The Effects of Exercise on the Elderly Population: A Literature Review

Angela M. Thoreson
University of North Dakota

Follow this and additional works at: https://commons.und.edu/pt-grad

Part of the Physical Therapy Commons

Recommended Citation
https://commons.und.edu/pt-grad/441

This Scholarly Project is brought to you for free and open access by the Department of Physical Therapy at UND Scholarly Commons. It has been accepted for inclusion in Physical Therapy Scholarly Projects by an authorized administrator of UND Scholarly Commons. For more information, please contact zeinebyousif@library.und.edu.
THE EFFECTS OF EXERCISE ON THE ELDERLY POPULATION:
A LITERATURE REVIEW

by

Angela M. Thoreson
Bachelor of Science in Physical Therapy
University of North Dakota, 1997

An Independent Study
Submitted to the Graduate Faculty of the
Department of Physical Therapy
School of Medicine
University of North Dakota
in partial fulfillment of the requirements
for the degree of
Master of Physical Therapy

Grand Forks, North Dakota
May
1998
This Independent Study, submitted by Angela M. Thoreson in partial fulfillment of the requirements for the Degree of Master of Physical Therapy from the University of North Dakota, has been read by the Faculty Preceptor, Advisor, and Chairperson of Physical Therapy under whom the work has been done and is hereby approved.

(Chairperson, Physical Therapy)
PERMISSION

Title The Effects of Exercise on the Elderly Population: A Literature Review

Department Physical Therapy

Degree Master of Physical Therapy

In presenting this Independent Study Report in partial fulfillment of the requirements for a graduate degree from the University of North Dakota, I agree that the Department of Physical Therapy shall make it freely available for inspection. I further agree that permission for extensive copying for scholarly purposes may be granted by the professor who supervised my work or, in her absence, by the Chairperson of the department. It is understood that any copying or publication or other use of this independent study or part thereof for financial gain shall not be allowed without my written permission. It is also understood that due recognition shall be given to me and the University of North Dakota in any scholarly use which may be made of any material in my Independent Study Report.

Signature ______________________

Date ______________________
TABLE OF CONTENTS

ACKNOWLEDGMENT .................................................. v

ABSTRACT ............................................................ vi

CHAPTER

I INTRODUCTION ................................................... 1

II CHANGES WITHIN THE AGING ORGAN SYSTEMS ........ 4

  Theories .......................................................... 4
  Organ Systems ................................................. 6
  Summary .......................................................... 23

III EFFECTS OF EXERCISE AND AGING ...................... 24

IV EXERCISE PRESCRIPTION ................................. 30

  Assessment ....................................................... 30
  Intensity .......................................................... 37
  Frequency ......................................................... 39
  Duration .......................................................... 40
  Exercise Progression ......................................... 43
  Special Considerations ....................................... 45

V CONCLUSION ..................................................... 48

APPENDIX A: ....................................................... 51

APPENDIX B: ....................................................... 53

REFERENCES ....................................................... 56
ACKNOWLEDGMENTS

I would like to take this opportunity to thank Meridee Green, MPT, for her helpful guidance in the completion of this literature review. I would also like to extend a thank you to all of the faculty and staff of UND-PT as well as my classmates for support, guidance, and the opportunity to learn. Finally, I would like to thank my wonderful parents for the love and support they have given to me all throughout life, but especially during the last few years. I would not be where I am or who I am today without them.
ABSTRACT

The population of those 65 years old or older has increased dramatically over the past several decades and will continue to grow well into the 21st Century. This change in U.S. demography has also led to an increased interest in geriatric medicine and the implications physical activity has on the social, medical, and economical aspects of treating this patient population.

Research has shown that people who participate regularly in aerobic activity have lower mortality and morbidity rates, even if an exercise program is started later in life. Moderate exercise has been proven to be an important part of treatment for many diseases. Exercise can improve physiologic and psychological function in the geriatric population and, in turn, increases independence and decreases acute and chronic care needs of these patients.

The purpose of this independent study is to provide a complete literature review of how the human body ages, how activity affects this aging process, and how health care providers can prescribe safe and effective exercise programs to the elderly patient population.
CHAPTER I
INTRODUCTION

Currently, more than 10 percent of the U.S. population is age 65 or older. It is predicted that by the year 2030, close to 20 percent of the U.S. population will be 65 or older. As the population continues to age and the demography of the country changes, there will be a shift in the health care demands that will need to be met for the geriatric population. Health care providers will need to address certain existing medical conditions of this population, as well as prevention of other conditions. The elderly have special needs versus the middle-aged adult, including dealing with losses associated with aging and remaining functional and independent.

Regular exercise has been proven to be a successful component in treatment of many diseases, as well as improving self-image and helping the elderly person to maintain independence. Exercise has also been proven to improve cardiovascular and respiratory function, decrease coronary artery disease, increase lean body mass while decreasing body fat, increase flexibility, increase bone mass, and decrease blood pressure. Exercise is an effective non-pharmacological means of helping to control all of these factors.
To effectively treat the geriatric patient population, it is imperative to first have an understanding of how each system within the human body ages and a few theories as to why the human body ages. These topics of how and why aging occurs will be discussed later in detail. Second, knowledge of the effects that exercise have on the human body need to be recognized so health care providers can justify what they are doing to treat the elderly and why. With exercise, blood flow and metabolism are increased, skeletal and cardiac muscle are conditioned, and oxygen consumption is increased as well as heart rate. These are just a few of the effects of exercise. Finally, with a solid understanding of how and why the human body ages, as well as the effects of exercise on the human body, health care professionals can then prescribe safe and effective exercise programs for the geriatric patient. Before prescribing an exercise program, the health care professional needs to assess all risk factors and past medical history, identify medications taken, and conduct a stress test to establish a baseline for an exercise regimen. From the stress test, a target heart rate (THR) can be calculated and is the level at which the patient should be exercising for a given time and intensity, both also determined from the stress test.

Exercise frequency, intensity, and duration are all key components to an exercise program and are all dependent upon each other. Metabolic equivalents (METs), maximum heart rate (MHR) versus THR and maximal oxygen uptake ($V_{O2}^{MAX}$) are all methods that are used to determine or monitor intensity.
Frequency and duration of each exercise session will be addressed in chapter three regarding exercise prescription. The benefits and guidelines for a strengthening and stretching program will also be covered later, as well as the muscle groups that should be targeted and safety precautions of which it is necessary for the health care professional to be aware. The literature review will conclude with an explanation of how to go about progressing an exercise regimen regarding duration, frequency, and intensity and discuss the three stages of progression: the Initial stage, the Improvement stage, and the Maintenance stage.

The purpose of this independent study is to provide a complete literature review of how the human body ages, how activity affects this aging process, and how health care providers can prescribe safe and effective exercise programs to the geriatric patient population.
CHAPTER II

CHANGES WITHIN THE AGING ORGAN SYSTEMS

The process of aging is unique and affects every organ system of the body. It is important that health care providers understand these changes when treating the geriatric patient population, as well as the theories behind the aging process. These changes all have implications in the prescription of exercise for the elderly which will be discussed in later chapters. There are several theories behind this aging process.

Theories

It is important that health care professionals have an understanding of these aging theories, as well as the aging process, to be able to better understand the changes geriatric patients are encountering with age and how that affects treatment plan prescription and progression.

Programmed Phenomena or Programmed Senescence Theory

This theory states that all cells contain specific “death” genes. These genes are designed to turn off as the tissues age. Evidence supporting this particular theory is evident in the embryonic stage of development, where the cells undergo a finite number of cell divisions. During this stage, tissues and organs undergo extensive as well as continuous remodeling. These processes
are genetically controlled and the genome is thought to dictate the number of possible cell replications. After so many replications, damaged or lost cells simply are not replaced.

Error Theory

The Error Theory is based on the cells' DNA and RNA genetic makeup.\textsuperscript{1,11} With aging, the information originally found in these molecules is converted by enzyme and protein synthesis and becomes increasingly subject to error. This error leads to a disproportionate number of molecules that cannot support the cell's metabolism.

Repair Failure

It is believed that errors in the transcription of DNA can be repaired by certain processes.\textsuperscript{1} Aging is believed to be rooted in the failure of DNA repair. The rate of DNA repair is known to be related to the species' life span and the rate of the repair of DNA in human cells decreases as the cells age.

