Health Issues

Exercise and the Elderly

Type of Issue: Elder health, prevention, public health, social trends

Definition: Regular physical activity undertaken for the purpose of maintaining or increasing physical and mental health.

The physiological deterioration commonly associated with aging is not entirely caused by the aging process; it is also caused by the physical inactivity that often accompanies aging. In the United States, it has been reported that adults over age fifty are the most sedentary members of the population. By the year 2030, it has been predicted that 22 percent of the population will be over age sixty-five. Increased physical activity is a frequently suggested mechanism for reducing the rising health care costs that accompany cardiovascular disease and deterioration of the musculoskeletal system. Even so, 50 percent of men and 70 percent of women over age sixty-five are not participating in enough regular exercise to have a sufficient impact on their health.

Four general components collectively represent physical fitness: cardiorespiratory endurance (aerobic capacity), anaerobic power, muscular strength and endurance, and body composition. All these components are susceptible to decline with aging; however, the magnitude of this decline is dependent upon the extent of physical inactivity and other health factors.

Aerobic Capacity

Aerobic capacity refers to the body's ability to maximally transport and utilize oxygen to the cells (maximal volume of oxygen consumed, or VO_2max). The body requires a higher volume of oxygen (O_2) to sustain increased magnitudes of exercise. Aerobic capacity declines with aging because of a cumulative effect of age-related functional changes in the heart as well as muscle mass loss caused by disuse or disease. The higher the O_2max value (measured in milliliters of oxygen used per kilogram of body weight per minute), the greater the person's aerobic capacity, or aerobic fitness. A higher aerobic capacity will allow an individual to exercise more comfortably and will also permit the older individual to complete activities of daily living without fatigue. Thus, functional ability is improved when aerobic fitness is improved.

Up to age thirty, VO_2max declines about 1 percent per year. Once adults reach middle age, the loss of VO_2max is accelerated unless regular aerobic exercise is undertaken. Between forty-five and fifty-five years of age, O_2max will be lost at a rate of 9 to 15 percent. Other accelerated losses occur between the ages of sixty-five to seventy-five and from seventy-five to eighty-five years of age. However, regular participation in aerobic exercise can slow or even reverse this decline. When middle-aged or older individuals participate regularly in aerobic exercise, they can expect a 10 to 25 percent improvement in VO_2max. This can mean the difference between being functionally impaired, on one hand, and gaining back independent-living skills and sports participation, on the other.

Individuals can have their aerobic capacities determined with an exercise stress test administered by a team of medical professionals, including a cardiologist, a nurse, and an exercise physiologist. An aerobic exercise training program that elicits 50 to 70 percent of one's O_2max would be sufficient to improve an older individual's aerobic capacity. Examples of aerobic exercise are walking, swimming, cycling, skiing, and dancing. Exercise of moderate intensity—enough to cause an increase in breathing and heart rate but not so much that it prevents one from being able to carry on a conversation—is sufficient for most people to gain health benefits. The experience of pain is a cue to stop exercise and reevaluate the exercise intensity level.

The Cardiovascular and Respiratory Systems

The primary purpose of the cardiovascular and respiratory or pulmonary systems (also referred to collectively as the cardiopulmonary or cardiorespiratory system) is to deliver oxygen and nutrients to the tissues while removing carbon dioxide and waste products from the tissues.

With aging, lung tissue loses elasticity, the chest wall becomes more rigid, and respiratory muscle strength is lost. This causes a loss of ventilatory (breathing) efficiency, making the mechanics of breathing harder for the aged. With exercise, the demand for more oxygen requires more frequent and deeper breaths. Since the aged pulmonary system is compromised, pulmonary ventilation is decreased during maximal exercise as well as during recovery after exercise. Even with aging limitations, in the absence of pulmonary disease, the resting tissues still have an adequate oxygen supply to carry out daily functional and recreational activities. The oxygen deficit and higher respiratory work is not noticed until vigorous exercise puts a demand on the system for more oxygen, challenging the ventilatory capacity of the lungs. Although the total amount of blood flow increases as aerobic capacity increases, this does not result in an improvement in gaseous diffusion in the aged. In fact, gas exchange of oxygen and carbon dioxide in the tissues decreases with aging, and exercise training appears to have little impact on this function. On the other hand, forced vital capacity (FVC), the maximum amount of air that can be expelled after a maximal inhalation, is one of the few pulmonary volumes influenced by both aging and exercise training. With aging, FVC declines approximately 4 to 5 percent per decade in the average individual. However, research studies that tracked aerobically trained individuals over twenty or more years found that their FVCs at age forty-five were the same as their FVCs at age twenty. This maintenance may be because of the mechanical stressing of the respiratory muscles afforded by regular aerobic exercise.

