ADULT DEVELOPMENT AND AGING

GOAL: To increase the ski teacher's awareness of how the aging process affects the senior skier.

COURSE OBJECTIVES: After completing this course, the ski teacher will be able to

- Understand and discuss the major physiological changes in the aging skier and how these changes will impact the delivery of a quality lesson.
- Understand the principles and concepts of fitness related activities for seniors.
- Describe the differences and commonalities of contemporary skiing vs. traditional styles of skiing.
- Identify the skills that need to be developed to enhance the foundation of movement patterns for the senior skier.
- Describe appropriate modifications of a ski lesson that will increase the performance and enjoyment of the senior skier.
- Describe how ski equipment has changed over the past twenty years.
- Discuss the reasons why modern day ski equipment might enhance the skiing experience of the senior skier.

COURSE OUTLINE:

<u>Introduction to Adult Development and Aging</u>

A. Program Content
   a. Personal introduction
   b. Course overview and goals
   c. Activities for the course

<u>Course Outline for Adult Development and Aging</u>

A. Physiological Changes of the Senior Skier
   a. Skeletal
   b. Muscular
   c. Senses
      i. Vision
      ii. Hearing
      iii. Balance
   d. Renal function
   e. Cardiovascular
   f. Medical considerations

B. Social and Emotional Considerations of the Senior Skier

C. Optimizing performance in the senior skier.
   a. Contemporary skiing concepts
   b. Ski Equipment

D. Modifying the lesson to enhance the experience of the senior skier
   a. Teaching styles and learning preferences
   b. Pacing and the importance of the "coffee break"
   c. Terrain selection
      i. Creating excitement in an environment conductive to safety and learning.
   d. Open discussion
      i. Sharing experiences of teaching seniors

E. Introducing contemporary equipment to the senior skier
   a. Shaped vs. straight skis
   b. Modern boots

F. Handouts
   a. *The Physiology of Aging & Exercise* by The American Council On Exercise.
   b. *Selections on the Physiology of Aging* from **Aging, Physical Activity & Health** by Roy Shepard.
   c. *Staying fit Over Fifty* from **Staying Fit Over Fifty** by Jim Sloan
   d. *Skiing Concepts* – PSIA Alpine Team
   e. *Weight Training & Stretching Exercise* prescribed by The American Council On Exercise
   f. *Strength Basics* by Sue Moses
   g. Stretches from Downhill Skiing
   h. **A Better Way to Stretch** prescribed by Advanced Children's Educators
   i. *Healthwise article* from January 2005 Consumer Reports

G. Questions and Answers

THE PHYSIOLOGY OF AGING & EXERCISE

Aging is a universal phenomenon that affects us all. Provided we live long enough, we will eventually experience significant sensory, motor and cognitive changes in response to advancing age. However, although we are all aging, we do not age at the same rate. While some people experience relatively rapid declines in physiological and psychological functioning, as they grow older, others undergo significantly less-pronounced changes over time (Fries & Crapo, 1981).

In recent years, gerontologists have focused on increasing our understanding of the factors responsible for individual differences in the rate and extent at which we age. Clearly, hereditary factors play an important role in determining the pattern of changes observed in senescence. This genetic component of human aging is largely beyond our control and gerontologists often joke that the single best way to ensure longevity and healthful old age is to choose one's parents wisely! However, in addition to the genetic factors influencing human aging, there is now strong evidence that many aspects of the aging process are related to environmental factors, such as nutrition, stress, smoking and physical activity (Bokovy & Blair, 1994).

The need to develop effective lifestyle interventions that have the potential to improve the quality of life for older persons is especially apparent when one considers the growing proportion of older adults in today's society. Whereas individuals older than 65 constituted a mere four percent of the American population in 1900, they now represent more than 12 percent of the population (Gerber, 1989). Available evidence strongly suggests that this growth rate will continue. The Census Bureau predicts that by the year 2010 there will be approximately 39 million people older than 65. By 2020, the number of those 65 and older will rise to 51 million – nearly 20 percent of the population (U.S. Census Bureau, 1990). Even more remarkable is the increase in the number of the oldest members of our society – termed the "old-old." By the year 2030, it is anticipated that more than 8 million Americans will be 85 or older (Fowles, 1991).

There is little doubt that such a dramatic increase in the number of older adults will have far-reaching consequences for society. The past two decades have witnessed a remarkable expansion of interest in the physical activity needs of older persons. The major medical and scientific organizations endorse the importance of physically active lifestyles for older adults (ACSM, 1995; U.S. Surgeon General, 1996; World Health Organization, 1997). It is now possible for students to specialize in the study of physical activity and aging, both through traditional academic programs offered at universities (Jones & Rikli, 1994), and specialized programs such as those offered by the American Council on Exercise.

This chapter examines some of the key issues influencing the relationship between physical activity and the aging process. We begin with a discussion of underlying biological mechanisms responsible for aging, including 1) What is aging? 2) What causes us to age? 3) What are the consequences of aging? 4) Why do some people appear to age faster than others? We then examine the role regular physical activity plays in physiological, psychological and social functioning, and the extent to which lifestyle changes promotes healthy aging. Finally, we discuss issues related to the prescription of exercise for older persons. Throughout the chapter a broad definition of physical activity is adopted, and the *acute* or short-term effects of a single bout of activity and the *chronic* or long-term benefits of extended participation are considered.

The Physiology of the Aging Process

Aging Defined

It may seem unnecessary to define aging. Age is typically defined as the number of years, months or days that have elapsed since a particular point in time, usually birth. Similarly, the *aging process* is almost always defined by the passage of calendar time. However, many gerontologist believe definitions of aging that focus exclusively on calendar time are incomplete, and that more complex definitions of both “age” and “aging” are needed to understand the intricacies associated with human aging.