Redundancy Failure

This theory is based on the premise that there is a supply of correct genes to take over for genes that become damaged during gene synthesis.\textsuperscript{1} As the cell continues to age, the supply of correct genes used for correction becomes depleted and the errors are then free to express themselves.

Somatic Mutation Theory

The idea that chronic exposure to normal background environmental radiation results in random genetic damage to cells is the basis to this theory.\textsuperscript{11}
When damage becomes extensive enough to impair critical functions, the cell dies. This theory was proposed to help explain the shortened life span noted in experimental animals exposed to chronic radiation.

Immunologic Theory of Aging

This theory maintains that aging is due to failure of the immune system which results in progressive destruction of body cells. With age, there is a decline in the functional capacity of the immune system which decreases the body’s ability to distinguish between self tissue and foreign tissue. Autoimmune disorders, which are more frequent in the elderly population, occur when the body’s own cells are attacked by the immune system. This theory does not, however, explain the aging process of simple animals who do not have a well-developed immune system.

Free Radical Theory

The Free Radical Theory was prompted by the observation that larger animals who have slower metabolic rates generally live longer lives. Metabolic rate determines the production of activated oxygen free radicals. Aging is thought to result from progressive damage to cell structures, especially the cell membrane by the O₂ radicals. There is, however, no evidence to support this theory currently.

Organ Systems

All of these theories are attempts at answering the question, “Why do we age?” None are absolutely proven, but all have valid points that can be applied
to aging within each organ system separately as well as to the body as a whole. With age, each system goes through changes in structure and function and it is very important that these changes, as well as the implications of these changes, are understood by the health care professional. Although the changes within each system are unique to a particular system, all systems are connected to one another in some way and affect each other directly or indirectly. In the remainder of this chapter, the following systems will be reviewed: the musculoskeletal system, including bone, skeletal muscle, articular cartilage, and intervertebral discs; the central nervous system; sensory functions, including hearing, vision, and cutaneous changes; the integumentary system; the respiratory system; the cardiovascular system; the gastrointestinal system; the endocrine system; the immune system; and the renal system.

Musculoskeletal System

Problems in the musculoskeletal system are some of the most prevalent problems of middle aged and elderly patients. Impairments of this system result from changes in the muscles, bones, intervertebral discs, tendons, ligaments, and joint capsules. These changes begin taking place during the fourth and fifth decades of life and are considered part of the normal aging process.

Bone.—A progressive and steady loss of bone density begins around 40 years of age, including a decrease in the amount of cancellous and cortical bone produced. With age, the process of resorption is faster than that of bone
deposition, resulting in a loss of bone. As the bone tissue decreases, there is a resultant decrease in bone strength and an increased risk of injury. Bone marrow space is decreased and is replaced with fat instead of marrow cells. The long bones, metacarpals, and ribs increase in circumference; the skull becomes thicker; and the pelvis becomes wider.

Vitamin D absorption also decreases with age, which results in a decrease in serum vitamin D levels. This decrease in serum vitamin D decreases calcium absorption and can be directly linked to an increased susceptibility to osteoporosis. Osteoporosis is a problem that affects millions of people and the complications of osteoporosis can be very dangerous. Hip fractures and vertebral fractures are a major cause of morbidity and mortality each year.

Around the time of menopause in women, the process of loss of bone mass accelerates and is due to estrogen withdrawal. Women between the ages of 55 and 65 years of age may present with acute back pain secondary to vertebral compression fractures and eventually develop kyphosis. If they fall, they are liable to suffer a Colles’ fracture due to falling on an outstretched arm. An x-ray will show a general reduction in bone density, biconcavity, or wedging of the vertebrae and perhaps a recent fracture of a long bone.

Treatment consists of several factors. Women of menopausal age (55-65 years of age) should be encouraged to take in an adequate amount of calcium (1500 mg) per day in their regular diet. They are also encouraged to avoid
smoking and the consumption of excess alcohol, as well as to maintain a moderate level of activity. It has been proven that physical stresses, as caused by physical activity, lead to the deposition of bone tissue at the site of increased stress and therefore increased strength.\textsuperscript{4,11} The physical therapist should also be aware that the female patient population of this age group may be on estrogen replacement therapy to help decrease bone loss and the incidence of fractures.

Skeletal Muscle.—There is a decrease in both the number and size of muscle cells with age.\textsuperscript{1,11,16,17} This decrease affects the trunk and lower extremities the most drastically. Remaining muscle cells atrophy, decrease in fiber diameter, and contain less elastic tissue, all of which ultimately result in a reduction of muscle mass.\textsuperscript{11} A loss of flexibility occurs which is also due to the loss of muscle mass and an increase in the cross-linkings of elastin in the connective tissue.\textsuperscript{16,17,19,20} Osteoporosis and arthritis, as well as certain muscle groups naturally shortening with age, help to contribute to the decrease in flexibility.\textsuperscript{1} Fewer capillaries are available to remove metabolites from the muscle cells. There is a decrease in the responsiveness of the muscle to neurotransmitters, including acetylcholine at the myoneural junction and also a reduction in cholinesterase activity. Hormonal stimulation of the muscle by testosterone, somatotropin, and thyrotropin is decreased, as well as the uptake of glucose during exercise by the muscle. All of these hormonal, neural, and muscle changes lead to a functional decrease in muscle strength of 30 to 50%, reduced muscle endurance, decreased muscle tone, and increased fatigability as
well as an increase in the risk of developing myofascitis, tenosynovitis, and arthritis.\textsuperscript{11,16,21} This process usually occurs earlier in males, but the extent of decline in this system can vary greatly. These factors do not mean elderly people are doomed to be weak and tired. It has been shown that with proper nutritional balance and protein intake, along with adequate exercise, muscle strength and endurance can be maintained.

Articular Cartilage.—The articular cartilage of the human body undergoes some important changes with aging. Degenerative changes increase in extent and severity as age increases. The articular cartilage cell density declines with skeletal maturity, but is thought to remain somewhat constant throughout adult life.\textsuperscript{16} These cells, however, go through morphologic changes. It has been proven that cartilage, with age, exhibits decreases in fatigue resistance, strength, and tensile stiffness. There is also fissuring, erosion, and thinning of the cartilage that takes place.\textsuperscript{11,16} The synovial fluid thickens, while the membrane becomes fibrosed, due in part to the decreased water content of the articular cartilage that occurs with aging. The proteoglycans and collagens, which make up the primary components of the cell matrix, also go through age-related changes. These changes, in turn, lead to decreases in the strength and density of the articular cartilage which can increase the risk of injury.

The aggregate molecules which are responsible for the tissue's resiliency and stiffness in compression become much smaller with age.\textsuperscript{16} The collagens of cartilage also demonstrate an increase in cross-linking as the aging process...
progresses. Some of the large-diameter collagen fibrils with more cross-linking may become less flexible, making the cartilage more rigid. This increase in rigidity, along with the decreased water content, could possibly limit how much the cartilage would be able to deform when placed under stress, which could lead to damage of the structure of the cartilage.

Intervertebral Disc.—Pain affecting the neck and back is one of the most common problems in the middle-aged and elderly population. Most changes occur in the central portion of the disc, namely the nucleus pulposus and annulus fibrosis. Throughout adulthood, cracks and fissures appear in the disc due mainly to the decreased water and proteoglycan concentration. Due to the dehydration of the discs, there is also a decrease in height of up to three to five centimeters that can occur with elderly individuals. The volume of the disc also changes, which may lead to the increased probability of disc herniation as well as affect the spine’s mobility, alignment, and loads to the facets, spinal ligaments, and paraspinal musculature. The thoracic curve increases, which displaces the scapulae anteriorly and increases the A-P diameter of the chest. Lumbar flattening and decreased flexibility in this region are both due to a decreased lordotic curve. All of these alterations may lead to a decrease in strength and mobility of the spine and an increase in occurrence of both spinal stenosis and facet joint degeneration.
Central Nervous System

With age, the Central Nervous System (CNS) goes through an overall reduction in sensory function. The number of neural transmitters decrease with age, as well as activity in the frontal lobes and cerebral blood flow. With the aging process, brain atrophy and a decrease in brain weight occur, as well as a decrease in both white and gray matter of up to .5% per year. The permeability of the blood-brain barrier is also increased.

