

An Update on Aerobic and Anaerobic Activity

Over the course of the last decade, physical activity has been recognized as a critical component in achieving and maintaining optimal health and weight. The American Dietetic Association, American College of Sports Medicine, American Heart Association and National Cancer Institute, along with numerous other national and international nutrition, exercise and health organizations, have taken strong proactive roles in promoting exercise (1, 2). The 2005 edition of *Dietary Guidelines for Americans* also promotes physical activity and provides a chapter that includes specific recommendations for key population groups (3). Further, for the first time, the United States Department of Agriculture used a figure climbing stairs to highlight the importance of daily physical activity in the updated “MyPyramid” food guidance system issued for Americans in 2005.



(Source: U.S. Department of Agriculture)

Benefits of Physical Activity

The benefits of physical activity are well documented. Regular, moderate-intensity physical activity reduces risk for chronic diseases such as high blood pressure, stroke, coronary artery disease, type 2 diabetes and osteoporosis, is an important factor in achieving or maintaining a healthy body weight and appears to promote psychological well-being. While minimum recommended amounts of physical activity offer some benefits, most people can obtain greater health benefits by gradually being physically active for longer periods of time or doing more vigorous physical activity (3). It is interesting to note that different types of physical activity may provide different benefits.

Types of Physical Activity

• Aerobic Activity

Dr. Kenneth Cooper coined the term *aerobics* in 1968 (4). Aerobic activity uses large muscle groups in continuous, rhythmic motions for sustained periods of time and is characterized by increases in heart rate, respiratory rate, blood pressure and body temperature. Examples are brisk walking, running, cycling and swimming.

Research showed that engaging in approximately 20 minutes of continuous aerobic activity, such as walking or jogging, on three days per week resulted in significant cardiovascular improvement after 12 weeks (2). Additionally, moderate-intensity exercise boosts natural immune functions and host defenses for several hours post-activity (1). Moderate-intensity aerobic activity has also produced significant positive alterations in mood states, such as depression, and increased mental acuity specific to planning, organizing and juggling intellectual tasks (5). For example, Blumenthal and colleagues showed that moderate-intensity exercise versus high-intensity activity was effective in reducing depression. Adults who were 50 to 77 years of age walked briskly for 30 minutes three times per week for 16 weeks. Findings showed that the exercise group matched a drug therapy group in relieving minor depression (2, 5). Aerobic exercise also appears to offset mental decline with aging through improved blood flow to the brain (6). Further, it assists in maintaining body weight through energy expenditure (7).

• Anaerobic Activity

Anaerobic activity is characterized by short-burst, high-intensity exercise (e.g., “stop and go” activities). Examples are sprinting, vaulting, basketball and resistance training (weight-lifting). Anaerobic activity has also been shown to have benefits for longevity and health. For example, resistance training has produced increases in bone mineral resorption (4), reduced muscle tissue loss caused by aging or energy restricted diets (1-2, 4, 7), and improved balance and increased fat-free mass (muscle tissue), which enhances overall functional fitness in adults (2-4).

Fueling Aerobic and Anaerobic Activities

Aerobic and anaerobic activities are fueled through different physiological energy systems. Aerobic activities such as low- to moderate-intensity walking, jogging, swimming, cycling or hiking require a continual supply of oxygen. From a fuel standpoint, protein and fat require oxygen for combustion, while carbohydrate can be burned with or in the absence of oxygen. In the case of physical activity that is aerobic in nature, approximately 40% of the energy expended in a 60-minute walk is derived from carbohydrate, 55% from fat and 3-5% from protein. The low to moderate pace of aerobic activity allows the cardiovascular system to gradually adapt to the increased oxygen demands of working muscles, which allows more fat to be used as a fuel source (4).

In contrast, anaerobic activities burn energy rapidly for short durations without oxygen. Rapid anaerobic energy transfer maintains a high standard of performance for maximal short-term efforts such as sprinting in a pool, stopping and starting over and over again on a basketball or tennis court, or doing repetitive movements in weight lifting. Anaerobic movements rely on three fuel sources that do not require oxygen to be burned: adenosine triphosphate (ATP), creatine phosphate (PCr) and carbohydrate in the form of glycogen (4). Compared with fat and protein catabolism, carbohydrate remains the preferential fuel during high-intensity anaerobic exercise because it rapidly supplies ATP during oxidative processes. High-intensity anaerobic exercise uses approximately 70% glycogen, 15% fat and 5-8% protein (4).

Regardless of the type of physical activity undertaken, energy is burned. The number of kilocalories burned with exercise depends on a number of factors, including: the duration of the activity (e.g., 30 minutes vs. 60 minutes), the frequency of the activity (e.g., once per week vs. five times per week), the intensity of the activity (e.g., walking 2 miles per hour vs. 5 miles per hour) and an individual's weight (1, 4, 7).