Chronological age is the length of time – expressed by the number of years or moths since birth- a person has lived. Its measurement is independent of physiological, psychological and socio-cultural factors. The presence of large differences in functional performance between individuals of the same chronological age, however, suggests that chronological age alone is an insufficient measure of senescence.

Many gerontologists believe that to increase our understanding of senescence, chronological age must be supplemented by other measures of aging designed to differentiate between individuals of the same chronological age. These measures are often described as indices of **functional age**. The most common measure of functional age is biological age, although other functional ages, including psychological age and social age, have been identified (Schroots & Birren, 1990).

Biological age characterizes senescence in terms of discrete biological, rather than chronological, processes. Research designs that emphasize chronological age typically focus on elements of calendar time (years, decades, etc.) as the principal units of analysis, whereas biological-age research focuses on senescent changes in biological or physiological processes and their subsequent effects on behavior. A common goal of all biological age inventories is to determine **relative age**, or the extent to which an individual is aging faster or slower than an average person of the same chronological age. For example, an individual who is aging successfully may have a biological age 10 years younger than their chronological age. Conversely, a person experiencing multiple medical problems in old age may be biologically older than they are chronologically.

Because there is little consensus as to how biological age should be measured, it is difficult to summarize the research on the effects of physical activity on biological age. However, most studies suggest that, on average, people who exercise regularly have lower biological ages than people of the same chronological age who do not exercise (Chodzko-Zajko & Ringel, 1987; Heikkinen et al., 1994; Kim & Tanaka, 1995).

In much the same way that people of the same chronological age can differ biologically, it also is possible for people to have different psychological ages (Schroots & Birren, 1990). **Psychological age** refers to an individual’s capabilities along a number of dimensions of mental or cognitive functioning, including self-esteem and self-efficacy, as well as learning, memory and perception (Birren, 1959). Birren suggests that some older persons demonstrate psychological adjustments typical for their chronological age, whereas others behave as though they were psychologically younger or older than their contemporaries. The concept of psychological age and its relationship to quality of life is now an important are of exercise science research. Recognizing the importance of regular physical activity in the psychological, social and physiological health of older personas, the Work Health Organization (WHO) published the *Guidelines for Promoting Physical Activity Among Older Persons* in 1997.

Social age refers to the notion that society often has fairly rigid expectations of what is and is not appropriate behavior for a person of a particular age (Rose, 1972; McGrath & Kelly, 1985). Socialization is a tremendously complex process, and it is difficult to make broad generalizations about the acquisition of social roles in later life (McPherson, 1990). However, the impact that social roles and expectation have on the lifestyle choices of older personas is of considerable interest in experimental gerontology. A number of recent studies have examined the extent to which later-life physical activity choice are dependent on an individual's perception of what is, or is not, age-appropriate behavior (Cousins & Vertinsky, 1995; Cousins, 1997). For example, many older persons consider it undignified to be seen physically exerting themselves in public. The WHO guidelines encourage older people to break away from such stereotypical perspectives about aging. Instead of encouraging seniors to "take it easy," the WHO promotes a more vigorous and healthful model of aging in which older persons are invited to lay a more active role in their own senescence (WHO, 1997).

Unfortunately, despite many years of research, there is no consensus on how best to quantify any of these alternative measures of aging. Thus, although it is apparent that chronological age is an inadequate measure of senescence and that alternative definitions of aging are necessary, no single unified definition of biological, psychological or social aging exists (Balin, 1994). Nonetheless, it is clear that an appreciation of chronological, biological and psychosocial perspectives on aging is essential to grasp the true essence of aging.

A central tenet underlying physical fitness and aging research is that physically fit individuals may be functionally younger than less-fit individuals of the same chronological age. From this point of view, research studies examining the relationship between age, physical fitness and behavior focus on both chronological and functional perspectives on aging.

Biological Theories of Aging

Biological theories of aging examiner the underlying mechanisms responsible for the structural and functional changes that characterize advancing age. Researchers have attempted to specify a single causal element responsible for age-related declines in physiological functioning but, to date, little progress has been made toward identifying a unified theory of biological aging (Hayflick 1985; Baker & Martin, 1994).

Aging is probably not a single biological process, but rather a wide variety of age-related changes that occur simultaneously in many different systems throughout the body. Together, these changes decrease the boy's ability to respond appropriately to the stresses of everyday life (Chodzko-Zajko & Ringel, 1987).

The complex nature of aging is reflected by the wide variety of theories proposed to account for the underlying mechanisms of aging. While many different classification schemes exist (Arking, 1991), the model proposed by the renowned biologist Leonard Hayflick is among the most straightforward (Hayflick, 1985). Hayflick was one of the first to demonstrate conclusively that cellular aging is influenced by both genetic and environmental factors. In his model of biological aging, Hayflick proposes that aging theories can be subdivided into three major classes: cellular theories, genetic theories and control theories.

Cellular Theories of Aging

Cellular theories of aging focus on the degenerative changes that occur at the level of the individual cell. The most commonly proposed mechanism of cellular aging is **free-radical oxidation** (Harman, 1956). A free radical is a highly unstable molecule of oxygen with an uneven number of electrons in its outer shell. The presence of an unpaired electron causes the oxygen-free radical to be both unstable and highly chemically reactive. To obtain the electron it needs to achieve stability, the free radical attempts to link up with other molecules. This process initiates a cascade of destructive chain reactions that my number in the thousands.

In healthy individuals, free radicals coexist in a state of equilibrium with a series of mixed-function oxidases that neutralize the destructive effects. The disruption of the equilibrium may be caused y a wide variety of intrinsic biological processes, as well as in response to environmental factors, such as exposure to radiation and chemical carcinogens. It is now well established that advancing age is associated with a reduction in the expression of mixed function oxidases, which in turn leads to a progressive increase in free-radical oxidation (Balin, 1983; Baker & Martin, 1994). Alterations to the structure of collagen and elastin, the destruction of DNA, and a progressive breakdown of the immune system are among the damages attributed to free radicals (Arking, 1991).