Nerve fibers in the brain decrease and begin splitting or fragmenting. Astrocytes of the cortex, subcortex, and cerebellum all degenerate. Neuroaxonal dystrophy, a swelling of the nerve axons, develops though the relevance of this occurrence is still unknown. The dendrites shrink, which causes a decrease in the number of messages received from other cells, slowing impulses and decreasing neuromuscular coordination. All of these changes caused by the dendrites shrinking lead to decreased short-term memory, decreased speed of learning, increases in the time needed to process new information, increased reaction time, decreased abstract reasoning, and impaired perception. There is a delay in the monosynaptic reflex arc which also slows reflexes in this patient population.

Secretion and metabolism of neurotransmitters also changes and affects the brain. Secretion of norepinephrine and dopamine is decreased and monoamine oxidase (MAO) secretion increases. The reduction of dopamine leads to decreased inhibitory functions. Posterior root nerve fibers and
sympathetic nerve fibers of the autonomic nervous system decrease in number. The motor nerve fibers and myelin sheath degenerate peripherally, but the motor neuron axons remain intact. Decreased reaction times, as mentioned earlier, result from decreasing motor neuron conduction velocity and prolonged muscle action potentials. The locus coeruleus, the portion of the brain that controls sleep, undergoes a loss of neurons with age. This decrease in neurons is also believed to increase insomnia and cause the elderly to wake from sleep frequently. There is an overall variability in all stages of sleep, including a decrease in rapid eye movement (REM) and slow-wave (phase IV) sleep. Overall, there is an increase in total daily sleep time, including an increased number of naps during the day.

Sensory Changes

An overall reduction in sensory function is associated with aging, including changes in hearing, vision, and sensation. These changes directly impact the elderly person’s safety and level of independence as well as the ability to remain active. Changes in the eye, ear, and skin will be discussed in detail.

Hearing.—Presbycusis, more commonly known as age-related hearing difficulties, usually occurs sometime during the fifth decade and is caused by structural changes in the organs of hearing. The ossicles can suffer from ankylosis which can lead to a decrease in the transmission of sound to the inner ear.
In the inner ear, or cochlea, there are changes in the basilar membrane which cause a loss of the ability to distinguish higher tones. A decline in pitch discrimination also accompanies the above stated changes. As the hearing loss progresses, the lower pitch tones also become more difficult to hear.

Vision.—The aging process affects all parts of the eye. Significant changes occur in the lens and retina as well as other structures of the eye, including macular degeneration and cataract formation. A decrease in elasticity of the lens, along with a decrease in the effectiveness of the ciliary muscle, cause difficulty in the ability to focus on near objects, known as “near-sightedness” or hyperopsia. The retina is affected by reduced light sensing thresholds of the rods and cones as well as a loss of luteal pigment in the macular areas. This leads to a decrease in the ability to distinguish bright colors and a longer period of time is needed to adapt to dark surroundings. Overall, there is a decrease in color vision and discrimination, diminished contrast sensitivity, and decreased accommodation. As a result, the elderly have less dynamic visual acuity, do not differentiate color well, and need brighter light to be able to see better. This has a direct affect on geriatric patients’ safety in dark or dimly lit areas and can ultimately affect the patient’s ability to remain independent.

Cutaneous Changes.—With age, our sensation diminishes. There is a decrease in proprioception which can result in a decrease in position sense and cause a loss of balance. The threshold for temperature, touch, and pain
sensation is increased which leads to reduced sensory and environmental awareness. As a result of aging, the body is not able to respond as well to temperature changes which can lead to difficulty with thermoregulation.\textsuperscript{11,17} Finally, there is decreased stereognosis, which results in a diminished ability to recognize forms or shapes. This can make fine motor tasks difficult for the elderly to perform and could also possibly lead to injury.

Integumentary System

The skin's ability to provide protection diminishes with age. The thickness of the stratum corneum remains the same, but its function as a chemical and moisture barrier is reduced.\textsuperscript{11} The thickness of the epidermis, too, remains unchanged, but mitosis decreases and cellular variation increases. Melanocytes decrease in number and function in the Caucasian population. They are also less efficient and are not uniform in pigment production caused by exposure to the sun.

Elderly people are more susceptible to hypothermia due to a decrease in thermal insulation, which is due to a decrease in the amount of subcutaneous adipose tissue.\textsuperscript{11,17} Skin pliability, compliance, and resiliency are all decreased secondary to an increase in collagen and elastin, as well as cross-linking and calcification of elastin fibers. This leads to decreased tone and elasticity of the skin, causing wrinkles. Hair loss and graying is common after age thirty in men and around the time of menopause in women, which is believed to be caused by a loss of melanocytes at the base of the hair follicle. There is also a decline in
hair and nail growth as well as a pattern change in hair distribution. The pattern and extent of hair loss are determined by genetic and endocrine factors. The changing hair patterns result in a thinning of hair on the legs and in the axillary and pubic areas. The nails become thickened and yellowed also.

Drier, less oily skin results from a decline in function of the sebaceous and sweat glands. The number of blood vessels and sensory nerves declines in the skin which leads to decreased sensation and diminished vasoactivity of the dermal arterioles. The skin of elderly people is more easily injured and, once it is damaged, heals at a slower rate. There is also a decrease in the skin’s immune response which makes the skin more susceptible to infections. As a result of these changes, the skin is at higher risk for suffering from pressure sores secondary to immobilization.

Respiratory System

The respiratory system is significantly changed with age. Overall, there is an increase in the work required to breathe due to the changes of the pulmonary system. More energy is required for breathing and vital capacity decreases from 20 to 60 years of age. The chest wall actually becomes stiffer secondary to rib and cartilaginous calcification. The diaphragm, intercostal muscles, and accessory muscles all lose strength. The stiffness of the chest wall, coupled with decreased respiratory muscle strength, causes an increase in dead space, diminished expiratory flow rates, and decreased vital capacity. The lungs show a rise in collagen and a reduction in elastin which decreases recoil and increases
compliance. This leads to a decrease in expiratory flow velocities. There is also enlargement of the alveoli and bronchioles and a decreased surface area. The arterial blood flow through the pulmonary vessels changes proportionally with cardiac output. Overall, there is a decrease in cardiac output and an increase in peripheral resistance. The diffusion capacity and amount of gas exchange both decrease as a result of alveoli enlargement and reduced pulmonary artery blood flow.

There is a loss of pulmonary connective tissue elasticity due to pulmonary fibrosis.\textsuperscript{21} This fibrosis decreases the volume of expired air and ventilation. A decrease in cilia activity within the bronchi facilitates an accumulation of secretions as well as a decrease in the cough reflex. These two factors together result in a pooling of secretions in the respiratory tract and an increased risk of pneumonia and other upper respiratory tract infections.

**Cardiovascular System**

With aging, there is a decrease in the number of myocytes, but the actual size of the heart does not change dramatically.\textsuperscript{11} The wall of the left ventricle becomes thicker which then demands an increase in oxygen. A cross-linking of collagen within the heart muscle increases myocardial stiffening, which then diminishes compliance and directly causes a decline in cardiac contractibility and the heart's ability to pump blood.\textsuperscript{11,17}

The cardiac valves become fibrotic secondary to hemodynamic stress and generalized thickening.\textsuperscript{11} A decrease in coronary artery blood flow to the
myocardium affects the oxygen and nutrient supply of the myocardium. The myocardial cells themselves increase in size with increased lipid deposition.

Within the electrical conduction tissue, several changes take place in the sinoatrial node (SA node), atrioventricular node (AV node) and the Bundle of His. Generally, there is a loss of myocytes in the conduction pathways as well as a fibrosis of these pathways. The SA node is less responsive to adrenergic stimulation due to a decreased number of pacemaker cells in the SA node. Myocardial cell irritability increases resulting in: slurred or notched P wave, longer PR interval, diminished QRS amplitude or notched T wave with a decreased amplitude.

All of these components come together to produce several changes in cardiac function of the geriatric patient. During stress or exercise, the aging heart is not able to respond quickly with an elevated rate and the maximum heart rate (MHR) is reduced. Once the heart rate is elevated, it takes a longer period of time for the heart rate to return to a resting state. With stress, the cardiac stroke volume and output generally decrease. The myocardium is less efficient and there is an overall diminished cardiac reserve with a reduced oxygen consumption in the myocardium.

