Medical Education Systems, Inc.

Physical Activity for Older Adults

The Importance of Physical Activity for Older Adults

Table of Contents

Learning Objectives

Upon successful completion of this course, you will be able to:

- Identify the exercise recommendations for older adults
- List the policy recommendations for health professionals
- Identify the policy recommendations for communities
- List the factors for prescribing exercise, including frequency, intensity and duration

Introduction

Although there is clear scientific evidence that regular physical activity has powerful positive effects on both psychological and physical well being, 75% of Michigan's 65+ population does not have the regular, sustained physical activity needed to maintain health.1 The cost to our state of this physical inactivity is exorbitant. A sedentary lifestyle contributes to the escalating cost of health care expenditures for older adults, which in Michigan was estimated to exceed $11.6 billion in 1999.

Worst of all, lack of physical activity most certainly contributes to premature deaths, needless infirmity, and loss of independence for significant segments of our aging population. The Michigan Governor's Council on Physical Fitness, Health and Sports believes that programs to facilitate increased physical activity among the aging population are crucial both to the quality of life of older adults and to the economic health of the state. We call on older adults, health care professionals, and policymakers at the local and state levels to work together to remove barriers to healthful exercise for our older adults. Delaying intervention will add to the existing burdens of needless infirmity, premature death, and uncontrolled health care costs.

This course summarizes accurate scientific information to serve as recommendations for policies and strategies that can increase the physical activity levels of older adults in the State of Michigan—and elsewhere in the United States. Performing regular physical activity is a valuable health practice for older adults. It can prevent or minimize chronic health problems and increase functional ability. Exercise programs, including stretching, range of motion, aerobic activity, and resistance exercises, can markedly improve endurance, strength, balance, and flexibility, all of which progressively decline with aging, especially in those who are physically inactive.

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Exercise Recommendations for Older Adults

• All capable older adults of Michigan, including those with limitations and disabilities, should engage in regular physical activity of at least a mild intensity, which increases total caloric expenditure beyond the level required for the normal activities of daily living. Increased physical activity can be accomplished through regular exercise programs, recreational pursuits and, for some individuals, sporting activities.

• To develop and maintain muscular strength, physical activity should include resistance/strength training (i.e., lifting weights or using resistance machines) consisting of exercises for 8-10 major muscle groups, performed 2-3 days per week, using one set of 8-15 repetitions for each exercise. The initial amount of weight selected should be just heavy enough to slightly fatigue the muscle group involved after performing the 8-15 repetitions. Progression of weight training can be accomplished by periodically increasing the amount of weight lifted by 10% and by increasing to three sets per session. Circuit training is an effective method of resistance training, performed by doing a series of resistance exercises, one following another within 30 seconds. Knee extension is an important resistance exercise because it strengthens the quadriceps muscles that are critically linked to the ability to walk. A normal breathing pattern should be maintained while performing resistance exercises; breath-holding should be avoided.

• To maintain and improve flexibility, coordination, and balance, range-of-motion and static stretching exercises should be performed daily. Relaxation and rhythmical breathing should be maintained. Routine stretching is particularly important for the muscles used in walking. Walking puts stress on muscles in the calf area (gastrocnemius and soleus muscles) that connect to the Achilles tendon, which in turn attaches to the heel (calcaneal bone). With walking, these muscles may become tight and may lead to soft tissue injuries in the lower leg, ankle and foot.

• For cardiovascular health, physical activity that is rhythmic and dynamic in nature, involving large muscle groups, should be performed regularly (preferably daily). These activities are referred to as aerobic exercises. Examples are walking, cycling, swimming, dancing, chair- and floor-exercising, stair-climbing, elliptical machines, and cross-country skiing.

• Light to moderate intensity exercise, such as walking, is usually appropriate and safe for apparently healthy deconditioned individuals. However, a physician should evaluate an individual with major medical conditions, especially one with known cardio-respiratory disease, before a more vigorous exercise training program is initiated.

• The goal for aerobic physical activities is that they should total a minimum of 30 minutes per day, either at one session or staged in shorter episodes throughout the day. Progression of effort can be accomplished by gradually increasing the duration or the intensity of the effort.

• Individuals who have been extremely sedentary should start with exercise sessions of short duration and very light intensity, gradually increasing the duration without increasing the intensity. It is advised that such individuals wishing to progress to more intense activity should first consult their physician.

• Exercise programs are particularly important for individuals with medical problems, physical limitations and psychological problems such as depression. Exercise programs can help prevent or delay disabilities associated with aging and can minimize or reverse some physical and psychological problems related to disease state. For such persons, highly individualized physical activity programs should be designed to maximize safety during exercise activities. It is important that older individuals know that the benefits of exercise require regular participation throughout life.

• Recreational pursuits involving physical activity are highly recommended, especially when performed in social settings.

• Exercise can be performed safely either at home or at an exercise facility in the community.

• The ability to regulate fluid balance is impaired with aging, making it imperative that an older adult rehydrate adequately before, during and following exercise. To reap the maximum benefits from exercise, nutritionally sound food choices are also important.

Policy Recommendations for Health Professionals

• Physicians, health care professionals, and auxiliary health care workers should be knowledgeable regarding the benefits of physical activity for older adult patients. They should be aware of the many physical, physiological, and psychological benefits of regular exercise so they can provide appropriate counseling to older adults and their family members.

• Physicians, health care givers and therapists should promote and encourage physical activity for their older adult patients. First, they should be physically active themselves, in order to serve as effective role models. Second, they should incorporate exercise into the preventive health and treatment plans of their older adult patients whenever possible. The Physician-based Assessment and Counseling for Exercise (PACE) Program developed by the Centers for Disease Control and Prevention can assist primary medical providers in this effort.

• Physicians should be strong advocates of routine exercise and highly recommend daily exercise to their older patients. In accordance with the above, physicians should:

1) Consider and address the factors that may make physical activity difficult for the older patient, including the impact of their current medications, psychological status, health-related factors, and social-demographic factors.

2) Be able to give patients with special health problems individualized exercise prescriptions tailored to their conditions. If that is not realistic, identify referral mechanisms so that appropriate, safe, individualized exercise prescriptions can be given.

3) When patients do undertake significant increases in exercise patterns, monitor the effects of the exercise on disease states and be prepared to modify dosages of prescription medications as indicated.

4) Promote physical activity with families and caregivers so that older adults can receive assistance and social support for this behavior.

5) Show concern and compassion for the older patient's special needs and concerns, emphasize the personal benefits of habitual exercise, and provide reassurance that routine exercise can be safely performed when done appropriately.

6) Provide continuous support and encouragement to help older adult patients with their commitment to regular exercise. Follow-up visits should emphasize the value that moderate exercise plays in maintaining good health and, in some cases, in the treatment of disease.

• Medical schools and allied health pre-professional training institutions should ensure that their graduates receive adequate training regarding the principles of exercise physiology and the specific health benefits of regular physical activity for older adults.

• Clinicians and scientists at academic institutions should actively conduct research to further clarify the benefits and optimal application of exercise programs for older adults.

• Health care professionals and auxiliary health care workers should provide knowledge, resources and leadership for establishing public health policies that focus on enhancing the quality of life for older adults.

• Health care professionals and auxiliary health care workers should assist in implementing public health awareness campaigns aimed at promoting regular physical activity programs for older adults.

• Hospitals and medical centers in Michigan should incorporate inpatient exercise programs as part of their standard care for older adult inpatients to minimize physical decline during hospital stays and to reduce the number of nursing home admissions. Exercise regimens should be personalized to the individual.

Policy Recommendations for Communities

• Local units of government should assess whether all possible measures are being taken to make it safe and convenient for residents to be physically active. The Governor's Council on Physical Fitness, Health and Sports can supply a self-assessment tool as part of the *Promoting Active Communities Award* application process.

• An awareness of the importance of exercise for older adults should be reflected in planning and designing community facilities, including schools, community colleges and universities, community centers, shopping malls, senior centers, recreation centers, parks, arenas, and other public facilities.

• Community resource planners should, in partnership with regional and state planners, support the development of safe and accessible public exercise areas, such as walking, jogging, and biking trails.

• Local groups interested in physical activity promotion should form partnerships with cardiovascular health coalitions, local health departments, and regional fitness councils of the Governor's Council on Physical Fitness, Health and Sports. Local groups can affiliate with the National Coalition for Promoting Physical Activity to get information on national efforts to achieve the *Healthy People 2010 National Health Objectives* related to promoting physical activity for older adults in the 21st century (see Appendix B).

• Older adult organizations should encourage members to participate in regular physical exercise programs. As part of this effort, these organizations should acquire training for their staff members in safe and appropriate exercise, including certification in cardiopulmonary resuscitation (CPR) and first aid.

• Older adult housing complexes should promote physical activity among their residents by providing adequate facilities and trained personnel to lead and supervise physical activity.

• Regional fitness councils and local public health agencies should encourage private institutions and commercial enterprises to promote exercise for older adults and to provide space for older individuals who wish to exercise in group settings. These institutions and enterprises include shopping malls, places of worship, commercial fitness centers, and places of employment. Special events and designated days devoted to exercise programs for older adults should be planned.

• Public information programs designed to encourage physical activity for older adults should be based on market data research that clearly identifies barriers to physical activity and factors that would motivate older individuals of various ethnic groups and geographic regions.

• Regional fitness councils, Area Agencies on Aging, and local public health departments should cooperate in sponsoring local public information programs in support of physical activity for older adults. Publicity materials should address both the importance of physical activity for older adults and specific events or programs available. They should be provided to local newspapers,

radio and television stations, public access cable television channels, and Internet/World Wide Web sites. The Michigan Governor's Council on Physical Fitness, Health and Sports and the Michigan Office of Services to the Aging can assist in developing these publicity materials.

The so-called aging of America is a well-known phenomenon. Throughout the 20th century, both the average age and the life expectancy of Americans have steadily increased. Since 1900, the percentage of Americans age 65+ more than tripled. As of 1999, one in eight Americans (34.5 million people) were age 65+. By 2030, it has been estimated that one in five Americans (over 70 million) will be age 65+.5 Furthermore, the older population continues to get older. Between 1900 and 1999, the number of individuals aged 65-74 increased eight-fold, while the number aged 75-84 increased 16- fold, and the number aged 85 and over increased 34-fold.5

The national trend toward an aging population is seen in Michigan as well. Michigan is currently one of nine states with more than one million residents age 65 and over.5 As of 1999, there were 1.23 million adults aged 65 and older in Michigan, comprising approximately 12.4% of our state's total population.5 Census projections for Michigan show that from 1990 to 1999 the total number of individuals living in Michigan aged 65 and over increased by 10.3%, while the number aged 85+ increased by 36%.6 As the ranks of older residents continue to increase in the years to come, we will see unprecedented challenges in maintaining their health status and in paying for their health care.