The formation of covalent and hydrogen bond cross-links between adjacent molecules is a consequence of age-related increases in free-radical oxidation (Bjorksten, 1968). The bonding of adjacent molecules alters their configuration and has significant functional consequences. For example, age-related changes in skin elasticity may be the result of the formation of cross-links caused by increases in free-radical oxidation (Partridge, 1970). Aging also is associated with significant declines in flexibility and range of motion (Vandervoort et al., 1992), and it is likely that these changes are due, in part, to intrinsic changes brought about by cellular aging.

Genetic Theories of Aging

Genetic theories of aging focus on the role of heredity in the regulation of senescence. Studies of identical twins reveal that a significant portion of age-related changes in physiological variables can be attributed to genetic mechanisms (Kallman, 1948). Medvedev (1981) proposed that aging is the result of a breakdown in the integrity of DNA nucleotide sequences. This loss of DNA sequences disrupts the ability of the cell to reproduce. Although some degree of DNA mutation occurs at all stages of the life cycle, the adverse consequences of these mutations are seldom realized until later in life.

Hayflick proposed that senescence is controlled by a purposeful sequence of events written into the genetic code (Hayflick, 1965; 1985). He showed that cells cultured in vitro exhibit a finite ability to reproduce. The Hayflick limit has been replicated in numerous tissues from a wide variety of species (Hayflick, 1985), and suggests that cellular aging is, at least to some extent, preprogrammed.

Hayflick’s finding indicates that, although important, lifestyle changes alone will not allow us to overcome the genetically programmed factors responsible for human aging. We cannot escape the aging process indefinitely.

Control Theories of Aging

A third class of theories explains aging in terms of the function of specific systems known to be vital for the control of physiological functioning. For example, it is now accepted that advancing age often compromises immune system functioning. Older persons not only exhibit a significant decline in T-cell activity, but they also are more susceptible to autoimmune disease (Walford, 1987).

The Major Histocompatibility Complex (MHC) is a complex series of genes that provides a viable link between the cellular genetic and control theories of aging. The MHC not only controls immunologic functioning, but also regulates the expression of mixed-function oxidases, which protect cells against damaging free-radical oxidation (Walford, 1983). Walford showed that genetic control of the immune system occurs in the MHC, the integrity of which typically deteriorates with advancing age (Walford, 1987). In addition to the immune system, the neuroendocrine and central nervous systems also have been implicated in the regulation of degenerative changes in aging (Arking, 1991; Baker & Martin, 1994). Future research will likely confirm the importance of several different control systems in the regulation of aging at the molecular, cellular and intact-organ levels.

Available evidence suggests that biological aging is a complex process regulated by numerous, redundant mechanisms. It is unlikely that a single biological mechanism can be identified as the principal factor responsible for senescence. Rather, it is more probable that a complex combination of mechanisms, acting at several different levels throughout the body, bring about the structural and functional changes that characterize old age. Since biological aging does not appear to be caused by a single mechanism, it is extremely unlikely that we will develop a "cure" for the aging process in the foreseeable future.

Figure 1.1
General Model of Aging

Structural Changes	Functional Consequences
Atrophy (↑)	Accuracy (↓)
Dystrophy (↑)	Speed (↓)
Edema (↑)	Range (↓)
Elasticity (↓)	Endurance (↓)
Demyelinization (↑)	Coordination (↓)
Neoplasm (↑)	Stability (↓)
Mutation (↑)	Strength (↓)

The Structural and Functional Consequences of Aging

The structural and functional consequences of aging are surprisingly consistent across a broad range of physiological systems. A general Model of Aging (Figure 1.1) summarizes the common structural and functional changes that are characteristic of aging throughout the body (Chodzko-Zajko & Ringel, 1987). With advancing age, most physiological systems eventually exhibit atrophy, dystrophy and edema at the cellular level. These disruptions in the integrity of the cell are, in turn, precursors of more gross morphological changes, such as decreased elasticity and compliance, demyelinization and neoplastic growth. As expected, these structural changes are almost always associated with profound behavior consequences

In much the same way that structural changes exhibit similarities across physiological systems, the functional consequences also are fairly consistent across different systems of the body. Aging organ systems, which are usually slower and less accurate, exhibit not only reduced strength and stability, but also decreased coordination and endurance.

Although structural decay and functional decline are an inescapable consequence of aging, both the rate and extent of this decline vary widely between individuals. Individuals may deviate from expected patterns of aging and, at least for some period of time, postpone the consequences of aging (Fries & Crapo, 1981). For example, while measures of cardiovascular functioning usually decline with age (Lakatta, 1990), physically fit and active individuals sometimes exhibit slower declines in function than less healthy people of the same age (Goldberg & Hagberg, 1990). Researchers at San Diego State University studied a group of regular exercisers for several decades. Declines in maximal oxygen consumption were considerably less than the 10 percent-per-decade decrease that is usually observed in the general population (Kasch et al., 1990).

The physiological consequences of aging cannot be offset indefinitely. Nonetheless, there is increasingly strong evidence to suggest that aging need not occur at a uniform rate. Indeed, many age-related changes may be modified by specific lifestyle interventions, including regular physical activity.

Lifestyle Interventions – Regular Physical Activity

The Benefits of Exercise for Older Adults

A good deal of attention has focused on the importance of regular physical activity as a means of enhancing health and effective functioning in old age. While most early research has focused on relatively young and healthy adults, there is now a conscious effort to extend our knowledge to a broader cross-section of the population. As understanding of the physiological, psychological and sociocultural significance of exercise grows, an increasing proportion of adults are opting to participate in some form of structured physical activity. Physicians and other healthcare professionals are now recommending exercise as an adjunct to more traditional therapy for a variety of physical and psychological disorders.