In both the arteries and veins, the proximal portions are affected first, with the intima becoming fibrotic and endothelial cell variation increasing. The amount of elastin and smooth muscle is decreased in the media and the amount of fibrotic and collagen tissue increases. With increased collagen cross-
linking, the vessel walls lose flexibility and recoil, resulting in a decrease in compliance. This decrease in compliance of the vessels leads to an increase in systemic vascular resistance that in turn diminishes tissue and organ blood flow and also decreases perfusion. A slightly elevated systolic blood pressure is also the result of increased peripheral vascular resistance and decreased compliance of the vessels.

The body's ability to respond to hyposensitive and hypersensitive stimuli is also decreased due to decreased baroreceptor function.\textsuperscript{11,17} There is a decrease in baroreceptor function because of a decrease in sensitivity of the receptors and diminished responsiveness of vessels secondary to rigidity. A decreased compliance of the systemic vascular system causes increased afterload, which results in the left ventricle being forced to work harder to meet the demands of the body.

**Gastrointestinal System**

A loss of appetite makes maintaining good nutrition difficult for the elderly population. Elderly people experience a decrease in taste due to both a decrease in the number of taste buds as well as an increase in the threshold for all four tastes\textsuperscript{11} (bitter, salty, sour, and sweet). The most significant losses affect the ability to taste salty and sweet. A decrease in smell and taste associated with normal aging, which cause food to taste and smell differently to an older individual than it does to a young person, contributes to the loss of appetite.\textsuperscript{21} The salivary glands undergo a decrease in the number of acinar cells which
causes a reduction in the amount as well as the rate of saliva secretion. The saliva also becomes increasingly alkaline.

A loss of teeth in the geriatric population is due to an atrophy of bone and gum tissue, not to mention actual wear on the teeth over many years. The dentin of the teeth may be exposed due to wearing down of the enamel, the protective outer layer of the teeth. It is still unknown if the loss of gingival epithelial tissue is pathologic or a normal part of the aging process.

Esophageal motion becomes uncoordinated which causes a delayed entry of food into the stomach. This condition is called presbyesophagus. With presbyesophagus, the esophageal sphincter fails to relax and the lower portion of the esophagus becomes dilated. This condition is not necessarily common, but is one that will affect some of the geriatric patient population.

There is a decrease in the gastric emptying time due to a loss of smooth muscle in the stomach. Because of the decreased emptying time, gastric epithelial cells are exposed to the gastric contents for an increased amount of time causing damage to those epithelial cells. There is a decrease in the number of chief and parietal cells in the stomach which can result in a decrease in HCl acid and pepsin secretion, as well as an increased pH. Gastrointestinal muscle strength and movement decreases, which leads to diminished peristalsis and GI motility as a person ages. This decreased motor function, as well as depression of the defecation reflex, leads to an increase in constipation. There is a decrease in perfusion of the gastrointestinal tract which may cause bowel
ischemia and a decrease in colonic muscle tone may contribute to diverticulosis, a common ailment of the geriatric population. Absorption of amino acids, lipids, calcium, glucose, and iron are decreased within the small intestine of the elderly person, affecting the nutrition and overall health of the elderly population.

Endocrine System

Aging causes endocrine organ changes that cause varying hormone activity, secretion rates, target organ sensitivity, and responsiveness. All of the endocrine glands in the elderly have an increased amount of connective tissue and changes in structure. The amount of each hormone secreted varies greatly with age among the endocrine glands also. For example, with age, adrenocorticotropic hormone (ACTH) secretion is unchanged from the pituitary gland, but thyrotropic hormone (TSH) secretion increases and secretion of aldosterone decreases. The rate of cortisol secretion is decreased from the adrenal gland, but the base level of cortisol is unchanged because of a prolonged degradation rate. Blood osmolality receptors in the brain increase in sensitivity to antidiuretic hormone (ADH), but the kidney, the target organ, declines in its responsiveness to ADH with age. All of these changes caused by aging can dramatically affect the elderly patient and the function of the other organ systems.

Immune System

The cells of the immune system cannot reproduce as effectively as they can in younger people. T-cell function is diminished, but the total number of T-
cells remains the same. Antibody production decreases, but production of autoantibodies increases, possibly causing the increased incidence of autoimmune disorders in the geriatric population, such as rheumatoid arthritis.

The elderly person's immune system has a diminished ability to respond to stimulation. They are able to respond with previously produced or "remembered" antibodies, but cannot respond to new antigens nearly as quickly. There is a decrease in the speed of tissue repair and an increase in vulnerability to disease.

Renal System

With age, the kidneys' size and weight are reduced and there is also a decrease of up to 30 to 50% in the number, size, weight, and function of the nephrons. The renal afferent arterioles experience an interstitial fibrosis. The diminished blood flow along with loss of nephrons decreases the glomerular filtration rate (GFR). Due to a decrease in the length of the tubules, as well as excretion and reabsorption rates, significant changes occur regarding urine production. There is a decrease in the concentration of urine, sodium retention, drug, or metabolite excretion and hydrogen ion secretion, while there is an increase in the renal threshold for glucose.

Urinary muscles weaken with age, accompanied by decreased sphincter tone and decreased bladder capacity. The muscular weakness can also lead to an increase in residual volume of urine in the bladder and problems with starting the urinary stream. An increased occurrence of residual volume can
increase the probability of an elderly person developing a bladder infection. The length of the urethra decreases and there is also a decrease in bladder innervation and a reduced sensation of filling.

Summary

With an understanding of the aging that takes place in every system of the human body, it becomes more apparent how these changes will affect the decisions that health care providers, namely physical therapists, make regarding treatment plans when prescribing an exercise regimen. The elderly patient population has an unique combination of age-related changes and medical needs that are unlike those of children, adolescents, or adults. Being aware of these changes not only helps health care professionals with the exact science of treatment prescription, but also allows for a greater understanding of these patients' needs as aging adults in our communities.
CHAPTER III
EFFECTS OF EXERCISE AND AGING

In the past several years, exercise and its effects on aging have become important medically, socially, and economically. With more and more of our population becoming older, there is concern about the consumption of health care costs by older persons. Exercise has long been acknowledged as a very important element in a healthy lifestyle for many reasons. Moderate exercise for older adults is important in the treatment of many diseases, such as cardiovascular disease, diabetes, osteoporosis, osteoarthritis, insomnia, deconditioning, and to some extent, obesity. It has also been found that exercise can stop the progression of or even reverse many of the adverse changes that occur normally with aging. Physical activity has been proven to improve functional capacity, such as balance, and modify cardiovascular risk factors as well as metabolic and psychological changes that go along with leading a sedentary lifestyle.5

Metabolism increases in proportion to the mass of muscle used and the amount of exertion put forth. The response to dynamic aerobic exercise is the most evident in the circulatory system. In the exercising muscle, blood flow increases from 4 to 7 mL/100g/min up to 50 to 75 mL/100g/min due to the
decreased arterial resistance and dilatation of capillary beds within the working muscle.\textsuperscript{22} Oxygen consumption increases 10- to 20-fold and cardiac output and heart rate increase three to four times with increasing oxygen uptake.\textsuperscript{23} Increasing blood flow to any area has many profound effects. An increase in blood flow increases the amount of both oxygen and nutrients delivered to an area. This in turn can aid in healing. An increase in the amount of toxins removed from a diseased area by an active circulatory system also increases healing potential. Increasing blood flow also decreases ischemia and pain. If oxygen delivery to a certain area is inadequate, work must be performed anaerobically instead of aerobically. This quickly causes fatigue.\textsuperscript{8}

Consistently performing a form of dynamic aerobic exercise results in a conditioning effect of the skeletal muscle.\textsuperscript{2} Metabolic capacity is increased as well as reserve for maximal effort. This then reduces metabolic and circulatory demands at any submaximal effort level. "Therapeutic benefits" of increased aerobic capacity and conditioning occur at submaximal workloads. Everyday activities, such as cooking or dressing, are examples of "submaximal" workloads. These changes all result in an increase in maximum aerobic capacity, although this increase will vary depending upon the person's initial level of activity, the intensity of the exercise performed, duration, frequency, consistency, and any limitations due to comorbidity. About one-half of this increase in aerobic capacity is due to peripheral changes. These include an increase in the metabolism and
use of oxygen at the tissue level. The other one-half of the effect from dynamic aerobic exercise occurs in the cardiovascular system.