Although people aged 65 and older represent only 12.7% of the population nationally, they accounted for 36% of all hospital stays and 49% of all days of care in hospitals in 1997.5 In 1998, older consumers averaged $2,936 in out-of-pocket health care expenditures, a 33% increase since 1990. The health costs incurred on average by older consumers in 1998 consisted of $1,528 (52%) for insurance, $670 (22%) for drugs, $596 (20%) for medical services, and $142 (5%) for medical supplies. Older Americans made 12% of their total expenditures on health, three times the proportion spent by younger consumers.5

Strategies to reduce these health care costs would be very beneficial to older individuals and to all taxpayers. Now that life expectancy is nearing an average of 80 years,5 society needs to focus on ways to age successfully with minimal illness and disability. Although the biochemical and physiological processes associated with aging are poorly understood, both research findings and extensive clinical experience strongly suggest that regular exercise may attenuate the aging process. For example, two common features of aging that can be attenuated by physical activity are decreased muscular strength and reduced functional capacity.7 The resulting weakness and frailty are associated with accidental falls, a major cause of morbidity in the aged,8,9 often leading to institutionalization and even death.10,11 Hip fractures related to falls and osteoporosis have been estimated to cost over $8 billion annually.12 It was reported in 1995 that falls were the second leading cause of death for individuals aged 65-84 years and were the leading cause of mortality in those 85 years or older.13 A review of the literature gave the risk of any hip, spine or distal forearm fracture in those over 50 years to be 40% in white women and 13% and white men.14 The heated national debates regarding ways to assure adequate funding for medical care for older adults have virtually ignored potential savings in health care costs that could be realized through improvements in personal lifestyle habits related to physical activity. Regular physical activity can play a major role in ameliorating many age-related

declines in the musculoskeletal and cardiovascular systems.[7] Furthermore, physical activity often can prevent the need for medical treatment, or it can serve as an important adjuvant to medical treatment.

Regular physical activity exerts beneficial effects on the functioning of the cardio-respiratory, vascular, metabolic, endocrine, and immune systems. In so doing, it greatly reduces risk factors for coronary artery disease, the nation's leading cause of death. It may also prevent the development of, or effectively treat, diseases such as noninsulin- dependent diabetes mellitus, osteoarthritis, osteoporosis, obesity, colon cancer, peripheral vascular occlusive arterial disease, arthritis, and hypertension.

Regular exercise reduces body fat stores, increases muscle strength and endurance, strengthens bones, and, importantly, improves mental health.[15] Lack of physical activity is a health issue in all segments of the population, but it is most prevalent in the older adult population. In Michigan in the year 2000, 75% of adults aged 65+ failed to meet the minimum recommendation for maintaining health (30 minutes per day, five days per week). Half of older adults reported so little physical activity that they fell into the sedentary category (less than 20 minutes of activity three times per week). Fully 23% of older adults reported no leisure time physical activity whatsoever in the past month.[1]

A sedentary lifestyle, as practiced by such a large proportion of Michigan older adults, has clearly been shown to be associated with more medical problems than are seen in more physically active individuals.[7,15,16] Scientific studies of preventive health programs which include regular light-intensity aerobic and resistance exercises demonstrate that risk factors for illness can be reduced and that older adults can modify their health behaviors.[7,15] There is no question that good health habits and regular exercise would markedly reduce health care costs in this large and rapidly growing segment of our population.

Public health efforts to effect behavior change often face unreceptive target audiences. For example, adolescents and young adults may be unresponsive to preventive health messages focusing on long-term benefits, such as longevity, and they may reject appeals that conflict with peer pressure or the actions of celebrity role models. Likewise, middle-aged adults may be unresponsive to messages promising future health benefits in return for a current investment of significant time and attention. In older adults, barriers to behavior change persist; however, the normal physiological changes accompanying normal aging often sharpen older adults' interest in feeling good, looking good, and having good health and longevity. It may be more likely that barriers can be overcome. Older adults generally possess significant time to act on behalf of their health and well-being. Furthermore, older adult citizens' commitment to improving exercise patterns is likely to be reinforced because benefits such as enhanced functional independence and self-esteem can be realized almost immediately and can be maintained indefinitely.

Physical activity enhances quality of life as well as longevity. Finally, promotion of an active lifestyle has the psychological advantage of recommending a positive behavior rather than proscribing one. Recommendations to the general public for appropriate and safe exercise training for improving physical fitness have come from many sources. The American College of

Sports Medicine (ACSM) first published a position statement in 1978 titled "The Recommended Quantity and Quality of Exercise for Developing and Maintaining Fitness in Healthy Adults."[17] This document provided recommendations for developing and maintaining cardiorespiratory fitness and a healthy body composition. Other national organizations published physical fitness recommendations through 1995 using the same scientific information as was used for ACSM, including the President's Council on Physical Fitness and Sports,[18] the YMCA,[19] the American Heart Association,[20] and the American Association of Cardiovascular and Pulmonary Rehabilitation.[21] The importance of these contributions is that the recommendations were largely based on sound scientific research.

Although the fitness benefits from vigorous exercise have long been recognized, the health benefits from more moderate exercise have only recently been widely acknowledged. In 1990, the U.S. Public Health Service published the document *Healthy People 2000*, which listed health objectives for the nation,[22] with revisions in 1995 to add objectives for physical activity and fitness.[23] A combined effort by the Centers for Disease Control (CDC) and the American College of Sports Medicine in 1995 resulted in guidelines for health enhancement through regular exercise training.[24]

In contrast to previous advice regarding exercise to improve cardio-respiratory fitness, these recent guidelines to improve both fitness and health recommend more frequent exercise—preferably daily—performed at a lower intensity at least 30 minutes per day; or accumulating an equivalent total duration through multiple shorter bouts of exercise. An important document promoting the health benefits of regular physical activity was published in 1996: the NIH Consensus Development Conference Statement on Physical Activity and Cardiovascular Health.[25] This group of scientists and health experts stressed that a sedentary lifestyle was a major public health problem in the United States and recommended that all children and adults exercise daily at a moderate intensity for at least 30 minutes. Most noteworthy is the more recent (1996) report of the U.S. Department of Health and Human Services, Physical Activity and Health:

A Report of the Surgeon General15 (see Appendix A). This is by far the most comprehensive document ever published using scientific evidence to demonstrate the cardio-respiratory fitness and health benefits of regular exercise. This report attributes 250,000 deaths per year to a sedentary lifestyle, and strongly supports the promotion of physical activity as an important public health measure. These and other physical activity recommendations to the public have primarily addressed physical activity for adolescents and middle-aged adults (Consensus Conference on Physical Activity Guidelines for Adolescents, American Academy of Pediatrics;[26] the 1988 Surgeon General's Report on Nutrition and Health;[27] the 1995 USDA/USDHHS report, "Dietary Guidelines for Americans";[28] the U.S. Preventive Services Task Force recommendations;[29] and the American Medical Association's "Guide for Adolescent Preventive Services"[30]).

Only recently has attention been focused specifically on the special needs of older adults. In 1996, the World Health Organization (WHO) issued comprehensive Guidelines for Promoting Physical Activity Among Older Persons.[31] The WHO experts on aging at this time

recognized the importance of setting exercise guideline for the aging since this segment of the world's population was so large and was growing at such a rapid rate. In this document, the WHO strongly and enthusiastically supports and endorses regular exercise as an integral component for healthy aging. In 1997, a state-level effort to develop public health measures based on scientific knowledge regarding exercise for older adults was initiated by the Michigan Governor's Council on Physical Fitness, Health and Sports. The position statement "The Importance of Physical Activity for the Elderly"[32] suggested public health measures, including appropriate physical activity programs, to improve and maintain healthy lifestyles in the elderly based on current information in the literature. While this effort was directed toward the state level, it drew national attention.

In 1998, the National Institute on Aging (NIA) launched a national education campaign for staying physically active after the age of 50 years, in cooperation with the National Aeronautics and Space Administration and the U.S. Public Health Service's Office on Women's Health in the Department of Health and Human Services. As part of this effort, a lay book was published, titled Exercise: A Guide from the National Institute on Aging, as a reference to older Americans on how to improve their health and well-being through habitual physical activity. Also in 1998, the American College of Sports Medicine published their position stand on the importance of regular physical exercise for older adults titled "Exercise and Physical Activity for Older Adults."[33]

This document provided scientific evidence on the various physiological and psychological benefits of regular exercise for older adults. For the purpose of this paper, physical activity is defined as any body movement resulting from skeletal muscle contraction and resulting in increased energy expenditure. Physical activity can be obtained through a variety of leisure time and occupational pursuits. In contrast, exercise refers to activities that are planned, structured, and performed routinely. Exercise training implies a systematic effort to enhance physical fitness resulting from biochemical and physiologic adaptations that improve the body's functional capacity, efficiency, muscular endurance, and range of motion. These enhancements can occur regardless of the initial fitness level and age of an individual. Improvement in physical fitness is assessed by measuring peak oxygen intake ($\dot{V}O_2$ max), referred to as aerobic capacity. Repeated episodes of aerobic exercise (usually involving sustained, dynamic contractions of large muscle groups) improve muscular endurance and strength while simultaneously improving the functioning of the cardio-respiratory system. In contrast, resistance exercise/weight training (involving lifting heavy weights) increases muscular strength and endurance but has less effect on improving cardiorespiratory efficiency.

Aging is generally associated with steady decreases in muscle strength and muscle mass, often resulting in reduced functional capacity, physical frailty and impaired mobility. For example, between the ages of 30 and 70, $\dot{V}O_2$ max declines by 0.40 to 0.45 ml/kg/min/yr [38-40] and maximum physical work capacity declines by 25-30%.[41-46] Loss of strength in healthy older individuals has been estimated at 1.5% per year, and loss of power at approximately 3.5% per year.[47] Many of the pathological and morphological changes attributed to the aging process are identical to those seen with a sedentary lifestyle.[7,48] Because physical training has such a pronounced effect on the cardiovascular, respiratory, endocrine, musculoskeletal, and immune

systems, such training has the potential to attenuate and even reverse the cardiovascular, metabolic, and musculoskeletal deterioration associated with the aging process. For example, moderate endurance-type exercise training by previously sedentary men and women generally augments the V˙O2 max by 10-30%. This level of improvement is equivalent to nearly a 20-year functional rejuvenation; the improved aerobic capacity approximates that of an untrained individual who is 20 years younger.

Older individuals who have remained active throughout their lives maintain much of their physical strength, endurance, and stamina. Relative to the sedentary older person, the individual who is habitually active has greater lean body tissue, a lower percentage of body fat, and greater bone density. The older individual who is physically active is better able to perform activities of daily living and, in general, has a better quality of life. Results of major epidemiological studies have shown that engaging in physical activity effectively enhances longevity.[49,50] For older adults with medical problems and physical limitations, exercise programs are particularly important. For such persons, highly individualized programs should be designed to maximize safety during physical activity and exercise.

Prescribing Exercise: Frequency, Intensity and Duration Factors

Clinical prescriptions for exercise include recommendations for the frequency, intensity, and duration of activity. In 1998, the American College of Sports Medicine published exercise prescriptions for adults titled “Position Stand on the Quantity and Quality of Exercise for Developing and Maintaining Cardiorespiratory and Muscular Fitness and Flexibility in Adults.”[51] This document stressed the importance of including aerobic, resistance, and flexibility exercises in an optimal training program for maintaining muscular strength, endurance, and flexibility of major muscle groups for all adults. In the area of aerobic exercise, it was recommended that aerobic endurance training be performed more than two days per week, at an intensity greater than 40-50% of maximal aerobic power (V˙O2 max), and for 10 minutes or more. To gain additional benefits of cardiovascular fitness, it was recommended that an individual exercise 3-5 times per week at 55-90% of maximum heart rate (HR max) or 40-85% of V˙O2 max for 20-60 minutes continuously. Importantly, it was recognized that exercise through the day in shorter bouts of 10 minutes could be sufficient stimulus for maintaining health and fitness. It was stated that lower activity levels, especially a lower level of effort that older individuals could perform, might reduce an individual’s risk of chronic degenerative diseases. A higher intensity of exercise was needed to derive the additional benefits of health, strength and stamina. Resistance training which included at least one set of 8-10 exercises that condition major muscle groups, performed in 8-12 (or even 10-15 repetitions for older adults) repetitions 2-3 days a week was sufficient to provide strength and prevent loss of muscle mass in most adults.