Two recently published reports strongly endorse participation in physical activity for individuals of all ages. In 1996, *The United States Surgeon General's Report* (U.S. Surgeon General, 1996) concluded that regular physical activity has important positive effects on the musculoskeletal, cardiovascular, respiratory and endocrine systems. Furthermore, the effect of exercise on these systems is associated with a number of health benefits, including decreased risk of premature mortality and reduced risks of coronary heart disease, hypertension, colon cancer and diabetes mellitus. In addition, regular participation in physical activity also appears to reduce depression and anxiety, improve mood and enhance our ability to perform daily tasks throughout the life span (U.S. Surgeon General, 1996).

The WHO *Guidelines for Promoting Physical Activity Among Older Persons* offer a similarly strong endorsement. The guidelines conclude that there is now compelling evidence that regular physical activity can assist in avoiding, minimizing and/or reversing many of the physical, psychological and social hazards that often accompany advancing age.

The following sections provide a brief overview of some of the physiological, psychological and social benefits of regular exercise. Whenever possible, an attempt is made to address both the acute effects of a single bout of physical activity, as well as the more persistent and long-term effects of sustained participation in exercise and physical activity. Because physical activity has been defined in many different ways, in this section, we will adopt the World Health Organization's broad and inclusive definition of physical activity, which includes all movements in everyday life, including work, recreation, exercise and sporting activities (WHO, 1997).

Figure 1.1

A Summary of the Physiological Benefits of Physical Activity for Older Persons

World Health Organization, 1997

Immediate Benefits:

- ✓ Glucose Levels: Physical activity helps regulate blood glucose levels.
- ✓ Catecholamine Activity: Both adrenalin and noradrenalin levels are stimulated by physical activity
- ✓ Improved Sleep: Physical activity has been shown to enhance sleep quality and quantity in individuals of all ages.

Long-term Effects:

- ✓ Aerobic/Cardiovascular Endurance: Substantial improvements in almost all aspects of cardiovascular functioning have been observed following appropriate physical training.
- ✓ Resistive Training/Muscle Strengthening: Individuals of all ages can benefit from muscle strengthening exercises. Resistance training can have a significant impact on the maintenance of independence in old age.
- ✓ Flexibility: Exercise that stimulates movement throughout the range of motion assists in the preservation and restoration of flexibility.
- ✓ Balance / Coordination: Regular activity helps prevent and/or postpone the age-associated declines in balance and coordination that are a major risk factor for falls.
- ✓ Velocity of Movement: Behavioral slowing is a characteristic of advancing age. Individuals who are regularly active can often postpone these age-related declines.

Physiological Benefits of Physical Activity

The physiological benefits of participation in regular physical activity are well established (see Table1.1). Among the short-term benefits attributed to regular exercise are improved sleep (Brassington & Hicks, 1995), improved glucose regulation (Giacca et al, 1994) and increases in catecholamine activity (Richter & Sutton, 1994). Long-term adaptation to extended exercise participation includes improved cardiovascular performance, increased muscular strength and endurance, enhanced flexibility and range of motion, decreased adiposity and improved lipid status (Spirduso, 1995). Goldberg and Hagberg (1990) suggest that the physiological responses of older adults to exercise training are essentially the same as those experienced by younger individuals. Several of the ore common physiological adaptations associated with regular physical activity are discussed below.

Cardiovascular Function

Maximal oxygen consumption (VO_2max) during exercise is an excellent measure of cardiovascular fitness (McArdle, Katch & Katch, 1994). VO_2max was previously thought to decline at a constant rate with advancing age (about 10 percent per decade). This decline was considered to be relatively stable across subjects and, to a large degree, independent of physical activity status (Hodgson, 1971; Dehn & Bruce, 1972). However, a number of recent studies suggest that age-related changes in VO_2max may be more variable (Heath et al., 1981; Rogers et al., 1990). For example, highly trained individuals who maintain high activity levels often experience little or no decline in VO_2max over periods of a decade or more (Kasch, Wallace3 & VanCamp, 1985; Pollock et al., 1987).

Although the mechanisms by which exercise influences cardiovascular performance in older adults are complex, there is evidence to suggest that both central (increased cardiac output) and peripheral (increased oxidative capacity of the skeletal muscle) factors are involved (Hagberg & Goldberg, 1990). It is not possible to postpone age-related declines in aerobic capacity forever. Nonetheless, there is increasingly strong evidence to suggest even modest levels of physical activity can result in significant increases in cardiovascular efficiency in old age.

Pulmonary Function

Pulmonary efficiency declines with age, resulting in compromised lung elasticity and compliance (McKeown, 1965). Degenerative changes in the vertebral discs alter the shape of the thoracic cavity with a resultant reduction in pulmonary volume (McKeown, 1965). Decreased strength and mass of the thoracic muscles further compromise pulmonary efficiency (Dhar, Shastri & Lenora, 1976), as do calcification and ossification of the costovertebral and costochondral joints (Grant, 1972).

In young and middle-aged individuals, aerobic exercise has minimal effects on vital capacity, expiratory volumes and other measures of pulmonary performance (Shephard, 1993). However, because regular exercise is associated with reduced vertebral degeneration rates and increased thoracic muscle strength, physical activity may help preserve adequate levels of pulmonary function in older adults (Shephard, 1993). Further research is needed to determine the precise effects of exercise on pulmonary performance in older populations.