During the aging process, the cardiovascular system undergoes several changes. First, in the myocardium, there is brown atrophy which occurs as well as fatty infiltration and a reduction in cardiac muscle fibers and intracellular components.\(^\text{21}\) Heart valves undergo fibrotic changes and calcification, coronary vessels narrow, and there is dilation and a decrease in elasticity of the aorta. All of these changes together result in a decrease in left ventricular filling and cardiac output. However, with aerobic training, there is an increase in maximal aerobic capacity as well as an increase in stroke volume and cardiac output.\(^\text{2}\) Overall, oxygen transport and the capacity to do physical work are increased. There are also small but very significant decreases in both systolic and diastolic blood pressure as well as heart rate and blood lactate responses.\(^\text{24}\) Heart rate and blood pressure are proportionately less for the given workload because of the reduction in aerobic requirements.\(^\text{2}\) There is also a decrease in sympathetic discharge, a decrease in peripheral vascular resistance, and the needs of the exercising muscle are met by a more efficient extraction of oxygen rather than an increase in blood flow and pressure. In the myocardium, there is a decrease in the oxygen requirements due to a decreased afterload and skeletal muscle has been shown to perform more efficiently. There are many other benefits of cardiovascular training in the elderly population, such as greater A-VO\(_2\) difference and stroke volume, a "protective effect" against osteoporosis,
decreased body fat and increased lean body mass, improved glucose tolerance, increased flexibility, decreased lipid concentrations, increased mental factors, and enhanced quality of life.\textsuperscript{5,6}

Results from a study conducted at Duke University found that elderly patients who participated regularly in an exercise program can benefit in many ways.\textsuperscript{7} The group consisted of 49 participants, all over the age of 64. They were randomly selected, evaluated, and began an exercise program of three days per week. The sessions were each 90 minutes in length and consisted of cardiovascular exercise, stretching, and strengthening. Results found 80% of participants improved in METS (metabolic equivalents) and treadmill time as well as showing a decrease in submaximal heart rate. Flexibility, measured in hamstring length, and strength, measured in abdominal strength, both increased significantly. It was found that "blood pressure, cholesterol, HDL, glucose, weight and percent body fat can be improved in the middle-aged population."\textsuperscript{7(p352)}

Exercise has several effects on many systems in the human body. Of these, its psychological effects are some of the most beneficial and noticeable to the individual who exercises. Depression and anxiety are problems that frequently plague the elderly and exercise has been proven to be a very effective, as well as non-pharmacological, means of controlling these problems.\textsuperscript{8} Since exercise elevates mood, this also improves perceived health. This can help elderly persons to live with minor aches and pains, which in turn decreases
medical demands and costs and helps to increase independence. Elderly patients who do exercise regularly say they feel that they have fewer aches and pains, feel as though they have an increased level of energy, suffer from stress less frequently, smoke less, consume less alcohol, and sleep and eat better. Physical activity has also been shown to improve cerebral function and overall self esteem. Insomnia is another common problem among the elderly. Most people state that they sleep better after exercise or a hard day of work. Improved sleep decreases the need for sleeping aids and the risks of using over-the-counter drugs with alcohol.

Motivation is a key factor in determining the failure or success of an exercise program. Pleasure is a very important motivator because, when exercise is enjoyable, a “positive addiction” to activity comes about. This then further encourages the patient to continue to exercise and continue to gain the benefits. It is very important that the patient be allowed to participate in the selection of a suitable exercise regimen. A supportive spouse, proximity to an exercise facility, and no injury or pain during participation are factors that are associated with compliance to an exercise program. Factors that have little or no relevance to compliance are previous activity level, present level of fitness, and attitude toward physical activity. It is also crucial that the value of an exercise program, both physically and mentally, be explained to the patient. Exercise should be encouraged to become a part of daily life. The patient should be allowed to experiment with what time of day is the best for him or her and then
settle into a regular schedule. Finally, try to encourage the patient to exercise with a group or another individual. Peer support is likely to increase compliance, as well as the enjoyment of the exercise, while being able to enjoy companionship.

Exercise is a valuable tool used in the control and regulation of several disease processes. It affects every system of the human body, most notably the circulatory system. It also has dramatic effects on one's mood and motivation level as well as providing a means for companionship, which is a benefit for anyone, not just the elderly.
CHAPTER IV

EXERCISE PRESCRIPTION

Exercise has been recognized as an important component of a healthy lifestyle for a long time among health professionals. The benefits are numerous, including physical, emotional, and psychological improvements to name a few. However, beginning an exercise program can be difficult and frustrating for anyone, especially the elderly who may have been inactive for many years and who may also have suffered from other complicating factors or disease processes.

Assessment

Before an exercise program is initiated, several areas must be explored in a pre-exercise assessment. Risk factors to an exercise program need to be identified, medications that are currently being used need to be identified for possible side effects/negative interaction with physical exertion, a general evaluation of ROM and strength should be conducted, and an evaluation of physical exertion or a stress test should be conducted to establish a baseline for an exercise regimen.4-6,8,9

An understanding of all medications the patient is currently taking is especially important. Tranquilizers, sedatives, anti-hypertensives, and
antidepressants can all have a serious effect on balance and physical activity. Peripheral neuropathies, decreased equilibrium, gait deviations, and orthostatic hypotension also seriously affect balance and the ability to ambulate or exercise independently.4,5 Patients with the above mentioned conditions need to be educated regarding their condition and the increased risk of falling. These patients will also need to begin their exercise program in a closely supervised setting.

During the pre-exercise assessment, physical examination is crucial to avoid worsening any pre-existing or underlying chronic diseases.4,5 The assessment is also important to help design a program that the patient will enjoy and with which he/she will remain compliant. The history taken during the pre-exercise assessment should include the following: previous and present exercise programs; chronic or acute diseases; medications; family history for cerebral vascular accident (CVA), heart disease, diabetes, hypertension; and lifestyle risk factors, including stress, smoking, obesity, hypertension, and an increased lipid concentration.4-6,9 A physical examination should include measurement of height and weight, blood pressure, resting pulse, cardiac exam, pulmonary exam, and musculoskeletal exam, including an evaluation of balance capabilities. Resting pulse is necessary to calculate the target heart rate (THR). Forced Vital Capacity (FVC) and Forced Expiratory Volume (FEV₁) are measured during the pulmonary exam and are directly related to the prescription of the exercise program. Finally, the musculoskeletal exam is necessary to determine
strength and range of motion, both of which are needed for an exercise regimen to be performed.

The exercise stress test is an important part of the assessment in order to perform the cardiac exam and establish a baseline for each individual patient as well as estimating a THR for which the patient should strive. Exercise testing is also very helpful when screening for high risk individuals when considering beginning an exercise program. An exercise tolerance test needs to tax the cardiovascular and respiratory systems as well as the endurance of the lower extremities. This is very helpful in establishing stress levels and providing information regarding specific exercise prescription.

There are several different methods of testing exercise tolerance, the most popular being the bicycle ergometer and the treadmill. The bicycle ergometer does not require weight-bearing stresses and there is increased stability provided by the seat and handle bars. It is also easier to obtain readings of vital signs, such as ECG tracings, pulse rate, and blood pressure with the bicycle ergometer tolerance testing method. However, the bicycle seat may be uncomfortable for some patients and some may find it difficult to maintain a steady pace or to keep their feet on the pedals. Also, if the muscles of the lower extremities fatigue quickly, the heart will not be stressed maximally and the tolerance test will not be accurate.

Another popular method used to test exercise tolerance is the treadmill. The treadmill is an accurate method for testing adults since walking is a natural
activity. Obtaining ECG, pulse rate, and blood pressure readings that are accurate is also relatively simple.\(^1\) However, the elderly may have difficulty coordinating their own walking pace to that of the treadmill which may cause difficulties with balance. It is recommended that all healthy men 40 years of age or older and women age 50 or older be tested by means of a treadmill test if they are planning a vigorous exercise program.\(^4,9\) A treadmill test is also recommended for all older men and women with symptoms suggesting cardiovascular, pulmonary, or metabolic disease or those individuals with a history of one of those listed problems, even if they are only planning a moderate exercise program.

