impair performance.

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Energy Systems, Fuels, and Nutrients to Support Activity

Fluids and Electrolytes to Support Activity

- Hyponatremia
 - Decreased concentration of sodium in the blood
 - Causes
 - Excessive sweat
 - Overhydration
 - Drinking sports drinks during an activity; sports drinks offer glucose polymers

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Energy Systems, Fuels, and Nutrients to Support Activity

Symptoms of hyponatremia

- Severe headache
- Vomiting
- Bloating
- Confusion
- Seizure

Prevention

- Replace sodium during prolonged events.
- Do not restrict salt in diets the days before events.

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Energy Systems, Fuels, and Nutrients to Support Activity

- Poor Beverage Choices: Caffeine and Alcohol
 - Caffeine is a stimulant.
 - Alcohol is not the beverage to replace fluids and carbohydrate.
- A diet that provides ample fluids and nutrient-dense foods to meet energy needs will enhance an athlete's activity and overall health.
- Pre-game and post-game meals should be light and carbohydrate rich.

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Nutrition for Physical Activity

The requirements for some vitamins and minerals may be altered in athletes.

- B vitamins
- Calcium
- Iron

Adequate intake of these nutrients can be met with a healthy diet and should not require supplementation.

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Vitamins, Minerals, and Athletic Performance

B vitamins

- Needed for energy metabolism
- Choose variety of whole grains, fruits, vegetables

Calcium

- Needed for normal muscle function, strong bones
- Low-fat dairy products
- Adequate intake may be a problem for females

Iron

- Needed for oxygen delivery and energy production
- Athletes have higher losses
- Lean red meats, vegetables, enriched grains

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Energy Systems, Fuels, and Nutrients to Support Activity

Vitamins and Minerals to Support Activity

- Supplements
 - Do not enhance performance
 - Deficiencies may impede performance
 - Timing makes a difference; supplements take hours or days to combine with cells.
 - Nutrient-dense foods provide nutrients needed.

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Energy Systems, Fuels, and Nutrients to Support Activity

Vitamins and Minerals to Support Activity

- Vitamin E
 - Protects against oxidative stress
 - Does not improve performance
 - More research needed
 - Vegetables oils and antioxidant fruits and vegetables
- Iron
 - Iron losses in sweat
 - Small blood losses in digestive tract
 - Poor iron absorption

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Energy Systems, Fuels, and Nutrients to Support Activity

Vitamins and Minerals to Support Activity

- Iron Deficiency
 - Common in physically active young women
 - Consume good dietary sources of iron
- Iron-Deficiency Anemia
 - Impairs physical performance
 - Cannot perform aerobic activity and tire easily

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Energy Systems, Fuels, and Nutrients to Support Activity

Vitamins and Minerals to Support Activity

- Sports Anemia
 - Low blood hemoglobin for a short time
 - Adaptive, temporary response to endurance activity
 - Does not require supplementation
- Iron Recommendations for Athletes
 - Blood tests should guide the decision
 - Depends on the individual

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Energy Systems, Fuels, and Nutrients to Support Activity

Fluids and Electrolytes to Support Activity

- Fluid Losses via Sweat
 - Muscle heat is 15-20 times greater when active than at rest
 - Cooling mechanism
 - 1 liter of sweat dissipates 600 kcalories of heat
- Hyperthermia – an above-normal body temperature
 - Body heat builds up
 - Triggers maximum sweating without sweat evaporation

Energy Systems, Fuels, and Nutrients to Support Activity

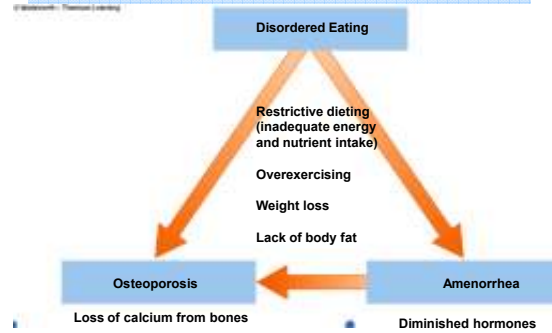
Symptoms of heat stroke – a dangerous accumulation of body heat with accompanying loss of body fluid

- Headache
- Nausea
- Dizziness
- Clumsiness
- Stumbling
- Hot, dry skin
- Confusion or other mental changes

Prevention of heat stroke

- Drink fluids
- Rest in the shade when tired
- Wear appropriate clothing

The Female Triad



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Female Athlete Triad

Demonstrates disordered eating

Amenorrhea

Female athletes are more likely to exhibit this

Seen in 15% swimmers, 62% gymnasts, and 32% of all other sport

Bone density similar to 50-60 year olds

Bone loss is irreversible (osteoporosis)