As with the pulmonary system, resting cardiovascular function experiences only moderate changes, whereas the cardiovascular response during exercise declines substantially with aging. The major reason that maximal aerobic capacity declines with aging is because of the decrease in maximal heart rate. Maximal heart rate (the highest heart rate attainable) declines approximately 6 percent per decade. Using the mathematical formula to estimate maximal heart rate (220 minus age equals heart rate in beats per minute), it can be seen that the estimated maximal heart rate of a seventy-year-old (150 beats per minute) is significantly less than that of a twenty-year-old (200 beats per minute). Heart rate is under the control of both the parasympathetic and sympathetic nervous systems. The parasympathetic nervous system is responsible for keeping the heart rate lower at rest. The sympathetic nervous system takes over during exercise so that heart rate can be increased in order to meet the increased oxygen demand. The decline in maximal heart rate is caused by the aging heart becoming less sensitive to sympathetic nervous system stimulation, thereby decreasing the heart's maximal contractile capabilities. This results in the inability of the heart to attain the higher maximal values that were possible during youth. No amount of exercise training can alter this. Submaximal exercise is also more strenuous for an older adult. Exercise sessions that were once easy during youth cause higher heart rates and longer recovery times when one is older. This reflects the heightened need of the aging heart to work harder in order to meet the increased oxygen demands of the exercising tissues.

Regular exercise participation lowers resting heart rate (the number of times the heart beats per minute) and improves stroke volume (the volume of blood ejected with each beat of the heart) in both the young and the old. Even though cardiac contractility and total blood volume in older individuals are less and the ventricular walls are less compliant, regular aerobic exercise training increases total blood volume and tone of the peripheral vessels, thereby reducing vascular resistance and increasing the volume of blood flow back to the heart. This enables the heart to eject more blood with each beat. In aerobically trained individuals, stroke volume is improved not only during exercise but also at rest. The lower resting heart rates commonly seen in trained individuals is partially caused by the improved stroke volume. Since the heart is able to deliver more blood with each beat of the heart, the heart does not need to work as hard to deliver oxygen. In addition, regular aerobic exercise enhances the heart's parasympathetic activity. Therefore, the combined effect of improved parasympathetic activity and improved stroke volume explains the bradycardia (a heart rate below 60 beats per minute) commonly observed in healthy, aerobically trained individuals.

Even though the cardiovascular parameters that determine aerobic fitness all decline with the aging process, participation in regular aerobic exercise has been shown to improve maximal stroke volume and cardiac output (the volume of blood pumped by the heart each minute, equal to heart rate minus stroke volume) by as much as 25 percent. Maximal cardiac output is increased because of the increase in stroke volume, since maximal heart rate does not increase. The types of exercise training employed, as well as the person's initial level of fitness, influence the magnitudes of these increases. Aerobic exercise, not strength training, is the type of exercise required to improve cardiovascular function. Those who are more severely deconditioned will be able to accomplish greater gains simply because they have more room for improvement.

Anaerobic Power

Converse to aerobic capacity, anaerobic power is not dependent upon the replenishment of oxygen to the cells. The fuel source used to power anaerobic movement is retrieved from energy stores located within the cell. Quick, explosive movements characterize anaerobic activities. In most athletic events, the ability to generate anaerobic power will have a direct effect upon athletic success. It is also important in daily living when one encounters an emergency situation demanding a quick, powerful response. A few examples of anaerobic activities include sprinting, throwing the discus, and lifting heavy objects.

The sports-related “anaerobic response” includes a sharp rise in lactic acid accumulation in the muscles and blood, a sharp increase in pulmonary ventilation, and a drop in the blood pH, giving rise to a more acidic state. Lactic acid accumulates with high-intensity or maximal exercise because of a combination of an increased production rate and a reduced rate of removal. The recruitment of fast-twitch muscle fibers (those fibers responsible for performing quick, explosive movements) also triggers the production of lactic acid. In addition, the need for more oxygen at maximal exercise stimulates the metabolic pathways to speed up. This results in an increase in glycolysis. Glycolysis is the energy pathway responsible for the initial breakdown of blood glucose (blood sugar) so that energy (adenosine triphosphate, or ATP) can be created to perform work. At the end of glycolysis, if enough oxygen is not available, excess lactic acid will be formed. An abundance of lactic acid quickly causes muscle fatigue, and exercise soon stops.