Physical Activity Recommendations

Recommendations for physical activity vary, based largely on the specific benefits being sought. For example, recommendations to gain and maintain cardiovascular fitness call for aerobic activity three to six times per week for 30-60 minutes per session. Benefits (many of which are also linked to decreased body weight) include increased maximal cardiac out-put, decreased myocardial oxygen demand for the same level of external work performed, decreased blood pressure and increased high-density lipoprotein (HDL) cholesterol. Regular aerobic training also has significant beneficial effects on insulin sensitivity. Further, recent research finds a role in the prevention and/or treatment of osteoporosis and certain cancers, such as colon cancer (4).

The American College of Sports Medicine's position statement on physical activity recommendations (7) states that significant health benefits can be seen with participation in a minimum of 150 minutes (2.5 hours) of moderate intensity exercise per week (30 minutes of exercise on five of seven days per week). Additionally, there may be advantages to progressively increasing exercise to 200 to 300 minutes (3.3 to 5 hours) of exercise per week (~60 minutes on five of seven days per week). One example is weight management.

Engaging in physical activity every day or nearly every day can play a central role in protecting against weight gain over time. Exercise produces cumulative calorie-expending effects; 0.45-kg body fat loss occurs when the calorie deficit equals 3500 kcal. Consequently, physically active men and women of all ages maintain a more desirable body composition and weight than do their sedentary counterparts (4, 8).

One weight-loss study compared food restriction to exercise (8). The food-restricted group showed greater total body weight losses; however, the exercise group showed greater body fat losses. Both groups showed decreases in insulin, triglycerides, serum leptin and low-density lipoprotein- (LDL) and very low-density lipoprotein- (VLDL) cholesterol concentrations, but only the exercise group showed an increase in fat-free mass, which led to greater improvements in blood lipid profiles than those in the food-restricted group.

To help manage body weight and prevent unhealthy weight gain, *Dietary Guidelines 2005* advises adults to engage in approximately 60 minutes of moderate to vigorous physical activity on most days of the week (while not exceeding calorie needs). It also recommends that previously overweight or obese individuals engage in 60 to 90 minutes of moderate-intensity physical activity daily to sustain weight loss. (3)

Energy Considerations for Vigorous Exercisers

Endurance activities such as marathon running, triathlon training and long distance cycling or swimming require that participants make a conscious effort to supply energy to their working muscles throughout the duration of the activity. In such events, glycogen availability becomes a critical factor in delaying fatigue.

The average person stores about 1600 to 1800 calories of muscle and liver glycogen. Within approximately 60 minutes of physical activity, 50% of stored glycogen has been used. Within 90 minutes, 75% of the glycogen supply is depleted and fatigue sets in, impacting speed, mental concentration and the ability to continue the activity at all. Because endurance-trained athletes may pass up opportunities to eat or drink during competition for fear of losing precious time, it is essential to emphasize the importance of eating or drinking a carbohydrate source *before* fatigue occurs. Eating or drinking carbohydrate-rich sport bars, gels or beverages designed for rapid digestion, absorption and metabolism during endurance activities helps by elevating blood glucose levels and sparing remaining glycogen stores (4).

Some Specific Dietary Recommendations for Endurance Training (1, 4, 7)

- Carbohydrates should comprise at least 55% to 60% of total daily calories and come predominantly from fiber-rich grains, fruits and vegetables.
- Recommended carbohydrate intake is 6 to 10 grams per kilogram of body weight per day.

(Note: Eating a high-carbohydrate diet, with adequate overall energy intake, conserves muscle protein in individuals who engage in endurance training.)

- Protein needs are based on an athlete's ideal body weight. Recommended protein intake varies, depending on type of training: approximately 1.2 to 1.4 grams of high-quality protein per kilogram of body weight per day for individuals engaged in endurance training; approximately 1.6 grams of high-quality protein per kilogram of body weight per day for individuals engaged in resistance training.

(Note: Increase these protein values by 10% for vegetarians, to adjust for less-efficient digestion of plant protein. If protein intake is adequate, plant protein can support muscle tissue growth and strength increases similar to those attained with animal-based protein sources.)

- Fat intake should not exceed 30% of total daily calories. Of this, 70% should come from unsaturated fatty acids.

the reason that even regular exercisers need to control portion sizes and caloric intake, unlike endurance athletes, who typically need extra calories (4).

Determining Calorie Needs for Physical Activity

Determine total calorie needs, using the following formula:

Gender Factor x Daily Rate x Activity Factor = Total Calorie Needs

0.64 (low)

1.0 for males x (weight) lbs. x 24 hrs. x 0.68 (moderate) = ___calories

0.73 (high)

0.64 (low)

0.9 for females x (weight) lbs. x 24 hrs. x 0.68 (moderate) = ___calories

0.73 (high)

Example: Determine calorie needs for moderately-active 180 lb. man:

$1.0 \times 180 \times 24 \times 0.68 = 2,938$ calories

Example: Determine calorie needs for an active 120 lb. woman:

$0.9 \times 120 \times 24 \times 0.73 = 1,892$ calories

Dietary Tips for Recreational Exercisers

A primary dietary difference between serious, endurance-trained athletes and those engaged in regular physical activity for health and weight management is recommended daily calorie intake (1, 4, 7). Another important consideration is adequate hydration.