Regardless of the testing method chosen to evaluate exercise tolerance, testing should be stopped if the person exhibits fatigue or any abnormalities brought on by the exercise. Some symptoms of which to be aware and for which to watch are:\(^1,6,9\) angina, dizziness, nausea, confusion, syncope or the feeling of exhaustion, or severe musculoskeletal pain. Signs for which the tester must be watching include: ST-T segment displacement, ventricular arrhythmias, atrioventricular conduction disturbances, atrial tachycardia, or atrial fibrillation. These can all be determined by watching the ECG carefully. Also, any changes in systolic or diastolic blood pressure should be carefully monitored.

It should be kept in mind that while activity for everyone is the ultimate goal, certain levels of types of exercise, especially among the geriatric population, is not always indicated or recommended.\(^9,21\) Some contraindications
to mobilization or initiation of an exercise program include loss of coordination or balance, marked weakness of the trunk or extremity musculature, bone or joint deformities that prevent the use of assistive devices or ambulation, psychiatric disorders that cannot be controlled (dementia, Alzheimer's disease), lack of patient motivation, a systemic condition in which exertion would endanger the patient's life (uncontrolled or unstable cardiac or pulmonary diseases), or uncontrollable pain brought on or worsened by movement (RA, radiculopathy, fibromyalgia, polyneuropathy). In most cases, however, these conditions or similar conditions do not completely hinder the patient from being able to participate at some level. It must be kept in mind by the therapist that adaptations and changes will need to be made based upon each individual patient.

It is very important that the patients understand how to monitor themselves while exercising, since most of their exercise time will not be closely monitored by a health care professional. The intensity of exercise should be monitored by checking the heart's response to activity. Instructing the patients in how to correctly take a pulse is very important and not too difficult. The patients can check their own pulse at either wrist over the radial artery or at the side of the neck over the carotid artery. A minimum of two to three minutes of steady exercise must be completed before taking a pulse in order to establish a consistent heart rate response. A 10- to 15-second count is adequate and the
patients should be instructed to keep their legs moving while taking the pulse to prevent pooling of blood in the lower extremities.

It is possible, however, that some patients will be unable to take their own pulse for a variety of reasons. The patient's sense of light or deep touch may be decreased due to diabetes and the patient may have difficulty feeling a pulse. Some patients may have trouble counting their pulse while watching the clock and keeping track of time or simply may be unable to see the clock or face of a watch well enough to obtain an accurate count. If one of these situations is the case, there are a couple of options that you as the physical therapist have. First, the Borg Scale of Perceived Exertion can be used which measures the patients' own perceptions of their effort, not the actual pulse rate.\textsuperscript{26} The Borg Scale is scored subjectively by the patient on a scale of 6 to 20, six being extremely light and 20 being extremely heavy.\textsuperscript{10} An example of the Original Borg Scale is provided in Appendix A. The patients should be instructed to exercise to the point where they feel the load or exertion is slightly heavy, but not too heavy.\textsuperscript{26} A good rule of thumb for elderly patients is: if they are unable to carry on a conversation while exercising, the exertion is too heavy. It is also this perceived exertion that will dictate how long the patient should exercise. The tester prescribing the exercise plan needs to be aware that the perception of "light" or "heavy" will vary from one individual to the next. It is important that we listen to our patients as well as be very aware of their medical history and any existing conditions that will affect the level at which they are able to exercise. Finally, if
neither one of the above stated options of taking their own pulse or utilizing the Borg Scale of Perceived Exertion will work for your patients, a pulse monitor can be used. This allows patients to still be an active part of monitoring their exercise program even if certain circumstances do present an obstacle for them.

Electronic pulsemeters detect the pulse by means of sensors. Typically, these devices are small, battery operated units that consist of the sensor and the monitor. These units can be strapped around the patient’s waist or wrist or attached to the exercise equipment itself. A lead wire with a distal sensor component and a monitor of some type are utilized. The sensors are typically built within a finger sleeve, earlobe clip, or chest strap and transmit heart rate information to the monitor.

Some of these devices can be worn during the exercise session and others are not as beneficial if used in that manner. Some pulsemeters, however, are equipped with more than one type of sensor. This allows selection of a sensor that is appropriate with the type of activity that is being performed. For example, an earlobe clip or chest strap would be preferred over a finger sleeve if the patient were performing an exercise with the upper extremities. The monitor consists of either a digital display (i.e., wrist watch) or a stationary scale and needle marker.

Many of the units allow programming of THR zones as well as storage of information. Common features include preset upper and lower limits of pulse...
rate for a given activity and an auditory signal to the patient or therapist that the pulse rate has moved out of the THR range.

Intensity

Prescription of an exercise program can be determined by several different methods. The two most common methods used to determine the proper intensity level are exercising at the THR and measuring maximal work capacity in METs.

The exercise target heart rate (ETHR) is calculated from the maximum heart rate (MHR) and the resting heart rate (RHR). The MHR is obtained either from the exercise tolerance test or is estimated by subtracting the patient’s age from 220. The RHR is simply the patient’s pulse rate at rest. The formula:

\[ \text{ETHR} = P \times (\text{MHR} - \text{RHR}) + \text{RHR} \]

is calculated by the tester. The “P” represents the percentage of the MHR that is desired for the individual. The recommended “P” as stated by the American College of Sports Medicine (ACSM) equals 60% to 90% of the MHR, but for those patients who have been sedentary for a long period of time or have a pre-existing condition causing concern to the physical therapist, 40% to 60% of the MHR has been shown to also provide important health benefits to this patient population. Patients may exercise at any level below the ETHR that is enjoyable, but for the exercise to be considered effective, it must be done at a certain intensity to obtain and maintain a conditioning effect based upon the ETHR.
The second method of determining the proper level of intensity for an exercise program is the use of metabolic equivalents, or METs. METs are used to compare the resting state to the energy costs of various activities. The estimated oxygen consumption at a resting state is equal to 3.5 mL O$_2$/kg/min. In other words:

$$1 \text{ MET} = 3.5 \text{mL O}_2/\text{kg/min}$$

Various values of METs have been assigned to different activities performed at different levels. The physical therapist prescribing the program should have access to a detailed listing of various activities and their METs to aid in finding ideas for proper prescription of exercise for the elderly patient. There is a list of possible activities provided in Appendix B.

A third method of determining exercise intensity is the use of VO$_{2\text{MAX}}$ values. This method is accepted as a measure of cardiorespiratory endurance and directly measures maximal oxygen uptake.\textsuperscript{10} Measuring VO$_{2\text{MAX}}$ involves analyzing expired air samples that are collected while the patient performs the exercise stress test on the bicycle ergometer or treadmill. Intensity, as recommended by the ACSM, should be 50% to 85% of VO$_{2\text{MAX}}$ or 60% to 90% of MHR, as stated earlier. As with METs, different activities performed at different levels of difficulty have been assigned to various VO$_{2\text{MAX}}$ levels. The physical therapist prescribing the exercise program should also have access to a listing of possible activities to be performed at certain VO$_{2\text{MAX}}$ levels.
Frequency

The frequency, or number of times exercise is performed, is a key component in obtaining a conditioning effect. It is generally agreed that the specified exercise needs to be performed three to five times per week.\textsuperscript{2,4,5,9} Frequency is directly related to both intensity and duration and depends upon those two factors.\textsuperscript{10} It is believed that patients with functional capacities of less than three METs benefit the most from multiple short exercise sessions daily, patients with a functional capacity of three to five METs should exercise once or twice daily for shorter amounts of time, and three to five exercise sessions per week for a specified amount of time are recommended for patients with a functional capacity of greater than five METs.