In regard to flexibility training (important in advancing age to prevent injuries), it was recommended that an individual stretch major muscle groups 2-3 days a week. While leisure-time physical activities have been highly recommended, their contribution to V˙O2 max in those aged 18-95 years is only minor.[52] Although the above recommendations describe appropriate exercise training goals for healthy older adults, modifications are needed for individuals who have been extremely sedentary for extended periods, are frail, or have chronic conditions.

Approaches to prescribing clinical exercise training programs for individuals over a wide spectrum of ability have been reported by Lampman.[53] In exercise prescriptions, intensity of effort can be expressed as a percentage of: maximum heart rate (HR max), heart rate reserve (HR reserve), V˙O2 max, and rate of perceived exertion (RPE). When formulating exercise prescriptions for older adults, it has been recommended that intensity of effort be expressed as HR max. This recommendation is based on research by Kohrt et al.,[54] showing that in healthy women aged 60-72 years, using HR reserve resulted in higher energy expenditure than expected.

Medications and Exercise

When a person who is taking medications begins an exercise program, it may be necessary to adjust either the medication dose or the exercise prescription. Attention to medication dosage is particularly important if an individual loses weight because of the exercise program. Drug dosage is often based on body weight; significant changes in weight may turn a proper pharmacologic dose into an overdose. Older adults should always check with their physicians regarding their medications to learn of any possible contra-indications to exercise training. They should also immediately report to their physicians any adverse medical signs or symptoms when exercising.[55] Cardiac medications. Older patients are frequently treated with multiple cardiac medications. None of the cardiac medications preclude moderate physical activity.

However, many of them need to be taken into account for vigorous exercise. Some cardiac drugs suppress the heart rate. These include α- and β -blockers (Carvedilol, Labetalol), Class III antiarrhythmic agents (Cordarone), all β -blockers, and some calcium channel blockers (Verapamil, Diltiazem, and Bepridil).[55] Individuals taking these drugs should not be administered submaximal fitness tests that require the participant to exert up to a predetermined or calculated heart rate. Rather, they should receive medically supervised stress tests. These same individuals require specialized exercise prescriptions if they are using training regimens that are based on reaching and maintaining a specific target heart rate; the target heart rate should be lower than predicted by age alone.

β -blockers are prescribed for a number of cardiac conditions, including atrial fibrillation, hypertension, long Q-T syndrome, arrhythmia prophylaxis, and/or angina. Eye drops containing β -blockers are sometimes prescribed to treat glaucoma. Most of these drugs (nonselective β -blockers, β -1-selectives, or ones that possess intrinsic sympathomimetic activity) should not adversely affect the response to acute exercise or to physical training,[56-61] even if an older adult desires to be a competitive athlete.[62] However, these drugs must be taken into account if an exercise prescription is written because they reduce resting heart rate, maximal exercise heart rate, myocardial contractility, and blood pressure. β -blockers with sympathomimetic activity have more of an effect on exercise heart rate than resting heart rate, but may influence an exercise prescription if cardiac reserve is used in formulating the exercise prescription.β-blockers should not be withheld when a patient undergoes an exercise stress test. Because β -blockers may vary in their pharmacological effects during the day, it is optimal for exercise sessions to take place at a regular time of day and similar to the time that the standard exercise test was administered.[63]

Patients who are taking long-acting β-blockers or other drugs for hypertension may need to have a lower dose when they adopt exercise training, since training usually results in a lowering of both systolic and diastolic blood pressure, even without weight loss.[64-67]

Amiodarone (Cordarone), a commonly prescribed drug for patients with life-threatening arrhythmias, has been shown to significantly improve exercise time during standard exercise testing in patients with congestive heart failure,[68] increase left ventricular ejection fraction, and improve exercise capacity.[69] Dosing should not require modification with exercise training, but since the drug depresses heart rate, exercise prescriptions based on target heart rate require specialized attention. Patients with life-threatening arrhythmias should undergo medically supervised exercise stress testing before initiating an exercise training regimen.

Other cardiac drugs and many antiarrhythmic agents influence resting and exercise heart rates and must be considered when devising a patient's individualized exercise prescription.[70] Because the physiological response to acute exercise is complex, involving many organ systems, these medications may have metabolic or physiological effects that may limit endurance time while performing the moderate- to high-intensity physical activities of a competitive athlete.

Diuretics. Older patients prescribed diuretics should not exercise in conditions of extreme heat and should be checked periodically for low potassium blood levels, which may provoke life-threatening arrhythmias if significant increases in the frequency, intensity, or time of exercise are attempted. Because older adults tend not to adequately hydrate and will perspire when exercising, they should be instructed to drink ample water on a daily basis, and extra water when exercising.

Drugs for Diabetes. Many older adults are being treated for diabetes, especially type II diabetes. Exercise training can therapeutically lower serum glucose levels in those with type II diabetes, especially if weight reduction occurs simultaneously. Improved glycemic control through exercise training is best accomplished in individuals with fasting glucose levels less than 200 mg/dl.[71] Hypoglycemia with exercise may occur in a patient on insulin therapy but usually does not in those taking sulfonylureas.[72] Patients on insulin therapy who begin to exercise may need their insulin dosage adjusted downward to prevent hypoglycemia. Regular exercise often permits significant reduction or even complete elimination of the need for medication. Older individuals with type I diabetes may experience hypoglycemia after acute exercise. This condition can be corrected with immediate administration of oral glucose, but it is recommended that insulin dosage be adjusted for long-term glucose control with exercise training. Patients on insulin therapy should not acutely exercise if their blood sugars are below 120 mg/dl or above 250 mg/dl.[73]

Psychotropic Drugs. Drugs that affect mental state can induce heat intolerance.[74] It is recommended that individuals on these medications avoid prolonged exercise in hot/humid environments. Removal of psychotropic medication has been shown to reduce the risks of falling in older adults, especially if exercise is initiated. Campbell et al. [75] conducted a home-based exercise program along with psychotropic medication withdrawal in older adults. They found that subjects who stopped taking their psychotropic drugs and also exercised had a significantly reduced risk of falling as compared to those withdrawing medication but not exercising.

Drugs and Body Weight. Body weight changes can occur when taking certain medications.[76,77] Some antidepressive drugs, such as monoamine oxidative inhibitors, lithium, and tricyclics, may cause weight gain [78-81] while serotonin reuptake inhibitors (Prozac) may cause weight loss.[82]

Antipsychotic drugs can cause weight gain[83] as do many anticonvulsants.[84] Insulin therapy usually results in weight gain,[85] as does treatment with sulfonylurea agents,[86] corticosteroids,[87] and drugs to treat cancers[88,89] and migraines.[90-92] Exercise training may counteract excess body weight gains or may help to prevent loss of lean body mass associated with drug therapy. Ephedrine, a weight loss drug that is also found in some herbal remedies, can cause a hypertensive crisis and rapid heart rate with extreme exercise.

Mortality

Older adults who are physically fit and physically active outlive their more sedentary peers. A longitudinal study of adults aged [75-80] showed that poor physical capacity at baseline (measured by tests of walking speed, stair mounting, and muscle strength) was a strong predictor of mortality during a five-year follow-up in women and, to a lesser extent, in men.93 Hakim et94 al. studied 707 nonsmoking retired men (average age, 68.9 years) who were participants in the Honolulu Heart Program to determine the association between distance walked per day and mortality from any cause over a 12-year period. Results showed that those who walked less than one mile per day had a mortality rate twice that of those who walked more than two miles per day. Those who walked more than two miles per day had a lower overall mortality rate as compared to similar men less active. The cumulative mortality rate after 12 years for those walking the most was reached by the least active walkers in less than seven years. Cancer deaths were statistically lower for those walking more than two miles per day.

Prevention of Disabilities

Older adults often value the quality of life more than the quantity of life.[95] In 1997, chronic conditions limited activities for 30% of adults aged 65-74, and for over half of adults aged 75+. Disability, defined as having problems performing two or more activities of daily living, has a major impact on the quality of life in older adults. In 1994-95, 52.5% of adults aged 65 and older reported at least some disability, and 33.4% reported having severe disability. Disabilities become more prevalent with advancing age; 71.5% of those age 80+ report at least one disability.[96]

Aging successfully until death without major disabilities appears directly associated with physical activity patterns of the older adult. Sarkisian and colleagues[97] identified modifiable predictors of functional decline that often lead to disabilities in women aged 65+ who were residing in a free-living community. The major predictors of functional decline included use of short-acting benzodiazepine, depression, obesity, low exercise level, and slow gait. All of these predictors are amenable to exercise intervention.

One cross-sectional study of 1,002 disabled women aged 65+ years[98] showed an inverse association between disability and reported physical activity. Furthermore, this study showed that those who were physically inactive had lower muscle strength and that lower muscle strength was also correlated with a greater degree of disability. Rantanen et al.[99] showed that

poor knee extension strength and poor balance were independent predictors of severe walking disability. Vita et al.100 used a questionnaire to assess disability in individuals with a mean age of 43 years, and again when the mean age was 75 years. People who were the most active in midlife and late adulthood aged more successfully—without disabilities or becoming institutionalized. Leveille et al.[101] found that those who remained physically active after 65 were twice as likely to die without a major disability than those who remained sedentary. Ferrucci et al.[102] reported that those aged 65+ years who were physically active survived longer and had fewer years of disability, even among smokers.

In a different study, Ferrucci et al.[103] showed that severe disabilities in individuals at least 70 years old, whether they develop gradually or rapidly, often lead to hospitalization. The oldest patients receive less intensive hospital care and are more often discharged to nursing homes. The authors conclude that exercise interventions initiated when elders are hospitalized could greatly reduce the severity of disabilities and the number of nursing home admissions.

Rozzini et al.[104] found that cognitive deterioration and depression were independently associated with disability in a free living, older (70+ years) population. They also found that a physical performance test could be more sensitive in the early detection of functional limitations than activities of daily living disability scales.

Disabled older people often do not have adequate lower limb strength to walk at a speed of 1.22 m/sec-1 that is necessary to safely cross signaled intersections. Rantanan et al.[105] tested strength using a handheld dynamometer and also measured maximum walking speed over a 4-m distance. Results suggested that strength testing might be a valuable method for identifying individuals at risk of impaired walking who would benefit most from strengthening exercises of the lower limbs. Older individuals with disabilities may have poor walking behavior not only due to the severity of walking difficulty but also due to health, socio-cultural, and psychological factors.[106] These findings stress the importance of addressing socio-cultural and psychological factors when formulating community exercise programs.

Body composition can influence mobility-related disability in both women and men aged 65-100. A cross-sectional analysis[107] showed at baseline a positive association between body fat mass (assessed by bioelectrical impedance) and disability. Three years later, the people who initially had no disabilities who had the highest body fat mass were most likely to have developed disabilities. While excessive body fat mass is associated with disabilities and is predictive for developing mobility-related disabilities within three years, a low skeletal muscle mass may not be associated with physical disability in the older adult.[107,108] Avoiding excessive accumulation of body fat while aging may protect against mobility-related disability.