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Signs and Symptoms of the Female Athlete Triad

1. Fatigue
2. Anemia
3. Depression
4. Stress fracture
5. Decreased ability to concentrate
6. Cold intolerance
7. Hypothermia
8. Cold and discolored hands and feet
9. Enlargement of the parotid glands
10. Sore throat
11. Callused knuckles from pressure against the teeth during induced vomiting
12. Erosion of dental enamel from frequent vomiting
13. Abdominal pain and bloating
14. Constipation
15. Dry skin
16. Face and extremity edema
17. Lightheadedness
18. Bradycardia
19. Changes in orthostatic blood pressure
20. Chest pain
21. Lanugo
22. Carotenemia

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A few years earlier, this Olympic gold medalist would have been too weak and malnourished from anorexia nervosa to have set a world record in the cycling road race.

Treatment for Female Athlete Triad

Reduce preoccupation with food, weight, and body fat

Increase meals and snacks gradually

Rebuild body to healthy weight

Establish regular menses

Decrease training



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Ergonomic Aids

Ergonomic aids: substances used to improve exercise and athletic performance.

- Many of these products are not effective
- Some of these products are dangerous
 - Potential for side effects
 - Many substances are banned for athletes
- Reliable research and accurate information on these products is hard to find
- Many product claims include: energy, enhance performance, change body composition

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Ergonomic Aids

Ergonomic aids used to increase muscles and strength include

- Anabolic steroids
- DHEA (dehydroepiandrosterone)
- GHB (gamma-hydroxybutyric acid)
- Creatine

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Ergonomic Aids

Ergonomic aids used to increase energy levels and optimize fuel use include

- Caffeine
- Ephedrine
- Carnitine
- Chromium
- Ribose

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Dietary Supplements

Carnitine

- Non-essential nutrient
- Facilitates transfer of fatty acids across mitochondria membranes
- Supplementation does not increase muscle carnitine or enhance exercise performance.

Chromium Picolinate

- Essential mineral in carbohydrate and lipid metabolism
- Supplementation has no effect on strength, lean body mass, or body fat.

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Dietary Supplements

Complete Nutrition Supplements

- Taste good and provide food energy, but do not provide complete nutrition
- Should not replace regular meals

Creatine

- Some studies suggest improvement in muscle strength and size, cell hydration and glycogen loading capacity
- Safety issues and side effects

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Dietary Supplements

Conjugated Linoleic Acid (CLA)

- Derived from linoleic acid, an essential fatty acid
- Increases lean body mass in animals
- Few human studies have been performed.

Caffeine

- Caffeine can enhance performance by stimulating fatty acid release.
- Adverse effects include stomach upset, nervousness, irritability, headaches, and diarrhea.
- Use in moderation.
- Use as an addition to other fluids, not as replacement.

Oxygenated Water

- Oxygen cannot enter the bloodstream by way of the GI tract.
- The body gets oxygen from the lungs.

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Hormonal Supplements

Anabolic Steroids

- Illegal
- Authorities ban use
- Plant sterols from herbs are poorly absorbed.
- Dangerous side effects on the body and the mind

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Hormonal Supplements

DHEA (dehydroepiandrosterone) and Androstenedione

- Hormones that are precursors to testosterone
- No evidence to support claims
- Short-term effects are identified

Human Growth Hormone (hGH)

- Used to build lean tissue and increase height if still growing
- Extremely high cost
- Many adverse side effects

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What It Takes To Lose a Pound



Body fat contains 3500 kcal per pound

To lose 1-2 lbs/wk

- ↓ energy intake by 500-1000 kcal/d
- ↑ energy expenditure with physical activity

Higher rate of weight loss may be due to loss of lean tissue (as well as adipose)

1 lb muscle = 1 lb fat

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Healthy Eating Plan

When designing a plan:

- Be realistic about energy intake
- Emphasize nutritional adequacy
- Eat small portions
- Lower energy density
- Focus on complex carbohydrates
- Remember water
- Choose fats sensibly
- Watch for empty calories



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Weight Maintenance

Preventing relapse

“Successful” weight-loss is defined as:

- Achieving a weight loss of $\geq 10\%$ of initial body weight and maintaining the loss for at least one year

National Weight Control Registry:

- Low fat, high carb diet
- Don't skip breakfast
- Keep track of what they eat
- Exercise for one hour daily

<http://www.uchsc.edu/nutrition/WyattJortberg/nwcr.htm>



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