It is also suggested that no more than two days off in a row be allowed between exercise sessions to maintain a conditioning effect. If patients choose to exercise every day, different activities should be performed each day.\textsuperscript{5} Days should alternate between high-intensity and low-intensity exercise programs. Other sources argue that exercising at a frequency greater than five times per week will dramatically increase the chances of injury.\textsuperscript{4} For the average person who exercises three times per week, the frequency can be increased every two weeks to increase the total work output. The total work output can also be increased by increasing the intensity of the exercise or the duration.\textsuperscript{9}
Duration

The duration of exercise is very important. It is key that the exercise chosen, no matter what it may be, be continuous for a certain amount of time. The amount of time needed to provide a conditioning effect is generally well accepted among several sources. The ACSM recommends that exercise be 20 to 60 minutes in duration. Lampman believes that each exercise session should be approximately 30 to 60 minutes long and Rooney also agrees that the optimal duration should be between 20 and 60 minutes maintained at the earlier discussed ETHR. Activity should be maintained for these given amounts of time and should utilize the large muscle groups of the body. Examples of activities that use the large muscles are rowing, cycling, walking, jogging, or swimming. It is recommended that the ETHR be maintained for 20 to 30 minutes, excluding warm-up and cool-down periods. If an individual is unable to exercise for the full 20 to 30 minutes, it is recommended that multiple sessions of 5 to 10 minutes be performed throughout the day to obtain the total of 20 to 30 minutes of aerobic exercise necessary to obtain benefits.

Two overlooked yet very important components of a balanced exercise regimen are flexibility and strength or resistance training. With aging, there is a decrease in flexibility due to increased cross-linkages of elastin in connective tissue. Years of inactivity can produce a great deal of limitations in motor ability and even completion of ADLs because of the decrease in flexibility. As little as 15 to 20 minutes of properly completed stretching activities per day can
produce dramatic increases in the elderly patient’s flexibility. Gentle stretching is very important during the workout as part of the warm-up and cool-down. The proper technique for stretching is crucial and is based on correct instruction and the patients’ own subjective judgments of when they “feel” a stretch in the targeted muscle group. Supervision of stretching technique is essential. Treatment should consist of at least one supervised session with a follow-up session to ensure the patient is performing each stretch correctly. As physical therapists, we will be instructing in the proper positioning of each stretch and helping the patient from falling into the bad habit of poor body positions. Do not allow the patients to “cheat” so that they feel as though they are getting a deeper stretch. That leads to the second important point of stretching—intensity.

The main goal when teaching the patients how to properly stretch is to tell them they should feel a mild tension in the appropriate muscle group. Stretching does not require an increase in intensity, duration or frequency, unlike aerobic conditioning. Progression will come as long as the correct technique is performed daily. Groups of muscles commonly needing daily stretching consist of the hamstrings, quadriceps, adductors, pelvic musculature, low back, calf musculature, and pectoral muscles. Maintaining adequate levels of flexibility in all muscle groups can help to enhance an individual’s functional capacities as well as help to reduce the risk of injury. It is important that the patients understand that they should warm up before stretching; never bounce, but
stretch slowly and smoothly; stay within a pain-free range of motion; and gradually ease into the stretch, holding it 10 to 30 seconds, if able.

Strength training is often seen as unnecessary for those participating in exercise and who are part of the geriatric population. It is a common misunderstanding that a decrease in strength is just a part of aging and the opposite is actually true.\textsuperscript{29} It really is a result of chronic inactivity and really is not directly related to increases in age.\textsuperscript{7} For a long time, it was believed by experts that strength training was too risky for elderly patients. It has actually been proven that strength training is very effective as well as safe. The safest method for resistance training is the use of light handweights with increased repetitions rather than heavy weights with fewer repetitions.\textsuperscript{4,5,8,10} Patients should begin by doing two sets of 8 to 12 repetitions two to four times per week. Over a period of time, generally weeks, the workload is slowly increased. This should be done by first adding repetitions (up to 25) and then adding a third set.\textsuperscript{28} (Each set consists of 8 to 12 repetitions.) The patient should be instructed to work within a pain-free range of motion and perform enough repetitions to produce fatigue. Fatigue should be based on the feeling that the last two or three repetitions were somewhat difficult to perform, approximately a 12 to 13 on the Borg Scale. Handweights are sufficient for and produce significant gains in strength and muscle mass in the upper extremities. Lateral raises, upright rows, shrugs, biceps curls, triceps presses, wrist curls, and bench presses are all examples of exercises that produce upper extremity strength increases. As with flexibility
instruction, the first couple of training sessions need to be closely supervised to ensure proper technique and that safety issues are understood and being followed.

**Exercise Progression**

Progression of an exercise program depends upon many factors. Intensity, duration, and frequency are all closely related and together determine the total amount of calories expended. For example, similar increases in endurance can be seen through low intensity, long duration exercise sessions as well as high intensity, short duration sessions.\(^\text{10}\)

After important information has been extracted from the history and pre-exercise assessment, a program can be started. Prescribing exercise programs can be confusing initially, but several parameters exist to establish guidelines for initiating and progressing such programs. Where you begin with prescription depends upon the findings from the history you have taken and the exercise tolerance test.

For intensity, exercise can be based on three methods: MHR, VO\(_{2\text{MAX}}\), and Relative Perceived Exertion scales (i.e., Borg Scale). Exercise duration of 20 to 30 minutes has been found to be the most beneficial in producing a conditioning effect and in the effectiveness of calorie expenditure. Initial times should be set reasonably so that individuals feel as though they are being taxed, but not an extreme amount. The frequency of exercise performance is directly related to functional capacity, measured in METs, or the ETHR. The
recommended rate of progression depends upon several factors. Medical and health status; functional capacity, MHR, or VO\textsubscript{2MAX}; age; and individual preferences all help to determine how an exercise program should progress from the initial program. For apparently healthy adults, there are three stages of progression: initial, improvement, and maintenance.

In the Initial Stage\textsuperscript{10}, low level aerobic activities (40\% to 60\% of VO\textsubscript{2MAX}) and activities that will produce minimal muscle soreness are the most beneficial. This stage lasts about four to six weeks; however, the length of this stage depends upon how the individual adapts to the program. The duration of exercise sessions should begin at approximately 12 to 15 minutes and gradually progress to 20 minutes per session. If need be, exercise sessions can be of shorter duration and performed two to three times per day. Patients should try to exercise three times per week, or every other day. In the initial stage, goals for the individual should be set and a realistic system of rewards should also be established. The rewards system is helpful to maintain compliance and helps to increase self-esteem as small goals are met.

The patient is more rapidly progressed through the second stage, the Improvement Stage\textsuperscript{10}. This stage is much longer in duration, four to five months. The intensity is gradually increased to be within the 50\% to 85\% of VO\textsubscript{2MAX}, near the upper range of those numbers. Duration is also gradually increased every two to three weeks until the patient is exercising continuously for 20 to 30 minutes.
The final stage, the Maintenance Stage, usually begins about six months after the exercise program has been initiated. The goals of the exercise regimen should be re-evaluated during this stage and new goals can be set. There may be only minimal further improvement while working at the same level, but is very important for maintenance of the newly obtained fitness level. At this point, it is very important that exercises and activities that interest the patient are continued or initiated to maintain compliance. It is very important to keep in mind that these guidelines are for apparently healthy individuals. Based on a thorough history and exercise tolerance test, the physical therapist should adjust the intensity, duration, and frequency appropriately. It is also very important that each patient be seen and treated as an individual and that each exercise program meet the needs of the patient.

Special Considerations

There are several other considerations to think about when prescribing an exercise program for a geriatric patient. First, clothing needs will vary and depend upon the activity chosen and the existing conditions. In cooler weather (between 50 to 80 degrees Fahrenheit), it is better to wear several layers rather than one or two heavy layers. On days that it is hot (above 80 degrees Fahrenheit), windy, or humid, elderly persons should exercise in an air-conditioned facility or outdoors during the coolest part of the day. Patients should drink water before, during, and after their exercise sessions. Good quality footwear for walking or other such aerobic activity are a necessity. It is
very important that the patients contact their physician immediately should any abnormal signs or symptoms occur, such as chest pain, shortness of breath, significant muscle or joint pain, pain in the neck or jaw, palpitations, feeling of faintness, nausea, vomiting, or excessive fatigue. When prescribing exercise, it should be considered that elderly patients are going to need increased time to adapt to training or to show improvements in strength, flexibility, or cardiovascular endurance.¹

Patient compliance can, at times, be a factor in maintenance of an exercise program, but there are a few steps that can be taken to help deter problems with compliance. Patients should be encouraged to exercise at the same time of the day for each session.⁹ This way, exercise becomes a part of the patients’ daily schedules and their lifestyles. Patients can also be encouraged to vary their activities while staying within designated boundaries for intensity, frequency, and duration to maximize enjoyment and minimize boredom. It has also been noted that when patients truly enjoy the activity that is part of their exercise regimen and have been allowed to be an active participant in their exercise planning, a “positive addiction”⁶(p99) to the activity develops. This increases the likelihood that the patients will continue with their program. It is also important to encourage patients to exercise with a friend, spouse, or group. This is an excellent way to allow for socialization and interaction with fellow cohorts and can increase the enjoyment of the activity. Physical therapists must explain to patients exactly why they are exercising. It is important that
patients understand the physical, emotional, and mental benefits to engaging in a routine exercise regimen.