There is a need for additional research to identify risk factors that predict disability and research to test interventions to determine whether they can reduce the burden of disabilities experienced by older adults. This is especially important for women. Major disabilities are more prevalent in older women as compared to men of the same age.[109] Women seem to have a higher rate of decline in functional capacity, leading to a higher prevalence of disabilities, and women survive longer with their disabilities.[110] Because declines in functional capacity are highly associated

with disabilities,[110] treatment strategies for older adults that improve functional capacity are necessary to enhance their ability to live independently.

Cardiovascular Benefits

For cardiovascular health, exercise benefits older adults as much as or more than it helps younger people. Cardiovascular adaptations to exercise training occur in older adults and do not appear to differ over a large age range. Not only can the declines in V˙O2 max associated with aging be attenuated by exercise, but also improvements following exercise can surpass those found in younger athletes. Stratton and colleagues[111] studied the effects of exercise training on men across a large age span. They observed increases in cardiac ejection fraction, stroke volume index, and cardiac index at peak exercise for most subjects. Improvements in physical work capacity in men aged 60 to 82 were similar in magnitude to improvements realized by men aged 24 to 32. Sheldahl and colleagues[112] reported that the physiologic adaptations to aerobic training in older individuals are similar to those changes seen in middle-aged healthy men. During their study, older individuals in training did not experience any orthopedic injuries associated with their exercise program and showed greater interest than the younger men in long-term participation and supervised aerobic training. Aerobic exercise performed by the aged has resulted in increased maximal voluntary ventilation, increased arterial-venous oxygen difference[113] and stroke volume,[113-116] lowered vascular resistance, and improved left ventricular performance.[117]

Augmented cardiac output with training is primarily due to an increase in stroke volume, the major hemodynamic change observed in older persons when they exercise. Schulman et al.[118] studied 10 sedentary men undergoing regular exercise for 24-32 weeks and eight older endurance-trained athletes who stopped training for 12 weeks. Their age range was 58-62 years. Those individuals who trained improved their cardiovascular function and those who detrained lost cardiovascular function. The gains in cardiovascular function with training were similar in magnitude to the losses in function with detraining.

The mechanisms responsible for a decreased cardiac function found with aging have not been clearly delineated. The diminished chronotropic and inotropic response to catecholamine stimulation associated with aging appears due to alterations in postreceptor adrenergic signaling transduction that is partially attenuated by exercise.[119] Exercise training reduces the QTc interval in those aged 60-80 years, suggesting an increased parasympathetic activity resulting in a more favorable autonomic balance.[120]

Hypertension

Hypertension is a silent killer that is linked to many cardiovascular complications such as left ventricular hypertrophy, hemorrhagic stroke, retinopathy, aortic aneurysm and dissections, and renal failure. Epidemiologic studies[121] have shown that the risk of developing hypertension is closely related to being sedentary. The sedentary lifestyle common among older adults may well be predisposing this population segment to hypertension and its sequelae. Among men who attended Harvard University, those who participated in sports during college years were less likely to develop hypertension later, and those engaged in vigorous sports during mid-life had a relatively low risk of developing hypertension. Other research with women showed that physically active women aged 55 to 69 years had a 30% lower risk of developing hypertension.

Those who have developed hypertension can benefit also from engaging in physical activity. In a meta-analysis of 47 studies assessing the effects of endurance exercise on individuals with essential hypertension, Hagberg[64] found that exercise training reduced systolic and diastolic blood pressure by 10.5 mm Hg and 8.6 mm Hg, respectively. A recent randomized study involving hypertensive older men being treated medically for hypertension showed that moderate intensity physical training provided an additional anti-hypertensive effect on both systolic and diastolic blood pressure in these patients.[65] Even low intensity physical effort has been shown to cause declines in blood pressure,[66,67] making exercise an especially appropriate intervention for older individuals.

Stroke

While stroke is the third leading cause of death in the United States,[125] research is limited regarding the benefits of exercise in preventing stroke. It is reasonable to expect that exercise would reduce risk of stroke because physical activity reduces risk of one of the primary antecedents of stroke: hypertension (see above). However, the few studies that have examined direct associations between exercise and stroke do not uniformly show the inverse association expected. Some examples of research supporting a preventive role of exercise in stroke incidence follow. Kannel and Sorlie,[126] studying men aged 35 to 64, showed an inverse association between physical activity and a 14-year incidence of cerebrovascular accidents. Paffenbarger and colleagues[127] also showed an inverse association between physical activity and death due to stroke. Most studies of exercise and stroke do not distinguish between ischemic stroke and hemorrhagic stroke. A recent report which did make that distinction found a protective effect of exercise: Abbott and colleagues,[128] studying men aged 45-68 years with a 22- year follow-up, showed that sedentary men had a higher incidence of hemorrhagic stroke when they were compared to physically active men. Furthermore, a reduced risk of ischemic stroke was found in physically active smokers when compared to inactive smokers.[128]

In the National Health and Nutrition Examination Survey I (NHANES I) Epidemiologic Follow-up Study, conducted over an 11.6-year period, the relative risk for stroke in those aged 45-74 years was determined based on reported levels of low, moderate, or high physical activity.[129] Low non-recreational physical activity was associated with an increased risk of stroke in white women aged 65-74 years, even after adjustment was made for baseline risk factors. An increased risk was seen also in men, blacks, and women reporting low recreational activity. Recent evidence from the Nurses' Health Study[130] (72,488 female nurses aged 40-65 years) provided convincing evidence that moderate intensity walking was associated with a reduced risk for total and ischemic stroke. These findings are of particular importance as the relationship between physical activity and the risk for stroke has not been well characterized in women. Results of this study also showed an additional benefit from more intensive exercise: those performing brisk or stride walking pace had a substantially lower risk of stroke than women walking at an average pace.

The concern that acute exercise might cause dangerous changes in blood-clotting factors in older hypertensive men was addressed by DeSouza et al.[131] This group reported a normal fibrinolytic response to acute exercise in 12 hypertensive men with a mean age of 69 ± 1 year.

Risk Factors for Heart Disease

Physical activity has been shown in many studies to cause improvements in risk factors for heart disease. Risk factors for coronary artery disease escalate with aging.[132-138] These risk factors include increases in total serum cholesterol, low-density lipoprotein cholesterol and triglycerides; low levels of high-density lipoprotein cholesterol; reduced glucose tolerance; hypertension, obesity and physical inactivity. The Cardiovascular Health study investigated risk factors associated with mortality risks in men and women aged 65 years and older in four U.S. communities. Lack of moderate or vigorous exercise was independently associated with mortality.

Many of the other independent risk factors such as hypertension, diabetes, and frailty found in this study could be favorably influenced by exercise. Epidemiologic evidence from both observational and randomized clinical studies identifying risk factors for coronary heart disease was reviewed by Corti et al.[138] Physical inactivity was found to be a highly prevalent independent risk factor of coronary heart disease in older men and women.

A cross-sectional study by Seals and colleagues[140] showed that master athletes (age 55 and older) had favorable plasma lipid and lipoprotein profiles, consistent with very low risk for coronary artery disease. In an intervention study by Binder and colleagues,[141] healthy, postmenopausal women received either 11 months of exercise training, hormone replacement therapy or both therapies to determine the effects on serum lipid and lipoprotein fractions. Results of this study showed that both interventions produced favorable alterations in certain lipid and lipoprotein fractions, but that the combined therapies were necessary to optimize reduction of overall cardiovascular risk factors. Improvements in insulin sensitivity, triglycerides and high density lipoprotein cholesterol levels, similar to those found in younger individuals, were noted in persons beyond age 60 who participated in an aerobic training program.[142] Among healthy older males aged 60-75 years who engaged in habitual physical activity, in vivo insulin sensitivity was closely associated with V˙O2 max.[143] Among men and women aged 65 years and older, walking more than four hours per week was associated with a reduced risk of hospitalization for cardiovascular disease.[144] A metaanalysis[145] of epidemiological studies showed a summary relative risk of death from coronary heart disease of 1.9 (95% CI, 1.6-2.2) for physically inactive compared to physically active individuals. Hakim et al.[146] investigated the effects of walking on the risk of coronary heart disease in 2,678 physically active men aged 71 to 93 years over a 2-4 year period. Those who walked less than 0.25 miles per day had a two-fold increased risk of coronary heart disease as compared to those who walked more than 1.5 miles per day. Men who walked between 0.25 to 1.5 miles per day were also at greater risk for coronary heart disease as compared to those walking longer distances. For every 0.5 mile walked per day the risk of coronary heart disease was reduced by 15%.

Patients with type II diabetes, aged 55-75 years, undergoing a 26-week exercise program, at an intensity of 60- 80% V˙O2 max three times per week, showed improvement in V˙O2 max, total triglycerides, VLDL-triglycerides, apolipoprotein B and total cholesterol levels but did not improve glycemic control or insulin sensitivity.[147] These studies support the contention that regular exercise and other forms of physical training can provide health benefits by reducing the risk of morbidities and mortality from cardiovascular and other chronic diseases.

Peripheral Arterial Disease

Claudication is a form of pain that occurs during walking. It is caused by advanced peripheral vascular occlusive arterial disease, and it becomes more disabling as patients age. Regensteiner and Hiatt[148] demonstrated that patients with peripheral vascular occlusive arterial disease who were treated with exercise training showed major improvements in their walking ability, their pain-free walking times, and their peak oxygen consumption, without exaggerated heart rate and blood pressure responses. Tinetti and colleagues[149] showed that a multifactorial intervention program—proper medications, behavioral changes, and exercise—was extremely beneficial for older patients with intermittent claudication. In a review article, Regensteiner et al.[150] summarized research showing that exercise rehabilitation improved maximal walking distance by 25-442% and pain free distance by 44 to 300% in older patients. Clearly, walking therapy is the major treatment for patients with peripheral vascular disease. Because most individuals with peripheral arterial disease often have many comorbidities (i.e., diabetes, coronary heart disease, hypertension), this patient population is one that can benefit substantially from routine exercise.

Cardiac Rehabilitation

The prevalence of advanced coronary artery disease increases with aging;[151] and the major cause of death in older adults is ischemic heart disease.[125] Exercise rehabilitation following an uncomplicated myocardial infarction has been shown in older adults to improve functional capacity, lipid profiles, obesity indexes, behavioral characteristics, and quality of life.[152,153] Unfortunately, however, it is known that those over the age of 60 (both men and women) with a myocardial infarction or angina often decline involvement in cardiac rehabilitation.[154]

Cardiovascular parameters were compared between a non-exercising healthy older group and a similar group of coronary patients undergoing cardiac rehabilitation.[155] While the control group showed no changes in these parameters, the cardiac rehabilitation group showed greater increases in physical work capacity. Older patients (65 years and older) who have undergone successful coronary artery bypass grafting have been shown to benefit greatly from a cardiac rehabilitation program. Williams and colleagues[156] reported that older patients undergoing cardiac rehabilitation improved their functional capacity in a manner similar to that of younger patients, reduced their body fat mass and had few adverse effects from exercise training.

Muscle Strength

The deterioration of muscle strength and functional capacity found in older adults may not be entirely a result of aging. Instead, muscle weakness and functional declines may stem largely from muscle disuse of a sedentary lifestyle.[48] A five-year longitudinal study was conducted to investigate natural changes in maximal isometric strength with ordinary everyday physical activity.[157] Fifty-five men and 111 women having a mean age of 75 years at baseline participated. Those remaining active doing household work, walking and gardening retained their strength at a higher level as compared to those that remained sedentary or decreased their activity. Those found to be weak at baseline showed high death rates over the five-year period.