Blood Pressure

More than 20 million older Americans have hypertension (Kannel & Vokanas, 1986). While both systolic and diastolic blood pressure increase significantly with advancing age (Spirduso, 1995), several exercise-training studies have shown that physical activity can reduce systolic and diastolic blood pressure in patients with borderline hypertension (Hagberg & Goldberg, 1990). For example, Hagberg et al. (1985) demonstrated that a six month program of low-intensity walking significantly lowered both systolic and diastolic blood pressure in hypertensive adults aged 60 to 65 years. These data suggest that exercise may have anti-hypertensive effects in older individuals similar to those previously reported in younger populations.

Blood Lipids

Aging is associated with increased in both total cholesterol and serum triglycerides (Buskirk, 1985). Hypercholesterolemia and hyperlipidemia are major medical problems that lead to the premature development of coronary artery disease (Castelli et al., 1977). Exercise training is now commonly associated with a reduction of coronary heart disease risk, and the American Heart Association (AHA) recognized sedentary living as an independent risk factor for the development of atherosclerosis (Fletcher et al., 1992). A number of studies have shown that highly trained masters athletes exhibit favorable biochemical profiles (reduced low-density lipoprotein cholesterol, elevated high density lipoprotein cholesterol) when compared with sedentary individuals of the same chronological age (Seals et al., 1984; Tamai et al., 1988). Because almost all instances of favorable improvements in biochemical profiles are associated with coincident decreases in body weight, it is frequently difficult to dissociate the effects of exercise from the effects of weight loss (Hagberg &Goldberg, 1990). These problems notwithstanding, there is sufficient evidence to suggest that regular exercise is associated with a decrease in body fat, which, in turn, is associated with a decrease in circulating lipids. However, the effect of exercise on blood lipids appears to be transient, and blood return to pre-exercise values within a few days of cessation of physical activity (WHO, 1997).

Muscle Strength and Endurance

Muscle strength and endurance decline significantly with advancing age (Spirduseo, 1995). Until recently, strength training was seldom emphasized as a component of exercise programs designed for older adults. The lifting of heavy weights requires maximal or near-maximal muscular contractions that, if incorrectly performed, can result in sharp increases in blood pressure due to a physiological mechanism known as the Valsalva maneuver (McArdle, Katch, & Katch, 1994). Since these acute elevations in blood pressure are potentially dangerous for hypertensive individuals, most professional organizations do not advocate strength training for older adults. However, a number of recent studies have examined the effect of dynamic strength training in elderly adults. Morgan et al. (1995) demonstrated that older adults who trained with weights for 12 months were able to gain appreciable increased in muscular strength and endurance. No adverse consequences associated with weight training were reported in this study. Fiaterone et al. (1990) demonstrated that men and women as old as 90 years can safely lift heavy weights (80 percent of 1 repetition maximum). Remarkable strength gains in excess of 100 percent were reported for some of the muscle groups training in this study.

Since the maintenance of adequate levels of muscular strength is critical for successfully performing many activities of daily living, exercise scientists are reevaluating the importance of strength training as a component of exercise programs for elderly adults. The American College of Sports Medicine recommends the inclusion of low- to moderate- intensity strength exercises in exercise-training regimens for older adults (ACSM, 1995).

Flexibility

Aging is associated with changes in the elasticity and compliance of connective tissue (Spirduso, 1995), resulting in significant decreases in flexibility and range of motion. Although declines in flexibility and active range of motion are observed in most seniors, there is some evidence to suggest that declines in these areas are due in part to decreased physical activity, and that not all older individuals lose flexibility at the same rate (Campanelli, 1996). Stretching exercises that emphasize range of motion and flexibility have been shown to increase ankle, knee joint and lower back flexibility in older adults (Frekany & Leslie, 1975). Almost all structured exercise programs advocate the inclusion of callisthenic exercises prior to aerobic exercise (Spirduso, 1995).

Psychological Benefits of Physical Activity

In addition to its effects on physiological variables, physical activity also can have significant psychological consequences. A summary of the long- and short-term benefits of physical activity for psychological functioning is included in Table 1.2.

Figure 1.2
A Summary of the Physiological Benefits of Physical Activity for Older Persons
World Health Organization, 1997

Immediate Benefits:

- ✓ Relaxation: Appropriate physical activity enhances relaxation
- ✓ Reduces Stress and Anxiety: There is evidence that regular physical activity can reduce stress and anxiety.
- ✓ Enhanced Mood State: Numerous people report elevations in mood state following appropriate physical activity.

Long-term Effects:

- ✓ General Well-being: Improvements in almost all aspects of psychological functioning have been observed following periods of extended physical activity..
- ✓ Improved Mental Health: Regular exercise can make an important contribution in the treatment of several mental illnesses, including depression and anxiety neuroses.
- ✓ Cognitive Improvements: regular physical activity may help postpone age-related declines in central nervous system processing speed and improve reaction time.
- ✓ Motor Control and Performance: Regular activity helps prevent and/or postpone all age-associated declines in both fine and gross motor performances.
- ✓ Skill Acquisition: New skills can be learned and exitin skills refined by all individuals regardless of age.

Among the short-term psychological benefits attributed to regular exercise are improved relaxation (Landers & Petruzzello, 1994), reduced stress and anxiety (Petruzzello et al., 1991) and improved mood state (Nieman et al., 1993). Long-term benefits include improved life satisfaction (Berger & Hecht, 1990), enhanced self-esteem and heightened self-efficacy (McAuley & Rudolph, 1995) and fewer mood state disturbances (O'Connor, Aenchbacher & Dishman, 1993). Some of the more common psychological benefits associated with regular physical activity are discussed below.

General Psychological Well-being

Although psychological health consists of both positive and negative components, previous research in the exercise sciences has focused predominantly on the effects of physical activity on negative components of psychological health, such as depression, anxiety and other stress-related disorders. McAuley and his colleagues (McAuley, 1994); McAuley & Rudolph, 1995) argued the importance of examining the relation between physical activity and more positive elements of psychological functioning, including self-esteem, self-efficacy and general well-being.