Data on aging suggest that anaerobic power, mechanical power, and mechanical capacity peak by age forty, then decline thereafter. Several factors may explain this decline. First, older adults have reduced blood glucose stores (glycogen) in the muscle tissue, which results in a decrease in glycolysis. A decrease in glycolysis will decrease energy production. Second, with aging, fewer fast-twitch muscle fibers are available because of atrophy (shrinkage from disuse). Third, the enzyme lactate dehydrogenase (LDH), which is responsible for lactic acid production when fast-twitch muscle fibers are activated, decreases with aging. Even though the anaerobic processes decline with aging, participation in anaerobic-type activities is still possible as long as the health and fitness status of the older adult is carefully considered.

The Nervous and Musculoskeletal Systems

With aging, the nervous system is unable to receive, process, and transmit messages as quickly as it did in youth. The clinical outcome is slower reaction and movement times. This is an important issue, as many aspects of functional independence require an individual to be able to react quickly in certain situations to prevent potential injury, such as when driving a car or regaining one’s balance to prevent a fall. Older individuals who exercise regularly have demonstrated better reaction times, balance, and coordination in comparison to their sedentary peers. Research investigating older adults who play tennis regularly has demonstrated that active older adults can maintain and perhaps improve their motor skills with continued use. Blood flow to the brain also increases during exercise. Short-term, immediate improvements in performance of memory tasks have been demonstrated immediately following aerobic exercise. Whether there is a long-term increase in cerebral blood flow because of regular exercise participation is a question subject to continued research.

Beginning in middle age, muscular strength declines because of a combination of factors, such as muscle mass loss, decreased motor unit activation, and a decreased ability of the muscles to contract forcefully. This decline is selective as well, with some muscle groups losing substantially more strength than others. For instance, leg and trunk muscle strength appears to decline at a faster rate than arm strength. The decline in muscle mass occurs in phases. From twenty-five to fifty years of age, only about 10 percent of muscle mass is lost. However, by age eighty, almost 40 percent of muscle mass is lost because of atrophy. This “wasting away” of muscle tissue commonly seen in the elderly is known as sarcopenia. Weakened respiratory muscles will result in limited aerobic capabilities. Weakened lower-extremity muscles give rise to balance problems and increased risk for falls. Insufficient strength to carry out activities of daily living or functional tasks results in a loss of independent living. Although the age-related loss of muscle mass and strength cannot be totally eliminated, it can be reduced. Aging does not impair the ability of skeletal muscles to respond to exercise training. Progressive strength training programs have demonstrated that older adults can achieve gains in muscle mass (hypertrophy) and muscle strength similar to what has been observed in young individuals.

Exercise has been shown to be beneficial in reducing bone mass loss (osteoporosis). Both weight-bearing aerobic training and strength training have been found to be beneficial in improving bone mass. However, the modest improvements shown to occur with bone mass because of exercise conditioning is not great enough to prevent a fracture caused by a fall. Rather, exercise training will help to reduce the risk of falls by strengthening the ambulatory musculature. Research studies indicate that aerobic training and strength training improve neuromuscular functioning, gait, and balance, all of which are important variables in the risk profile for falls.

Psychosocial Benefits of Exercise

Psychological well-being includes components such as self-esteem, self-efficacy, depression, and anxiety. The majority of research studies investigating these factors in older individuals agree that participation in regular exercise is associated with improved psychological well-being. The benefits are greater and more consistent if the individual participates in an exercise program for at least ten weeks. Either aerobic training or strength training will work well, but very light or very vigorous exercise is not as effective as moderate-intensity exercise.

It is often cited that older individuals benefit from group activities— group interactions alleviate feelings of loneliness often encountered with aging. While this may be true for some, home-based exercise may be preferable to the class setting for certain groups of older adults. Many older adults remain very active and are unable to fit a regularly scheduled exercise class into their own tight schedule. Others are unable to get to the exercise site because of transportation problems or physical disabilities but are still capable of performing some type of exercise or physical activity at home. A safe, moderately paced home program would better meet their needs.