Muscle weakness is characterized by structural and physiological changes. Contributors to muscle loss are decreased anabolic hormone secretions and neuromuscular changes with age-related decreased synthetic rates of specific muscle proteins. Muscle weakening with aging

results from a decrease in type II muscle fibers, which probably accounts for the diminution of muscle strength in older adults.[158-160]

Changes in mitochondria structure and distribution are linked to losses of oxidative activity[161-163] and may be a major factor in the reduced ability of older adults to perform endurance activities. Measures of intracellular threshold to assess muscle oxidative capacity showed a lower metabolic response to acute exercise in older (mean age = 66.7 years) as compared to moderately active young individuals.[164]

The muscle wasting that typically accompanies aging can be attenuated or reversed through strength training and aerobic exercise. Animal studies have shown that aerobic training can increase oxidative capacity and facilitate related improvements in the health and function of older muscle tissue.[165-167] Many human studies have shown the same thing. Healthy older women undergoing a 16-week resistance exercise program improved their strength, walking velocity, and ability to perform daily tasks.[168] Isokinetic strength in persons over 75 years of age improved with resistance training using simple equipment.[169]

Knee extension strength is an objective means for assessing an older adult's ability to live independently as it is linearly associated with walking speed in older adults, even in those considered most disabled.[170] Knee extension strength is also associated with the ability to mount a certain step height necessary to climb stairs.[171]

Isometric knee extension strength and walking speed were improved both by resistance training and by aerobic exercise (track walking and step aerobics) performed for 18 weeks by 76- to 78-year-old women.[172] Relative to the training methods, strength training resulted in a mean improvement of 19.1% in knee extension strength, whereas the aerobic exercise group showed a 30.9% improvement.

Even the most frail can benefit from an exercise program. High-intensity resistance training has been shown to improve muscle strength and to reduce fatigue and pain in older, physically frail individuals.[173] A 12-week exercise program consisting of both moderate to high resistance training for the lower extremities and stationary cycling (aerobic exercise) was effective in improved gait and balance in older male nursing home residents.[174] Brill and colleagues[175] conducted a successful 11-week strength and flexibility program for elderly nursing home residents with dementia, which greatly improved strength and flexibility in participants. Importantly, the benefits of exercise can be achieved without exacerbating disease activity or joint discomfort associated with rheumatoid arthritis.[176]

While resistance training results in marked improvements in muscle strength, the combination of resistance training and multi-nutrient supplementation appears superior over resistance training alone for improving muscle strength and remodeling and functional adaptation in older adults aged 72-98 years.[160] The regenerative potential of skeletal muscle and muscle mass are associated with growth factor and insulin-like growth factor (IGF-I), which are believed to be important regulators of skeletal muscle growth.[177] Strength exercises performed by older adult subjects, whether they were physically conditioned or not, resulted in increased total

and free IGF-I blood concentrations.[178] Discussion regarding hormonal factors and muscle strength are presented later in the text.

Falls

The leading cause of injury in individuals age 65 and over is falls, which often result in hospitalization and long-term disabilities, and can lead to a permanent loss of independence. Of those over the age of 65 years, 33% fall each year.8 About 9,000 of those people die from their fall-related injuries.[184] Of those that fall, the greatest number of deaths result from hip fractures.[185]

Major factors that are associated with falls in older adults include musculoskeletal and neurologic disabilities, difficulties in gait and balance, psychoactive medications, visual impairment, and dementia.7,186 Muscle weakness in individuals of advanced age places them at an increased risk for falls. Nevitt and colleagues conducted a prospective study to determine factors leading to injurious falls in old adults.[181] They reported that older adults who could protect themselves during a fall had a reduced risk of injury. Having strength in the upper and lower extremities reduced the risks of falling and injury.

Strength training is effective in increasing strength in upper and lower extremities. In a recent comprehensive review of the role of resistance training for health,[187] the President's Council on Physical Fitness and Sports recommended resistance training as a preventive measure against falls among older adults. Specifically, it was suggested that older adults perform resistance training exercises for 8-10 muscle groups, 2-3 days per week, using 8-15 repetitions of each exercise.

Arthritis and Osteoarthritis

Older patients with arthritis can greatly benefit from disease-appropriate exercise rehabilitation programs, gaining improvements in their general strength, range of motion, and joint function.[165] Exercise also has the potential to preserve or improve functional capacity and to reduce joint inflammation and pain.[188] A review of the literature by Van den Ende et al.[189] showed that those with rheumatoid arthritis benefitted from exercise therapy by increasing their aerobic capacity and muscle strength without causing detrimental effects on disease activity or joint comfort. These authors did point out, however, that long-term radiological studies on progression of the disease are necessary.

The low load joint activity of aquatic exercise makes it especially appropriate for those with rheumatoid arthritis or osteoarthritis. The Arthritis Foundation identified successful recruitment techniques for older adults into an aquatic exercise program, including recruitment letters to members of the Arthritis Foundation and local television coverage.[190] Noreau et al.[191] showed that dancing improved cardio-respiratory fitness levels in women with Class III rheumatoid arthritis and reduced depression, tension, anxiety, and fatigue as well.

Resistance muscle training is also an effective treatment for those with rheumatoid arthritis. Circuit training using light loads with high repetitions was performed by those aged 35-76 years over a 12-week period. As compared to controls, those that resistance trained showed improvements in joint count, nighttime pain, and sit-to stand time.[192]

Although exercise has been clearly shown to be beneficial to people with arthritis, Iversen et al. found that not all rheumatologists supported exercise training for their patients, especially aerobic exercise.[193] Patients were most likely to exercise if their rheumatologist believed exercise was useful, if the patient believed it was useful, and if the patient received social support for the exercise behavior. Brus et al.[194] studied the effects of patient education on compliance with treatment regimens and health among newly diagnosed patients with rheumatoid arthritis. They concluded that physicians caring for people with arthritis should stress the benefits of routine exercise. This is supported by the work of Kamwendo et al.[195] who found that although most patients felt that exercise is an important strategy, their perception of the benefits of exercise in their own daily life was affected by their own positive or negative experiences.

Some clinicians believe that lower extremity exercise may be detrimental to those with knee osteoarthritis. This belief was challenged by Mangione et al.[196] Adults with a mean age of 71 ± 6.9 years cycled on a stationary ergometer for 10 weeks either at a low or high intensity. Both approaches resulted in improved aerobic capacity and improved gait with reduced pain. Daly and Berman had similar results after placing older individuals with physical disabilities due to knee osteoarthritis on an exercise program.[197] Bautch et al.[198] also documented an absence of joint damage in people with knee osteoporosis after low-intensity weight-bearing exercise. They used biological markers of cartilage degradation (synovial fluid keratan sulfate and hydroxyproline) and the Arthritis Impact Measurement Scales to quantify exercise-induced changes. Improvements in health status occurred, pain levels were reduced, and biological markers did not show exacerbation of joint disease.

In a study where knee extensor and flexor muscle training improved isokinetic torques of these muscles, subjects reported a reduction in pain and an improvement in function as assessed by the Health Assessment Questionnaire.[199] A walking or strength training program performed over 18 months by older adults with knee osteoarthritis resulted in static postural stability.[200]

In the recently reported Fitness Arthritis and Seniors Trial (FAST), 439 individuals aged 60 and over with knee osteoarthritis and self-reported disability were studied.[201] This was a randomized study comparing resistance exercise, aerobic exercise, or a health education program. Results showed that either type of exercise program improved measures of physical performance, reduced pain, and reduced disability scores in older disabled individuals.

Long-term exercise training does not appear to contribute to excessive degenerative joint disease. In a study by Panush and colleagues,[202] radiological examination of the lower extremities of 17 male runners with a mean age of 56 years, and of 18 male non-runners with a mean age of 60 years, showed comparable values for osteophytes, cartilage thickness, and grade of degeneration. Runners in this study did not show an increased prevalence of osteoarthritis. Similarly, Lane and colleagues[203] found no increase in the prevalence of osteoporosis or osteoarthritis in veteran runners aged 50 to 72 years. These investigators compared 40 older adult long-distance runners to 41 similar aged non-runners, examining roentgenograms of the hands, the lateral lumbar spine, and the knees. The runners displayed a 40% greater bone mineral content of the first lumbar vertebra, with no group differences in joint space narrowing, crepitation, joint stability, or symptomatic osteoarthritis. The usual age-related reduction in total body calcium and total body

potassium has not been found in older marathon runners.[204]

Osteopenia and Osteoporosis

Throughout life, bone remodels itself by simultaneously forming new bone by osteoblasts and resorbing old bone by osteoclasts. With aging, it is typical for the rate of bone loss by resorption to exceed the rate of formation of new bone. In women, loss of bone occurs exponentially following cessation of estrogen production at menopause. This age-related demineralization of bone and increased bone porosity creates major problems for older adults in the forms of osteopenia (reduced bone strength and mass) and osteoporosis (bone fragility).[205-207] Osteoporosis increases vulnerability to fractures from minor falls, leading to hospitalization, institutionalization, loss of independence, and increased mortality.

Nationally it is estimated that 28 million Americans are affected by osteoporosis.[210] The National Osteoporosis Foundation estimates that 324,000 women and men in Michigan had osteoporosis in 1996, with an additional 628,000 having low bone mineral density. In Michigan in 2000, it has been estimated that there were 38,600 osteoporosis fractures, with an associated medical care cost of $410 million.[211]

Current recommendations for reducing risk of bone fractures in older adults include routine exercise, dietary supplementation with 800 IU/day of vitamin D and 1500 mg/day of calcium, and, when not contraindicated, estrogen replacement therapy.[212]

Inactivity may be a contributor to osteopenia and weakened bones, as reductions in muscle mass and bone mass parallel each other with aging. Skeletal disfiguration may result from bone and muscle loss.[213] Prevention of falls in those with osteoporosis is very important. For a person with osteoporosis, falls can cause severe bone fractures, especially in the wrist, spine, hips, and extremities, necessitating hospitalization and frequently leading to loss of independence through institutionalization. Physical activity can improve muscular strength, balance, and gait—all of which should help prevent falls in older osteoporotic individuals, thus preventing associated morbidity and mortality among vulnerable older adults.

Optimal training modalities for improving skeletal strength in childhood and through middle age are vigorous physical activity involving weight-bearing, resistance, and impact exercise. For older adults, skeletal strengthening to help prevent osteoporotic fractures can be achieved with impact activities (perhaps not as forceful as in younger individuals), strength training, and balance training (such as Tai Chi).[214]

Osteogenic exercises can be effective for improving musculoskeletal health in patients with osteoporosis. Exercise training can be an important factor in preventing bone loss and also serves as a stimulus in increasing bone mineral content. Exercise may maintain bone mass above the threshold for fracture. Review of the literature suggests that while both aerobic and resistance training can stimulate bone density throughout the body,[187] resistance training is more site specific.[215] Smith and colleagues[216] reported a 2.29% bone mineral increase in the radius of older women who exercised. Total body calcium increased in post-menopausal women participating in an exercise training program for one year, whereas it declined in a similarly aged sedentary group.[217]

Following an eight-month exercise program, older women showed a bone mineral increase of 3.5% in the lumbar spine.[218] In a study of women between 35 and 65 years of age who exercised for 45 minutes/day, three days/week, researchers found significant increases in bone mineral mass and in the width of the radius, ulna and humerus bones.[219] Because the greatest increases were in the radius and ulna as compared to the humerus, these investigators concluded that bones function in discrete units in response to exercise, with the greatest changes occurring in bones associated with active muscles or weight-bearing structures. The effects of exercise on bone mass, balance skill, and aerobic capacity were studied in women and men aged 40-70 years who had reduced bone mineral density.[220] Preisinger and colleagues[221] also found prescribed exercise effective in preventing bone loss in post-menopausal women. Nelson et al.[222] reported that high-intensity strength training for post-menopausal women was effective and feasible in reducing risk factors for osteoporotic fractures. Moreover, they showed that the strength training improved muscle mass, strength, and balance. Pollock and colleagues[223] showed that men and women 60 to 90 years of age who underwent six months of isolated lumbar training improved lumbar bone mineral density compared to controls. Menkes and colleagues[224] reported a significant increase in femoral neck bone mineral density in middle-aged to older men following 16 weeks of strength training.