A review of 38 studies examining the relation between regular physical activity and general psychological well-being in older adult populations indicates that the vast majority of studies report a positive association between physical activity and well-being (McAuley & Rudolph, 1995). While this relationship appears to be independent of the mode of exercise employed (Mihalko & McAuley, 1996), the strength of the association is greatest for programs lasting 10 weeks or longer.

Depression and Anxiety

The incidence of depression increases significantly with age (LaRue, Dessonville & Jarvik, 1985). However, several studies suggest that the association between chronological age and depression may be confounded by decreases in physical activity levels that usually accompany advancing age (Parent & Whall, 1986; Berkman et al., 1986). When statistical procedures are used control for individual differences in fitness, the association between advancing age and depression is substantially reduced (Chodzko-Zajko. 1990). Accordingly, data suggesting depression increases with age may be at least partially due to the tendency for physical activity levels to decline with age and not simply due to the passage of time.

A number of studies have shown that participation in regular exercise reduces depression in patients with mile-to-moderate levels of clinical depression (Greist et al., 1979; Martinsen, Medhus & Sandvik, 1985). Similarly, studies with non-clinical populations also indicate beneficial effects of exercise on mood state and anxiety (Morgan & O'Connor, 1987). Despite this association between physical activity and depression, it has yet to be conclusively demonstrated that e3xercise plays a causal role in the reduction of depression (O'Connor, Aenchbacher & Dishman, 1993). Additional research is needed to examine the precise nature of the relationship between physical activity and both anxiety and depression in old age.

Cognitive Functioning

Age-related declines in cognitive performance are well established. However, cognition is not a unitary phenomenon and there are wide variations in the magnitude of changes in cognitive performance tasks observed with advancing age. Age-related changes in cognitive performance appear to be maximized for tasks that require rapid and complex processing, and are minimized for tasks that are more automatic or can be performed at a self-paced rate (Chodzko-Zajko & Moore, 1994).

Despite the fact that both processing resources and cognitive performance decline with advancing age, there are often considerable differences between subjects in both the rate and extent of this decline. There is now substantial evidence to support the hypothesis that physically fit older adults often process cognitive information more efficiently than less-fit individuals of the same chronological age (Chodzko-Zajko, 1991). However, it is clear that the relationship between physical fitness and cognition is highly task-dependent. Physical fitness effects are observed more often during tasks requiring rapid cognitive processing than during self-paced or automatic processing tasks (Chodzko-Zajko & Moore, 1994). Because numerous task and subject-related factors can influence the relationship between fitness and cognition, extreme caution is warranted before making generalizations about the influence of physical fitness on cognitive performance.

Despite the presence of a cross-sectional association between fitness and cognitive performance, the effect of exercise on cognitive performance remains unclear. Several well-controlled studies successfully demonstrated improvement in cognitive performance following training (Dustman et al., 1984; Hawkins, Kramer & Capaldi; 1992; Moul, Goldman & Warren, 1995). However, at least as many studies have been unable to replicate these finding (Blumenthal et al., 1989; 1991; Panton et al., 1990). Both the magnitude of improvement in aerobic capacity and the demand-level of the cognitive task may be important factors in determining the presence or absence of training effects. It is important to point out that the magnitude of changes in cognitive performance observed following exercise has always been small. At present, there is no compelling evidence to suggest that short-term exercise training results in clinically significant improvements in cognition.

A number of mechanisms have been proposed to explain the relationship between physical fitness and cognitive performance in old age (Chodzko-Zajko & Moore, 1994). Some evidence suggests that highly fit adults process information in the central nervous system faster and more efficiently than less-fit individuals of the same chronological age. This increased efficiency may be secondary to improvements in cerebral circulation, nerve cell regeneration and/or changes in neurotransmitter synthesis and degradation.

Social Implications of Regular Physical Activity

The vast majority of research studies examining the effects of exercise on the aging process have focused on the physiological and psychological benefits of activity. However, it would be inappropriate to conclude this section without a brief comment about the importance of physical activity for the social functioning of older persons.

In the WHO Guidelines for Promoting Physical Activity Among Older Persons, a number of significant short- and long-term effects of physical activity on sociocultural variables are discussed (see Table 1.3). Empowering older individuals and assisting them in playing a more active role in society are among the social benefits attributed to physical activity.

Aging is associated with a need to adjust to changing roles. Factors such as the deaths 0f friends and loved ones, retirement, financial hardship, ill health and isolation force many older people to systematically relinquish more and more of the roles that are meaningful part of their identity (McPherson, 1990). Physical activity can help older persons better adjust to these changing roles. Activity programs provide seniors with the opportunity to widen their social networks, to stimulate new friendships and acquire positive new roles in their retirement (McPherson, 1990, 1994).

Advancing age is characterized by a progressive and insidious decline in the functional capacity of most physiological systems. While these declines in functional capacity are, to a large extent, inevitable and inescapable, considerable differences exist between individuals in the rate and extent of this decline. Several lines of research suggest that individuals who engage in healthful behaviors can often postpone or reduce these adverse consequences and, thus, deviate from expected patterns of aging.

The *United States Surgeon General's Report on Physical Activity and Health* recommends incorporating regular physical activity, which has significant physiological, psychological and sociocultural benefits, into the everyday lives of all Americans of all ages. The World Health Organization (WHO, 1997) concludes that there is now ample evidence that physical activity is associated with improvements in functional ability and health status and may frequently prevent or diminish the severity of certain diseases.

The benefits of physical activity are not restricted to the healthiest segment of the older-adult population. On the contrary, there are significant benefits of physical activity for even the most frail members of society. As the advantages of physical activity for older adults become more widely appreciated, it is likely that a growing proportion of the population, regardless of age, will begin to include exercise as an integral component of their everyday routine.