Health Benefits

It has been demonstrated that participation in regular exercise can assist with weight management and body-fat reduction, lower blood pressure for those with mild hypertension (elevated blood pressure), reduce blood triglyceride and low-density lipoproteins (LDL, or “bad cholesterol”), and improve high-density lipoprotein levels (HDL, or “good cholesterol”). Both aerobic and strength training programs can promote a loss of calories and therefore reduce fat deposits and encourage muscle maintenance or growth throughout the life span. However, only aerobic training has been proven to be effective in improving the lipoprotein profiles and lowering blood pressure in older individuals.

The risk of glucose intolerance increases as one ages because of insulin resistance.

“Glucose intolerance” is a term used to describe the body’s inability to regulate its glucose (blood sugar) level. This causes the blood glucose level to be chronically elevated, which can lead to diabetes. Insulin is a hormone that helps to regulate blood glucose levels. It is released when the blood glucose levels are elevated, such as after eating a meal or during high-intensity exercise. Therefore, the role of insulin is to reduce the blood glucose level. However, sometimes the body cannot utilize its insulin properly. This creates a condition known as insulin resistance. The result is an overload of blood glucose in the system, which again predisposes the individual to diabetes. Physical inactivity and obesity compound the problem. Regular participation in either aerobic exercise or strength training has been shown to be equally effective for improving glucose balance and the body’s ability to use insulin in older adults.

Risks and Guidelines

There are many exercise options available for the older adult, depending on specific goals and health status. Even though exercise is associated with a variety of health benefits, it is also associated with such health risks as worsening existing medical problems, muscle and joint injuries, and, in some cases, heart attack. Therefore, exercise programs should be designed to maximize the benefits and minimize the potential risks.

Regardless of age, the Report of the Surgeon General recommends that everyone should participate in moderate exercise for at least thirty minutes on all or most days of the week for optimal health and fitness. This should be accomplished gradually. If one’s goal is to improve aerobic fitness, blood pressure, cholesterol level, mood, or glucose tolerance or to reduce body fat, moderate aerobic exercise should be done at least three times per week. This requires activities that are rhythmic in nature, involve the use of larger muscle groups, and can be sustained for at least fifteen to twenty continuous minutes. If the goal is to increase muscle mass, muscular endurance, or strength, then a well-rounded strength-training program should be done twice per week, with each session followed by at least one day of rest. If the goal is to maintain or improve bone mass, either weight-bearing aerobic exercise or resistance training could be used. The ideal exercise program includes both aerobic training and strength training.

A healthy older individual can begin a light to moderate exercise program without the need for a medical examination or clinical exercise test. However, if the individual has risk factors for heart disease, is taking medications, or has any medical concerns, he or she should consult with a physician to determine a safe level of exercise participation.

Bonita L. Marks

See Also

Aging; Broken bones in the elderly; Cholesterol; Diabetes mellitus; Exercise; Exercise and children; Hypertension; Medications and the elderly; Mobility problems in the elderly; Muscle loss with aging; Osteoporosis; Reaction time and aging; Safety issues for the elderly; Sports injuries among children; Temperature regulation and aging.

For Further Information

American College of Sports Medicine. *ACSM Fitness Book*. Edited by Susan M. Puhl, Madeline Paternostro-Bayles, and Barry Franklin. 2d ed. Champaign, Ill.: Human Kinetics, 1998. A basic book written by academic and clinical professionals intended to guide adults who wish to begin a low-intensity exercise program.

Ettinger, Walter H., Brenda S. Mitchell, and Steven N. Blair. *Fitness After Fifty*. St. Louis: Beverly Cracom, 1996. A “how-to” book written by experts in the field of aging and epidemiology for middle-aged and older individuals desiring to become physically active.

Hurley, Ben F., and James M. Hagberg. “Optimizing Health in Older Persons: Aerobic or Strength Training?” In *Exercise and Sport Science Reviews*, edited by John O. Hollszy. American College of Sports Medicine Series 26. Baltimore: Williams & Wilkins, 1998. This chapter in a collection of exercise-related papers reviews the facts known about the effects of aerobic exercise and strength training on the physiological processes in the older adult.

Rowe, John W., and Robert L. Kahn. *Successful Aging*. New York: Pantheon Books, 1998. A summary of research results dedicated to determining the effects of aging on the body and maximizing health in older individuals; written for the layperson by renowned gerontologists.