Advanced osteoporosis is accompanied by the gradual development of skeletal disfiguration, called “dowager’s hump” or kyphosis. Kyphotic postural change is the most physically disfiguring and psychologically damaging effect of osteoporosis, and is often accompanied by chronic pain.[213] Loss of bone in the spine is an important determinant of deformity risk in both men and women.[225] Loss of muscle mass hastens the process. Disproportionate weakness in the back extensor muscles or loss of flexor strength considerably increases the risk of compressing porous vertebrae.[213]

Silman et al.[226] conducted a population survey study to determine the effect of regular levels of physical activity on the risk of vertebral deformity in 14,261 European men and women aged 50-79 years. Very heavy levels of activity early in life were associated with an increased risk of vertebral deformity in men, but not in women. In women, walking or cycling more than 1/2 hour per day was associated with a reduced risk of vertebral deformity. A proper exercise program can improve musculoskeletal health in osteoporotic patients and also can reduce the chronic pain syndrome and decrease depression.[213] For frail patients with advanced osteoporosis, changes in exercise practices should be medically supervised, to avoid increasing fracture risk.

Body Composition

The body is composed of two major compartments, the lean body mass that includes bones and organs and the adipose, or fat, mass. A loss of 25 to 30% of lean body mass is typically seen with aging, but weight is usually maintained by increased fat accumulation.[227-232] Some of the shift toward less muscle mass and more fat mass is attributable to age-related reductions in somatotrophic hormones such as growth hormone and insulin-like growth factor (see next section). However, a sedentary lifestyle accelerates lean body mass atrophy and accumulation of adipose tissue.

Older athletes have been shown to have less than 14% body fat, whereas their sedentary counterparts had 30% or more.[233] Previously active older persons who became sedentary increased their body fatness,[234,235] being 12 kg heavier than those continuing to exercise past the age of 55, and 7 kg heavier than those routinely exercising at 65 years.

Excess body fatness is considered obesity. Obesity has been associated with many debilitating diseases[236] and increased health risks.[237] For example, the NHANES I Epidemiologic Follow-up Study showed an increased risk of hypertension over a 10-year follow-up in white women aged 25-74 years with higher truncal obesity.[238] Obesity can often be successfully treated with appropriate physical activity programs.[239] Sidney and colleagues[233] found that just a mild level of activity, resulting in a caloric expenditure of 150-200 kcal per day, can increase lean body mass by 10% and decrease skinfold thickness by 17% in older subjects. Regular exercise, even without weight loss, can markedly improve cardiovascular disease risk factors.[240] Physical activity is an important component in weight loss programs[241] and for sustaining long-term weight loss.[242]

The association between body composition, assessed by bioelectrical impedance, and mobility-related disability (self-reported difficulty walking or stair climbing) was examined in 2,714 women and 2,095 men aged 65-100 years using information from the Cardiovascular Health Study.[107] Results suggested the importance of maintaining low body fatness as one ages because high body fatness was found to be an independent predictor in both older men and women of mobility-related disability.

Although high body weight is associated with a number of health and mobility problems, being heavy is protective when it comes to risk for osteoporotic bone fractures. Body muscle mass and fat mass were correlated with bone mineral density in a cross-sectional study (Framingham Heart Study) consisting of 504 women and 285 men with an age range of 72-93 years.[243] For both men and women, after adjusting for age, physical activity, estrogen, thiazide medications, and smoking status, people with increased muscle mass had greater bone mineral content. In women, but not men, those with higher percent body fat had higher bone mineral content.

Losing weight may also bode ill for risk of fractures. Weight loss and weight gain after the age of 50 was studied by Langlois et al.[244] to determine the relationship between changes in body weight and the risk of hip fracture in white men aged 67 years or older. Results showed a close association between extreme weight loss (10% or more of body weight) and increased risk of hip fracture, probably secondary to poor health. A weight gain of 10% or more was associated with a decreased risk for hip fracture. Body composition measures were not performed to note if the gain was primarily lean body mass.

Growth Hormone and Exercise Effects on Muscle and Bone

There is currently a great deal of popular interest in growth hormone (GH) as a “fountain of youth.” It is possible that one of the ways exercise exerts its positive impact on the aging process is by stimulating the body’s production of growth hormone. With aging, there is typically a decline in muscle mass and strength. Part of the decline is known to be caused by reduction in physical activity, but there are also corresponding age related declines in circulating levels of several hormones known to affect the rate of synthesis of muscle proteins— GH, insulin-like growth factors (IGF-I and IGF-2), testosterone, and dehydroepiandrosterone-sulfate

(DHEA).[245,246] The respective roles that exercise and the declines in these hormones may play in altering changes in skeletal muscle protein are not yet clearly understood.[247,248]

Studies have been done to identify independent effects of these hormones. For example, Rudman et al.[249] treated healthy men aged 61-81 years who had low IGF-I concentrations with six months of human GH or a placebo. Lean body mass increased and adipose mass decreased in those receiving GH. Similar results were obtained in a later study by Rudman et al.[250] where men over 61 years old who had low growth hormone secretion were treated with biosynthetic human growth hormone. Gupta et al.[251] administered GH to older men (aged 50-65) who suffered from postpoliomyelitis syndrome who also had low levels of serum IGF-I. In this case, serum IGF-I levels were raised but there were no improvements in muscle strength.

There is some evidence that exercise can modify GH secretion rates and the ability of IGF-I to promote muscle growth, although there are conflicting findings in some studies. Horber et al.[252] compared three groups of men (untrained young, untrained old, and trained old) to determine whether body composition changes with advancing age were related to inactivity or reduced growth hormone secretion. The old trained group consisted of men aged 67.4 ± 1.2 years that were physically capable of competing in a 16.5-km race. The old untrained had greater fat mass and lower lean mass than the untrained young or old trained group. The young untrained men had higher IGF-I levels than any of the old men, but the old trained had higher values than old untrained men. The authors concluded that body compositional and metabolic changes with advanced aging may be attenuated by regular physical training. Chadan et al.[253] supervised seven healthy 62- to 69-yearold women as they performed four bouts of physical activity on separate occasions at either a low or moderate intensity for either 25 or 50 minutes. GH levels were elevated immediately following the physical activity. Although IGF-I levels were not affected by any activity condition, circulating levels of two binding proteins for IGF-I did increase in response to moderate intensity exercise for 50 minutes, suggesting that exercise may cause the IGF-I that was present to be more biologically active.

Exercise also promoted the biological activity of IGF-I in the muscles of old female mice. Willis et al.[254] found that IGF-I did not stimulate protein synthesis in isolated in vitro soleus muscle preparation. Following acute exercise of the muscle, however, there occurred an increase in IGFI receptor messenger RNA, with an increased ability of IGF-I to stimulate protein synthesis. The same authors observed similar effects of long-term exercise when old female mice voluntarily exercised in a wheel.[255] The exercising mice were found to have an increased muscle mass, an increased IGF-I-stimulated rate of protein synthesis in their soleus muscle, and an increased IGF-I receptor mRNA.

Growth hormone has been studied in relation to improvements in muscle mass and strength that follow a resistance-training program. Kraemer et al.[256] compared endocrine changes with heavy resistance training in younger vs. older men. Following a 10-week heavy resistance-training program, strength and muscle cross-sectional areas were increased in both young and old subjects. Both age groups enhanced their hormonal profile in response to resistance training but the response pattern differed by age group. GH levels were not enhanced in either age group. In the young men, exercise training induced an increase in free testosterone and an increase in

resting IGF-binding protein-3. In older men, exercise training did not affect IGF-binding protein-3, but it did induce decreases in resting cortisol levels and increases in total testosterone.

Since GH administration increases muscle mass in individuals who are deficient in GH, some healthy subjects and athletes are interested in taking GH to increase their muscle mass and strength. Frisch[257] studied the effects of adding GH supplementation to a resistance training program by healthy older men and younger men. The improvements in muscle strength obtained by resistance exercise training were not enhanced by additional administration of GH. The larger increases in fat-free mass observed in the GH-treated groups were caused by fluid retention or accumulation of connective tissue, not by an increase in contractile protein.

Administration of GH has been shown to have positive effects on bone formation in both animals and humans. In old female rats, Oxlund et al.[258] found that mild exercise increased bone mineralization, and GH increased bone formation. The combination of exercise and GH resulted in a further increase of 39% in bone formation rate and a further increase in bone strength. Similarly, Mosekilde et al.[259] found that GH and exercise, when administered together to old female rats, had either an additive or synergistic anabolic effect on all bone sites studied. In humans, there is experimental evidence of an association between GH or IGF-I and bone mineral density. Among 682 older adults (72-94 years) studied in the cross-sectional Framingham Osteoporosis Study,[260] there was a positive correlation between IGF-I levels and bone mineral density at five different bone sites in women but not men after adjustment for other confounding variables. The results suggest that future clinical trials may be in order to test GH as a treatment for osteoporosis in older women.

The effect of heavy resistance exercise, alone or in combination with daily GH administration, was studied in 18 older men aged 67 ± 1 year having normal bone mineral density.261 The resistance training consisted of a 75-90% effort with 5-10 repetitions/set and four sets/day on four days/week for 16 weeks. The exercise program resulted in an increased bone mineral density but the administration of GH to those exercising did not cause an additional enhancement in whole body or regional bone mineral density. This lack of treatment effect by GH occurred even though there were GH-induced increments in serum IGF-I and osteocalcin suggesting a higher rate of bone turnover but not an increase in bone mineral accumulation in these older men.