Figure 1.3
A Summary of the Social Benefits of Physical Activity for Older Persons
World Health Organization, 1997

Immediate Benefits:

- ✓ Empowering Older Individuals: A large proportion of the older adult population voluntarily adopts a sedentary lifestyle, which eventually threatens to reduce independence and self-sufficiency. Participation in appropriate physical activity can help empower older individuals and assist them in playing a more active role in society.
- ✓ Enhanced Social and Cultural Integration: Physical activity programs, particularly when carried out in small groups and/or in social environments, enhance social and inter-cultural interactions for many older adults.

Long-term Effects:

- ✓ Enhanced Integration: Regularly active individuals are less likely to withdraw from society and more likely to actively contribute to the social milieu.
- ✓ Formation of New Friendships: Participation in physical activity, particularly in small groups and other social environments stimulates new friendships and acquaintances.
- ✓ Widened Social and Cultural Networks: Physical activity frequently provides individuals with an opportunity to widen available social networks.
- ✓ Role Maintenance and New Role Acquisition: A physically active lifestyle helps foster the stimulating environments necessary for maintaining an active role in society, as well as for acquiring positive new roles.
- ✓ Enhanced Intergenerational Activity: In many societies, physical activity is a shared activity that provides opportunities for intergenrerational contact, thereby diminishing stereotypical perceptions about aging and the elderly.

SELECTIONS ON THE PHYSIOLOGY OF AGING

From

Aging, Physical Activity & Health

By

Roy Shepard

Muscle Strength, Endurance, and Coordination

The muscle atrophy that accounts for so much of the decrease in lean mass with aging reflects both a decrease in average fiber size and a decrease in the number of muscle fibers (Aoyagi and Shepard 1992). However, it remains unclear how large a fraction of the total loss of muscle tissue is due to aging per se and how much reflects a decrease of habitual physical activity with aging (Lexell 1993). In support of the latter explanation, individual examples have been cited of very active individuals in whom little loss of lean mass has occurred over an extended period of observation (Bemben et al. 1995; Forbes 1987).

Muscle endurance is generally better preserved than peak muscle strength as people age (LaForest et al. 1990), although some authors have also described age-related decreased in endurance (for example, Clarke, Hunt, and Dotson 1992). The strength of most muscle groups shows a pattern of decline similar to that described earlier for lean tissue mass, although in part because of measurement problems and in part because of alterations in composition of the lean compartment, the correlation may not be very close (Shepard et al. 1991). Much of the muscle atrophy and associated loss of strength seems to reflect a selective denervation of muscle fibers, with reinnervation by axonal sprouting from an adjacent unit that has retained its nerve supply (Brooks and Faulkner 1994; Aoyagi and Shephard 1992). The greatest functional losses occur among the largest and fastest motor units (Doherty, Vandervoort, and Brown 1993). Accordingly, some authors have found that the decrease in strength is most obvious at high speeds of muscle contraction (LaForest et al. 1990). However, Harries and Basey (1990) reported a similar age-related loss of isokinetic strength at all speeds over the range of 0 to 5.24 red/sec.

Liver

The liver undergoes a substantial reduction in mass from age 60 to age 90 years, but in the absence of heart failure or alcoholism, hepatic function seems only marginally affected (Morris et al. 1991); any changes do not seem to influence exercise performance.

Kidneys

The kidneys reach their maximal size in early adulthood and show an accelerating decrease in mass after the age of 50 years. By the age of 80 years, the total renal mass averages only 70% of the young adult peak value (McLachian 1987). Nevertheless, when assessing whether such a loss has occurred in an elderly exerciser, it is difficult to dissociate the effects of local ischemia and renal infections from the normal aging process (Cox, Macias-Nunez, and Dowd 1991). Moreover, when assessing function, one must take account of the overall decline in lean body mass and peak aerobic power. Thus, residual renal function usually remains adequate to meet the demands of a smaller peak rate of muscle metabolism until the senior reaches an advanced age.

The loss of renal tissue is accompanied by an obliteration of glomeruli, a reduction in the number of glomerular capillary loops, and a progressive deletion of entire nephron units. By the age of 80 years, renal blood flow in only 50% of the young adult peak. The glomerular filtration rate shows at least a parallel decline. The elderly person thus has increasing difficulty in correcting the disturbances of mineral (Mascis, Bondia, and Rodriques-Commes 1987; Suderam and Manikar 1983) and water balance (Bengele et al 1981) that may arise when exercising in a hot environment. Correction of an acidosis also takes longer than it would in a younger person (Maciaset al. 1983).

Bone

There is general agreement that senescence is associated with a progressive loss of both minerals and matrix from the bones, although as with so many other issues of aging, it is less clear to what extent this is an inevitable process and to what extent it reflects a decrease of habitual physical activity or some pathological change.

Osteoporosis implies a low bone mass and associated micro-architectural deterioration in the bone tissue (Kiebzak 1991). During the perimenopausal period, the process affects mainly trabecular (spongy) bone, predisposing to compression fractures of the vertebrae and fractures of the wrist on falling. However, in older individuals there is a progressive loss of both trabecular and compact bone, predisposing to hip fractures.

Some authors distinguish osteomalacia (pathological deficiency of calcification, but a normal bone matrix) from osteoporosis (in which the amount of bone is reduced, but its characteristics are unchanged). Common causes of osteomalacia are lack of magnesium, boron, and vitamins C and D (a dietary deficiency, a lack of exposure to sunlight and thus reduced endogenous synthesis of vitamin D, or a poor intestinal absorption of calcium and phosphorus); hepatic disease (leading to impaired 25-hydroxylation of vitamin D); and renal problems or a high intake of protein or sodium (all of which lead to an increased excretion of calcium, vitamin D, or both).