Engaging in physical activity for 30 to 60 minutes on five days per week promotes energy balance, while being physically active for 90 to 120 minutes on five to six days per week promotes energy deficit and weight loss. For example, a 60-minute walk at a pace of three-miles per hour burns approximately 300 calories (300 calories per hour). Compare this energy expenditure to a 90-minute run that burns closer to 1000 calories (670 calories per hour). Even more striking—an endurance athlete engaging in a 7-hour hike would burn about 300 calories per hour, for a total of 2100 calories—a full day's worth of calories for many people. Such differences in intensity and duration of physical activity are

Nutrition Notes for Coaches and Student Athletes

Dispelling misconceptions about nutrition and promoting healthful eating are two of the most important educational efforts that health professionals can offer coaches, athletic trainers and athletes. One area rife with misconceptions is how best to achieve weight loss. Some coaches may encourage athletes to drop weight quickly to reach a specified weight class, run faster or otherwise improve performance. Athletes may skip meals, severely restrict fluids or energy intake, and eliminate foods or entire food groups, thus compromising their energy levels and nutritional status, to reach their goals. Slower weight loss through moderate caloric reduction (500-700 kcal/day) reduces loss of fat-free tissue and helps ensure adequate energy for training or competition. Ideally, weight loss should be postponed until the athlete's competitive season has concluded.

The Bottom Line

People exercise for a variety of reasons, in a variety of ways, at varying levels of exertion and duration. Therefore, dietary advice for physically active people should be based on their existing diets and individual goals for losing, maintaining or gaining weight.

MyPyramid is an excellent tool to use for planning a balanced diet, adjusting caloric intake where appropriate to meet energy needs. Frequent or endurance exercisers who find it difficult to eat enough calories to maintain a desirable body weight should be guided toward nutrient- and energy-dense foods that provide calories in small portions. Examples are peanut butter (190calories/2 tablespoons), nuts (~160 calories/ounce), cheese

(~100 calories/ounce), dried fruit (130 calories/1.5 ounce) and 100% fruit juices (~120 calories/cup). Calculating protein, carbohydrate and fat needs based on body weight can benefit active people, who frequently, and often erroneously, consider dietary supplements to be necessary for weight gain or increasing muscle mass.

References:

1. Nutrition and Athletic Performance: Position of the American Dietetic Association, Dietitians of Canada and the American College of Sports Medicine. *J Am Diet Assoc.* 2000; 100(12):1543-56.
2. Fletcher GF, Balady G, Blair SN, Blumenthal J, Caspersen C, Chaitman B, Epstein S, Sivarajan ES, Froelicher VF, Pina IL, Pollock ML. Statement on exercise: benefits and recommendations for physical activity programs for all Americans. *Circulation.* 1996; 94:857-62.
3. *Dietary Guidelines for Americans 2005.* US Department of Health and Human Services and US Department of Agriculture. Available at: <http://www.health.gov/dietaryguidelines/dga2005/document/>. Accessed on January 31, 2006.
4. McArdle WD, Katch FI, Katch VL. *Sports and Exercise Nutrition*, 2nd ed. Baltimore, MD: Lippincott, Williams and Wilkins, 2005.
5. Blumenthal JA, Babyak MA, Carney RM, Huber M, Saab PG, Burg MM, Sheps D, Powell L, Taylor CB, Kaufmann PG. Exercise, depression and mortality after myocardial infarction in the ENRICH trial. *Med Sci Sports Exerc.* 2004; 36(5):746-55.
6. Babyak MA, Blumenthal JA, Herman S, Khatri P, Doraiswamy M, Moore K, Craighead WE, Baldewicz TT, Krishnan KR. Exercise treatment for major depression: maintenance of therapeutic benefit at 10 months. *Psychosom Med.* 2000; 62:633-8.

References:

7. Jakicic JM, Clark KL, Coleman E, Donnelly JE, Foreyt J, Melanson E, Volek J, Volpe SL. American College of Sports Medicine position stand. Appropriate intervention strategies for weight loss and prevention of weight regain for adults. *Med Sci Sports Exerc.* 2001; 33(12):2145-56.
8. Tsai AC, Sandretto A, Chung YC. Dieting is more effective in reducing weight but exercise is more effective in reducing fat during the early phase of a weight-reducing program in healthy humans. *J Nutr Biochem.* 2003; 14(9):541-9.

Additional Resources:

U.S. Department of Agriculture, MyPyramid Food Guidance System, available at: www.MyPyramid.gov.

Nutrition and Your Health: Dietary Guidelines for Americans, 2005 Dietary Guidelines Advisory Committee Scientific Report, available at: <http://www.health.gov/dietaryguidelines/dga2005/report/>.