Immune System

Aging typically is accompanied by a decrease in immune function, which in turn increases the risks for infection, tumor development, and auto-immune diseases.[262] The immune system is complex, consisting of numerous different types of cells and systems. With aging, the numbers of some types of immune cells decreases, and the functioning of some of the cells is dysregulated.[263,264] Some of the changes with aging that have been documented include decreased production of interleukin- 2 cells,262 decreases of total T-cell count,[262] changes in Tcell subsets,[262,265] reduced proliferative responses to mitogens,[262] reduced B-cell antibody production capacity,[264] partial replacement of virgin T-cells by memory T-cells, and signal transduction defects in circulating T-cells.[266] Natural killer T-cell activity apparently does not decline.[262]

It is well known that exercise causes shifts in the immune system. Moderate exercise has positive effects. During moderate-intensity aerobic exercise there is an immediate increase in white blood cells (leukocytes). The increase in leukocytes is proportional to the intensity and duration of the exercise performed.[267] Immediately after exercise, there is a characteristic decline in both leukocytes and monocytes to below resting levels, while circulating levels of neutrophiles continue to increase, peaking several hours postexercise. These changes persist for only a few hours with short-duration or moderate-intensity exercise. None of these changes have been shown to be detrimental to overall immunity. In fact, several randomized exercise training studies have demonstrated that moderate exercise (such as daily brisk walking for 45 minutes) is associated with a significant reduction in upper respiratory tract infections.[268,269]

The response to prolonged periods of intense training is somewhat different. Prolonged periods of intense training may lead to slight impairment in immune parameters such as neutrophil function, immunoglobulin levels, and possibly natural killer cell functioning,[270] and homeostasis may not be restored for up to 24-73 hours. Similar short-term impairments in immune parameters are observed in individuals performing exhaustive resistance exercises.[271] Both cortisol and catecholamines are believed to play a role in this physiological response.[272-274] The longer duration of detrimental changes in the immune system with extreme exercise is consistent with epidemiological evidence that intensive exercise done over extended time periods by competitive athletes is associated with increased susceptibility to upper respiratory tract infections.[270]

Natural killer lymphocyte cells are of interest because they can recognize and destroy foreign cells immediately without activation of other components of the immune system. Shephard and Shek[262] performed a meta-analysis to describe the effects of exercise on natural killer cells. In general, there was a marked increase in natural killer cell count at the end of exercise. Following exercise, cell counts dropped to less than half of normal levels for a couple of hours but, except in unusual circumstances (e.g., prolonged, intense, and stressful exercise), normal resting values are restored within 24 hours. If activity is both prolonged and vigorous, the decrease in natural killer cell counts and in their cell-destruction capacity may begin during the exercise session. Although the usual depression of natural killer cell count seems too brief to have major practical importance for health, there could be a cumulative adverse effect on immunity and health experience in athletes who perform very prolonged, intense exercise several times per week.[275]

Although most of the research on exercise and immunity has been done on young athletes, there is also experimental evidence of immunological benefits to exercise in older populations. Ferrandez and De la Fuente[276] examined the effect of moderate swimming exercise for 20 days in old and young mice. The moderate training exercise improved natural killer and antibody-dependent cellular cytotoxicity activity in both age groups. Gueldner et al.[277] studied a sample of 46 independently dwelling, ambulatory, and mentally alert women aged 60-98 years. The self-reported active subjects demonstrated significantly stronger immune response than those who reported themselves to be sedentary. Nieman et al.[278] supervised 32 sedentary, elderly Caucasian women, 67-85 years of age, in walking or calisthenics for 12 weeks. Twelve highly conditioned elderly women, 65-84 years of age, who were active in endurance competitions, were recruited for comparisons.

Twelve weeks of moderate cardio-respiratory exercise improved the V˙O2 max of the sedentary subjects 12.6%, but did not result in any improvement in natural killer cell activity or T-cell function. The highly conditioned elderly women in this study had superior NK and T-cell function when compared with their sedentary counterparts. Although there is not a large body of evidence proving that moderate exercise training will reverse effects of aging on the immune system, the preponderance of evidence suggests that such moderate activity will have beneficial effects. In two recent reviews of this evidence,[262,264] experts conclude that a single bout of moderate exercise is well tolerated by the elderly. Some moderate training programs in older adults have increased resting natural killer cell activity, have seemed to check age-related declines in T-cell function and, in fact, seemed to stimulate immune function to a greater extent than in young subjects.

A note of caution with regard to overexertion in the frail elderly was raised by one small study by Rincon et al.[279] Six frail males (70+ years) received an exercise intervention of increasing strenuousness for 60 minutes three times per week for three months in comparison with seven controls having no intervention. Cytotoxic activity of natural killer cells significantly decreased over the course of the study.

To reduce the small risk of detrimental effects, overexertion should be avoided, and attention should be paid to nutritional status.280 If an older adult decides to initiate prolonged exercise, foods with rich sources of zinc, Vitamin C, iron, and magnesium should be part of the diet, and carbohydrate beverages such as juice should be consumed immediately after exercise. Carbohydrate beverage ingestion by endurance athletes has been associated with fewer disturbances in blood immune cell counts.[281]

Cancer

Cancer is the second leading cause of death in the United States.[282] Epidemiologic studies have examined the relationship between cancer risk and sedentary living. At present, the only cancer for which prevention has been linked to habitual physical activity is colon cancer.[15] While there are studies suggesting that exercise may help prevent other types of cancer, further research is needed to clarify how regular physical activity may reduce the risks of developing other cancers, such as prostate, testicular, breast, ovarian, and endometrial cancers. From a treatment perspective, the positive effects of physical activity on mental health make regular exercise an important component of cancer therapy. Yoshioka[283] reported that terminal cancer patients who received exercise in a hospice facility believed it made an important contribution to their overall health care.

Psychological Health

Two of the major psychiatric disorders occurring in later life are depression and cognitive impairment. The prevalence of severe depression in older adults can be as high as 4% [284] and the occurrence has been reported higher for the elderly living in nursing homes as compared to those living in a community setting.[285] Depression is the second leading cause for health care costs and hospitalization in older adults.[286-288] Declines in functional capacity may contribute greatly to psychiatric disorders found in older adults. Poor physical health in older adults has been associated with poor mental health including more depression, increased anxiety, and reduced

levels of positive relationship and autonomy.[289] In comparison, those with good physical health and without functional impairment do not display symptoms of depression as they age.[290] Because those who exercise maintain functional capacity and a reduced risk for disease states, continued psychological well-being with aging may in part reflect good medical status secondary to maintained physical fitness. Conversely, elderly individuals reporting depressive symptoms have been found to be at high risk for subsequent physical decline.[291]

The prevalence of depression has been linked to physical inactivity. An epidemiological study[292] of 1,244 men and women aged 65 to 84 years found involvement in regular exercise for many declined as they aged. This was especially true for the women. Those individuals that were the most sedentary displayed a high prevalence of depression whereas those that were exercising regularly perceived themselves very well psychologically. Other cross-sectional studies have found similar results of an inverse relationship between physical activity and reduced symptoms of depression.[293,294] As these were cross-sectional studies, the authors could not detect a causal effect between physical activity and the absence of depression.

Other studies, however, do support a cause-and-effect relationship between physical activity and absence of depression. For example, Farmer et al.[295] conducted an eight-year longitudinal study of adults aged 25-77 years living in the community. They found that those reporting physical inactivity at baseline were more likely to have depressive symptoms at follow-up than those physically active at baseline. Physical inactivity was an independent risk factor for depression, even after controlling for educational background, income, employment, age and health-related confounding variables. Sedentary women were at especially great risk for developing high levels of depression as they aged. Similarly, Camacho et al.[296] studied the relation of physical activity and the risk of subsequent depression at baseline (1965) and follow-ups in 1974 and 1983. Those individuals not depressed at baseline and sedentary were more likely to be at risk for depression at both follow-up periods as compared to those reporting moderate to high levels of physical activity at baseline. Furthermore, individuals who were physically active at baseline but became sedentary over the study period developed similar depressive symptoms as those reporting inactivity at baseline. Results of this study suggest that improving exercise habits could markedly reduce the risk of developing depression in the future.

A cause-and-effect relationship between physical activity and mental health status is most convincingly demonstrated in intervention studies. Physical activity has consistently been shown to have positive effects on various measures of mental health status, including alleviation of depression symptoms and behavior, reduction of anxiety, improvement of mood, improved concept of personal control and self-efficacy, and preserved cognitive function. The most well-documented mental health benefits for individuals of all ages are those induced by aerobic exercise.[15] Such improvements have been demonstrated both in epidemiologic[295-299] and clinical studies.[300-311]

Intervention studies using exercise treatment for older subjects have shown mixed results but this may be due to the fact that subjects were not always diagnosed with depressive symptoms at baseline. In one reported study where depressed older individuals were randomly assigned to one of three groups—exercise, placebo (social contact), or control (waiting list)—symptoms were reduced in both the exercise and social groups but not the control group.[312] These results

demonstrate the importance of exercise as well as socialization for an antidepressive effect and suggest the importance of having older adults exercise in a social setting. In a study by Hassmen et al.,[313] mood was shown to improve equally whether men and women (mean age, 66 years) received exercise treatment or mental tasks. Although in this study the exercise group performed better on complex tasks than the group given mental tasks, the investigators concluded that the mood improvements might have been the result of routine socialization with other individuals.

Evidence exists demonstrating that physical activity can improve an older individual's concept of personal control, self-efficacy, resilience to stress, and sleep patterns.[314] Men aged 60 to 79 were shown to become more self-sufficient following a 14-week program of walking and jogging.[315] In another study, following a five- to six-week program of walking on a treadmill, male subjects aged 70 to 81 reported feeling healthier and more relaxed.[316]

Patterns of improvement in psychological well-being with exercise in the aged individual appear similar to patterns seen in younger persons.[317] As found in the young, older adults benefit from exercise training by reporting and showing decreased symptoms of depression, improved sleep, enhanced self-esteem, and feelings of greater energy.[318,319] To maintain the mental health benefits, Lampinen et al.[320] demonstrated that the exercise effort needs to be maintained throughout life. They found that, over an eight-year period, adults aged 65 years and older who reduced their intensity of physical activity had a greater risk of developing depressive symptoms.

Depression may alter an individual's adherence to a cardiac risk factor reduction program after an acute myocardial infarct.[321] For this reason, it may be prudent to have patients diagnosed with depression post myocardial infarction followed closely clinically and participate in a supervised cardiac rehabilitation program. Exercise programs are important for older adults following a myocardial infarction as it is known that many display a low level of physical exercise prior to their myocardial infarction and have symptoms of depression after their myocardial infarction.[322] Furthermore, depression following myocardial infarction, over all ages, is a significant predictor of mortality.[323]

Chronic (over six years) depression has been linked to an increased risk of cancer in those 71 years and older,[324] and since exercise training can improve mood in older adults, it is conceivable that exercise treatment for depression might also be beneficial in decreasing the risk of cancer. Depressive disorders have been associated with both cognitive function and subsequent reduced cognitive ability in older women,[325] and it is conceivable that exercise treatment for depression could improve cognitive function. Studies have shown that regular physical activity has a strong positive association with higher levels of cognitive performance on tasks such as math, acuity, and reaction time.[326-328]

Because it is known that several cognitive measures may decline with aging, van Boxtel et al.[329] studied aerobic fitness in those aged 24-76 years to determine whether those more physically fit found cognitively demanding tasks to be easier. These investigators found that cognitive speed requiring relatively large attentional resources was positively influenced by aerobic fitness in this cross-sectional aging study. Recent research has revealed a possible molecular basis for physical activity's role in enhanced cognitive function. Gomez-Pinilla and Kesslak[330] reported that

learning improved basic brain fibroblast growth factor messenger RNA in rats. When high activity levels were combined with learning, there was an increased expression of trophic factors in select brain regions.