Finally, although it has not been proven to directly extend the lifespan of elderly patients, regular exercise does improve the overall quality of life for these patients. Exercise improves function, which allows the geriatric patient to maintain independence and a positive self image. It also decreases the demands for acute and long-term medical services which are of concern in a country whose geriatric population has grown significantly over the past few years and is only expected to continue to rise.
CHAPTER V
CONCLUSION

Dramatic increases in the numbers of geriatric individuals present communities and health care providers with several new challenges in treatment implementation and progression. Due to the large portion of the U.S. population that will be 65 years of age and older in the next few years, society is now faced with the medical, social, and economical implications of treating these patients. Exercise has been proven as an effective means of treatment for and prevention of many disease processes in the elderly patient population. Exercise has also been shown to improve psychological function, increase independence, and decrease both the acute care and chronic care needs of this patient population.

Before exercise is prescribed for the geriatric patient, there are several areas in which the health care professional must be aware and knowledgeable. These include an understanding of the theories of the aging process, the effects of aging on the organ systems of the body, the effects of exercise on the human body, and a basic understanding of exercise prescription regarding intensity, frequency, and duration of exercise. Even when exercise is initiated later in life, a decrease in both morbidity and mortality have been proven.
Through the safe prescription of exercise for the geriatric patient population, improvements in strength, flexibility, endurance, blood pressure, body fat, cholesterol, glucose tolerance, and perceived quality of life can be attained. These improvements can lead to decreases in or prevention of many conditions that commonly affect the elderly, such as diabetes, cardiovascular disease, osteoporosis, insomnia, and obesity. The key to patient compliance and motivation is patient education. One of the goals of health care providers is to have the patient understand the importance of exercise as well as find enjoyment and value in it. As physical therapists, we can help to instill healthy exercise habits and promote an increased body awareness among geriatric patients for the maintenance of functional abilities and prevention of serious conditions.

Exercise is a very important part of a healthy lifestyle and is key for people of all ages for several different reasons. For the geriatric population in particular, maintenance of strength, endurance, and independence as well as prevention of several disease processes that commonly affect the elderly is more important than ever. With an ever-increasing population of geriatric individuals, it is imperative that, socially as well as economically, health care professionals understand the needs of the elderly as well as value them as integral members of society. Exercise is a way to improve not only the physical health of these individuals, but also their psychological health. Our goal as health care providers for geriatric patients is to assist them in being able to maintain independence for
as long as possible as well as to participate in the activities that they enjoy within their communities.
APPENDIX A
**BORG PERCEIVED EXERTION SCALE**

<table>
<thead>
<tr>
<th>VALUE</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>Very, very light</td>
</tr>
<tr>
<td>7</td>
<td>Very light</td>
</tr>
<tr>
<td>8</td>
<td>Very light</td>
</tr>
<tr>
<td>9</td>
<td>Fairly light</td>
</tr>
<tr>
<td>10</td>
<td>Somewhat hard</td>
</tr>
<tr>
<td>11</td>
<td>Hard</td>
</tr>
<tr>
<td>12</td>
<td>Hard</td>
</tr>
<tr>
<td>13</td>
<td>Very hard</td>
</tr>
<tr>
<td>14</td>
<td>Very hard</td>
</tr>
<tr>
<td>15</td>
<td>Very, very hard</td>
</tr>
</tbody>
</table>

APPENDIX B
Table 7.3—Leisure Activities in METs: Sports, Exercise Classes, Games, Dancing

<table>
<thead>
<tr>
<th>Activity</th>
<th>MEAN</th>
<th>RANGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Backpacking</td>
<td>—</td>
<td>3-4</td>
</tr>
<tr>
<td>Badminton</td>
<td>5.8</td>
<td>5-11</td>
</tr>
<tr>
<td>Billiards</td>
<td>2.5</td>
<td>—</td>
</tr>
<tr>
<td>Bowling</td>
<td>—</td>
<td>2-4</td>
</tr>
<tr>
<td>Canoeing, rowing, and kayaking</td>
<td>—</td>
<td>3-8</td>
</tr>
<tr>
<td>Conditioning exercise</td>
<td>—</td>
<td>3-8+</td>
</tr>
<tr>
<td>Climbing hills</td>
<td>7.2</td>
<td>5-10+</td>
</tr>
<tr>
<td>Cycling</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pleasure or to work</td>
<td>—</td>
<td>3-8+</td>
</tr>
<tr>
<td>10 mph</td>
<td>7.0</td>
<td>—</td>
</tr>
<tr>
<td>Dancing (social, square, tap)</td>
<td>—</td>
<td>3-8</td>
</tr>
<tr>
<td>Dancing (aerobic)</td>
<td>—</td>
<td>6-9</td>
</tr>
<tr>
<td>Fishing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>From bank</td>
<td>3.7</td>
<td>2-4</td>
</tr>
<tr>
<td>Wading in stream</td>
<td>—</td>
<td>5-6</td>
</tr>
<tr>
<td>Golf</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power cart</td>
<td>—</td>
<td>2-3</td>
</tr>
<tr>
<td>Walking (carrying bag or pulling cart)</td>
<td>5.1</td>
<td>4-7</td>
</tr>
<tr>
<td>Hiking (cross-country)</td>
<td>—</td>
<td>3-7</td>
</tr>
<tr>
<td>Horseshoe pitching</td>
<td>—</td>
<td>2-3</td>
</tr>
<tr>
<td>Hunting (bow or gun)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small game (walking, carrying light load)</td>
<td>—</td>
<td>3-7</td>
</tr>
<tr>
<td>Big game (dragging carcass, walking)</td>
<td>—</td>
<td>3-14</td>
</tr>
<tr>
<td>Music playing</td>
<td>—</td>
<td>2-3</td>
</tr>
<tr>
<td>Activity</td>
<td>Calories</td>
<td>Time per Mile</td>
</tr>
<tr>
<td>----------------------------------</td>
<td>----------</td>
<td>---------------</td>
</tr>
<tr>
<td>Running</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12 minutes per mile</td>
<td>8.7</td>
<td></td>
</tr>
<tr>
<td>11 minutes per mile</td>
<td>9.4</td>
<td></td>
</tr>
<tr>
<td>10 minutes per mile</td>
<td>10.2</td>
<td></td>
</tr>
<tr>
<td>9 minutes per mile</td>
<td>11.2</td>
<td></td>
</tr>
<tr>
<td>8 minutes per mile</td>
<td>12.5</td>
<td></td>
</tr>
<tr>
<td>Shuffleboard</td>
<td></td>
<td>2-3</td>
</tr>
<tr>
<td>Skating, ice or roller</td>
<td></td>
<td>5-8</td>
</tr>
<tr>
<td>Skiing, snow</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Downhill</td>
<td></td>
<td>5-8</td>
</tr>
<tr>
<td>Cross-country</td>
<td></td>
<td>6-12+</td>
</tr>
<tr>
<td>Skiing, water</td>
<td></td>
<td>5-7</td>
</tr>
<tr>
<td>Showshoeing</td>
<td>9.9</td>
<td>7-14</td>
</tr>
<tr>
<td>Stair climbing</td>
<td></td>
<td>4-8</td>
</tr>
<tr>
<td>Swimming</td>
<td></td>
<td>4-8+</td>
</tr>
<tr>
<td>Tennis</td>
<td>6.5</td>
<td>4-9+</td>
</tr>
<tr>
<td>Volleyball</td>
<td></td>
<td>3-6</td>
</tr>
</tbody>
</table>
REFERENCES