Urinary Incontinence

Stress urinary incontinence is a condition where the urethral sphincter is unable to adequately prevent urine loss when a sudden increase in intra-abdominal pressure may occur, as it may with coughing or laughter.[331] This condition is fairly common in older adults, especially in older women.[332] While surgery can be a treatment, alternative therapy such as pelvic muscle exercises or Kegel exercises that train the pubococcygeus muscle can help alleviate this condition. When this muscle group is trained, it can exert a closing force on the urethra that effectively increases urethral resistance. Wells and colleagues333 compared pelvic muscle exercise to pharmacological treatment (phenylpropanolamine hydrochloride, 50 mg per day) for the treatment of stress urinary incontinence in 82 women aged 55 to 90 years. After six months of therapy, pelvic exercises were as beneficial as drug treatment in reducing stress incontinence. Others have also shown that pelvic muscle exercise is effective in the treatment of stress urinary incontinence in older women.[334-336]

Sexual Dysfunction

There is some evidence that regular physical activity can protect against the sexual dysfunction accompanying aging, but little research has been conducted in this area.
The prevalence and risk factors for erectile dysfunction were studied in 427 men over 40 years old in South Australia by Pinnock et al.[337] Seven domains of sexual function were examined. Sixty-four percent of those between the ages of 70-79 years old reported erectile dysfunction. Independent predictors of poor sexual function with aging were elevated triglyceride levels, use of blood pressure medications, and prostate surgery for non-cancer disease. Importantly, a history of vigorous exercise was protective against erectile dysfunction across all ages.

Important to all people in Michigan are public health programs that attenuate, prevent or postpone premature aging and its link to morbidity and mortality. Exercise training programs designed to retard the health deterioration associated with aging[338] should be essential components of Michigan's public health planning process. Such measures will improve elder citizens' current health status, prevent much of the increased morbidity and mortality associated with aging, and improve quality of life while reducing their needs for health care and human welfare resources in both the public and private sectors. An important public health goal is to achieve more physically active lifestyles among Michigan's older adult residents. Achieving this goal will improve the health status and quality of life for this quickly growing population, increasing the period of time individuals can remain contributing members of society. Additionally, more active older adults will have fewer needs for health care and human welfare resources. The policies developed to attain this goal must address both the behavioral and environmental barriers that interfere with or prevent Michigan's older adult residents from adopting more active lifestyles.

APPENDIX A

Physical Activity and Health: A Report of the Surgeon General[7]

Document Description

A New View of Physical Activity

This report brings together, for the first time, what has been learned about physical activity and health from decades of research. Among its major findings:

• People who are usually inactive can improve their health and well-being by becoming even moderately active on a regular basis.
• Physical activity need not be strenuous to achieve health benefits.
• Greater health benefits can be achieved by increasing the amount (duration, frequency, or intensity) of physical activity.

The Benefits of Regular Physical Activity

Regular physical activity that is performed on most days of the week reduces the risk of developing or dying from some of the leading causes of illness and death in the United States. Regular physical activity improves health in the following ways:

• Reduces the risk of dying prematurely.
• Reduces the risk of dying from heart disease.
• Reduces the risk of developing diabetes.
• Reduces the risk of developing high blood pressure.
• Helps reduce blood pressure in people who already have high blood pressure.
• Reduces the risk of developing colon cancer.
• Reduces feelings of depression and anxiety.
• Helps control weight.
• Helps build and maintain healthy bones, muscles, and joints.
• Helps older adults become stronger and better able to move about without falling.
• Promotes psychological well-being.

A Major Public Health Concern

Given the numerous health benefits of physical activity, the hazards of being inactive are clear. Physical inactivity is a serious, nationwide problem. Its scope poses a public health challenge for reducing the national burden of unnecessary illness and premature death.

APPENDIX B

Healthy People 2010: National Health Promotion and Disease Prevention

Objectives

Health objectives for the United States are spelled out in a document titled *Healthy People 2010: National Health Promotion and Disease Prevention Objectives*. The document is based on the 1996 Surgeon General's Report on physical activity[15] and a 1995 revision of *Healthy People 2000*.[22, 23] The goals of this national health promotion and disease prevention initiative are to achieve increased quality and years of healthy life and eliminate health disparities among the American population. Physical activity is listed as one of the leading health indicators that have a

major impact on the health of individuals and communities. The new focus of physical activity recommendations is on engaging in health-enhancing physical activities rather than high intensity physical exercise. *Healthy People 2010* also encourages physical activities that promote strength and flexibility for older adults, as they can be protective against disabilities, help ensure functional independence, and enable participation in regular physical activity.

Healthy People 2010 Objectives - Physical Activity in Adults

22.1 Reduce the proportion of adults who engage in no leisure-time physical activity:

• Those aged 45-64 years – 42% engage in no leisure-time physical activity
• Those aged 65-74 years – 51% engage in no leisure-time physical activity
Target – increase by 20%

22.2 Increase the proportion of adults who engage regularly, preferably daily, in moderate physical activity for at least 30 minutes per day:

• Those aged 45-64 years – only 14% engage in 30 minutes of activity five or more days per week.
• Those aged 65-74 years – only 16% engage in 30 minutes of activity five or more days per week.
• Those 75 years or older – only 12% engage in 30 minutes of activity five or more days per week.
Target – increase by 30%

22.3 Increase the proportion of adults who engage in vigorous physical activity that promotes the development and maintenance of cardio-respiratory fitness three or more days per week for 20 or more minutes per occasion:

• Those aged 45-64 years – only 21% engage in vigorous physical activity.
• Those aged 65-74 years – only 13% engage in vigorous physical activity.
• Those 75 years or older – only 6% engage in vigorous physical activity.
Target – increase by 30%

22.4 Increase the proportion of adults who perform physical activities that enhance and maintain muscular strength and endurance:

• Those aged 45-64 years – only 14% engage in strengthening and endurance exercises.
• Those aged 65-74 years – only 10% engage in strengthening and endurance exercises.
• Those 75 years or older – only 7% engage in strengthening and endurance exercises.
Target – increase by 30%

22.5 Increase the proportion of adults who perform physical activities that enhance and maintain flexibility:

• Those aged 45-64 years – only 28% engage in stretching exercises.
• Those aged 65-74 years – only 24% engage in stretching exercises.
• Those 75 years or older – only 22% engage in stretching exercises.
Target – increase by 43%..

Healthy People 2010 Objectives – Access
22.12 (Developmental) Increase the proportion of the nation's public and private schools that provide access to their physical activity spaces and facilities for all persons outside of normal school hours (that is, before and after the school day, on weekends, and during summer and other vacations).

23.13 Increase the proportion of worksites offering employer-sponsored physical activity and fitness programs.
Target – increase by 75%

23.14 Increase the proportion of trips made by walking.
• Those aged 45-64 years – only 14% made trips of one mile or less by walking.
• Those aged 65-74 years – only 16% made trips of one mile or less by walking.
• Those 75 years or older – only 19% made trips of one mile or less by walking.
Target – increase of 47%..

23.15 Increase the proportion of trips made by bicycling.
• Those aged 45-64 years – only 0.3% made trips of five miles or less by biking.
• Those aged 65-74 years – only 0.3% made trips of five miles or less by biking.
• Those 75 years or older –only 0.1% made trips of five miles or less by biking.
Target – increase off 2%..

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For Physical Activity for Older Adults

Select the ***best*** answer to each of the following items. Mark your responses on the Answer Form.

1. Lack of _____ most certainly contributes to premature deaths, needless infirmity, and loss of independence for significant segments of our aging population.

a. health care funding
b. good nutrition
c. physical activity Examination
d. None of the above

2. Physicians, health care professionals, and auxiliary health care workers should be knowledgeable regarding the benefits of physical activity for older adult patients. They should be aware of the many _____ of regular exercise so they can provide appropriate counseling to older adults and their family members.

a. physical
b. physiological
c. psychological benefits
d. All of the above

3. Performing regular physical activity is a valuable health practice for older adults. It can prevent or minimize chronic health problems and increase functional ability.

a. True
b. False

4. Exercise programs, including _____, can markedly improve endurance, strength, balance, and flexibility, all of which progressively decline with aging, especially in those who are physically inactive.

a. stretching
b. range of motion
c. aerobic activity
d. All of the above

5. An awareness of the importance of exercise for older adults should be reflected in planning and designing community facilities, including _____ and other public facilities.

a. shopping malls
b. community centers
c. recreation centers
d. All of the above

6. Regional fitness councils and local public health agencies should encourage private institutions and commercial enterprises to promote exercise for older adults and to provide space for older individuals who wish to exercise in group settings.

a. True
b. False

7. The so-called aging of America is a well-known phenomenon. Throughout the 20th century, both the average age and the life expectancy of Americans have steadily increased. Since 1900, the percentage of Americans age 65+ more than tripled. As of 1999, one in eight Americans (34.5 million people) were age 65+. By 2030, it has been estimated that one in _____ Americans (over 70 million) will be age 65+.

a. seven
b. six
c. five
d. three

8. Regular physical activity exerts beneficial effects on the functioning of the _____ systems. In so doing, it greatly reduces risk factors for coronary artery disease, the nation's leading cause of death.

a. cardio-respiratory
b. metabolic
c. immune
d. All of the above

9. A sedentary lifestyle, as practiced by such a large proportion of older adults, has clearly been shown to be associated with more medical problems than are seen in more physically active individuals.

a. True
b. False

10. Aging is generally associated with steady decreases in muscle strength and muscle mass, often resulting in reduced functional capacity, physical frailty and impaired mobility. For example, between the ages of 30 and 70, V˙O2 max declines by 0.40 to 0.45 ml/kg/min/yr 38-40 and maximum physical work capacity declines by _____%.

a. 10-15
b. 25-30
c. 30-45
d. None of the above

11. Moderate endurance-type exercise training by previously sedentary men and women generally augments the V˙O2 max by 10-30%. This level of improvement is equivalent to nearly a 20-year functional rejuvenation; the improved aerobic capacity approximates that of an untrained individual who is 20 years younger.

a. True
b. False

12. When a person who is taking medications begins an exercise program, it may be necessary to adjust either the medication dose or the exercise prescription. Attention to medication dosage is particularly important if an individual _____ because of the exercise program.

a. becomes forgetful
b. loses weight
c. becomes fitter
d. None of the above

13. Most drugs for the elderly (nonselective β-blockers, β-1-selectives, or ones that possess intrinsic sympathomimetic activity) should not adversely affect the response to acute exercise or to physical training, even if an older adult desires to be a competitive athlete. However, these drugs must be taken into account if an exercise prescription is written because they reduce _____.

a. resting heart rate
b. maximal exercise heart rate
c. blood pressure
d. All of the above

14. Amiodarone (Cordarone), a commonly prescribed drug for patients with life-threatening arrhythmias, has been shown to significantly improve exercise time during standard exercise testing in patients with _____.

a. congestive heart failure
b. increased left ventricular ejection fraction
c. improve exercise capacity
d. All of the above

15. Older patients prescribed diuretics should not exercise in conditions of extreme heat and should be checked periodically for low potassium blood levels, which may provoke life-threatening arrhythmias if significant increases in the _____ are attempted.

a. frequency
b. intensity
c. time of exercise
d. All of the above

16. Ephedrine, a weight loss drug that is also found in some herbal remedies, can cause a hypertensive crisis and rapid heart rate with extreme exercise.

a. True
b. False

17. Major factors that are associated with falls in older adults include musculoskeletal and neurologic disabilities, _____.

a. difficulties in gait and balance
b. psychoactive medications
c. visual impairment
d. All of the above

18. Aging typically is accompanied by a decrease in immune function, which in turn increases the risks for _____.

a. infection
b. tumor development
c. auto-immune diseases
d. All of the above

19. Claudication is a form of pain that occurs during walking. It is caused by advanced peripheral vascular occlusive arterial disease, and it becomes more disabling as patients age.

a. True
b. False

20. Older patients with arthritis can greatly benefit from disease-appropriate exercise rehabilitation programs, gaining improvements in their general strength, range of motion, and joint function.

a. True
b. False