Other investigators distinguish osteopenia (a loss of bone mass for example 2.5 SD below the reference standard for a young adult) from osteoporosis (a combination of osteopenia with a mechanical failure of the skeleton). A third basis of classification distinguishes primary osteoporosis (due to aging) and secondary osteoporosis (where there is some additional cause such as immobilization of a body part, a nutritional deficiency, and endocrine disorder, a malignancy, a genetic abnormality or the prolonged use of drugs such as corticosteroids).

Genetic factors have a major influence on peak bone mass, possibly accounting for as much as 60% to 80% of interindividual variability (Slemenda and Johnson 1994; Slemenda, Miller, Hui, et al. 1991; Slemenda, Miller, Reister, et al. 1991). On the other hand, interindividual differences in the subsequent rate of bone loss seem to be determined more by environmental factors. A number of authors in the Untied States have stated that African Americans have a higher peak bone density than white or Asian subjects, although it is difficult to establish how far racial differences in socioeconomic status and lifestyle contribute to these observed differences.

Bone loss is well-recognized complication of bed rest (Krolner and Toft 1983) and immobilization of a limb (Chi et al. 1983). Many cross-sectional comparisons have found better conservation of bone mass in active than in sedentary subjects (Drinkwater 1994). Muscle development (a marker of habitual activity) is also inversely related to bone loss (Cottreau et al. 1995; Sandler 1989).

Vision

Aging is associated with a progressive deterioration in various aspects of vision, many of which tend to limit the range and extent of physical activities and the performance attained (Makris et al. 1993). There is a reduction in the visual field, difficulty in focusing upon near objects (a lack of accommodation), and a steady diminution of visual acuity (Graham 1991; Stelmach and Worringham 1985). A substantial minority of the elderly population reach the legal definition of blindness, and most of the remainder need to wear some type of glasses. Weakness of vision in one eye, impaired proprioceptor function in the eye muscles, and poor retinal focusing lead to a deterioration of spectroscopic vision in many seniors. These various impairments lead to difficulty in distinguishing colors (particularly at night), an impaired performance of tasks that depend on visual skills, and a greater risk of collision with external objects.

Shrinkage of the visual field is caused in part by mechanical factors. Drooping of the upper eyelid (senile ptosis) restricts vision in an upward direction, while loss of fat from the rear of the eye socket causes a sunken eyeball, limiting vision in all directions. These external changes may be exacerbated by a pathological distortion of the retina itself, associated with an increase of intraocular pressure (glaucoma).

The near point at which small objects can be brought into focus increases from around 0.1 m for a young adult to 0.5 m for a person aged 50 years and 1 m for a person 70 years of age. The rate of accommodation of the eye to a change of focal length is also slower in an old person. Difficulties of refraction are compounded by an increase in the anteroposterior diameter of the lens, a yellowing of the lens substance, coreneal astigmatism, an uneven refraction of the light associated with the loss of retro-orbital fat, and an increased scattering of light both in the lens and in the vitreous fluid (Michaels 1994).

The cross sectional area of the pupil is greatly reduced in an old person because of the rigidity and atrophy of the iris. The ability of light to penetrate the eye is further diminished by changes in the optical properties of the lens, and the development of opacities in the vitreous fluid. The chemical constituents of the lens appear to be vulnerable to oxidation by superoxides, and changes can thus be minimized by a large intake of ascorbic acid, vitamin E, and other antioxidants (Graham 1991). Floaters in the vitreous fluid are commonly produced by sudden jarring movements that tear the posterior surface of the vitreous from the optic disk (Graham 1991). By the age of 60 years, the retina receives only about one-third as much white light and one-ninth as much blue light as in a young adult.

Hearing

Auditory acuity decreased with aging (Mills 1991). Often an old person has a poorer ability to understand speech than might be inferred from pure tone audiometry (Mills 1991). This leads to withdrawal of the senior from all types of social events, including those that generate physical activity.

Some investigators have ascribed a major part of hearing loss to environmental noise. This can be an important factor in certain industries, particularly if adequate ear protection is not worn; but in general, intrinsic age-related changes seem to be more important (Davis 1987). Effects from a thickening and loss of elasticity in the eardrum and from impaired articulation of the ossicles of the middle ear are small, but larger adverse effects stem from a progressive loss of receptor nerve cells in Corti's organ, a decrease of elasticity in the vibrating partition in the cochlea, damage to the auditory nerve, and a deterioration of function in the brainstem nuclei or the auditory cortex. Only about 1.6% of young adults have a significant hearing impairment, but by the age of retirement 12% to 30% of the population are affected, and by the age of 80 years more than 50% of people have a substantial hearing impairment. A hypersensitivity to sound (loudness recruitment) may also develop, so that noisy conversation or loud music for gymnastics class may cause annoyance and even pain.

The old person has particular difficulty in detecting high-frequency sounds (Moller 1981) and in distinguishing a true signal from random "noise." A part of the latter is generated internally in the auditory pathway (the sensation of tinnitus, a ringing or buzzing in the ears; Coles 1981). As a consequence of these various changes, the auditory reaction time increases and the affected individual has difficulty in detecting the direction from which a sound originates.

Reaction Speed and Central Processing

The speed of response to signals (a combination of reaction speed and movement time) decreases progressively with aging. The slowing of response is particularly marked if the subject must make generalizations, undertake a complex task (Lupinacci et al. 1993), or must distinguish between several competing signals (Charness 1991; Era, Jokela, and Heikkinen 1986; Stelmach 1994). Tasks that require effortful processing seem particularly sensitive to personal fitness (Chodzo-Zajko 1991).

Often the inherent loss of function with aging is exacerbated by an excessive use of depressant medications (Jarvik and Neshkes 1985), hormonal disturbances (Lavis 1981), or nutritional deficiencies (particularly a lack of B vitamins). In contrast, the slowing of reaction speed is sometimes less obvious in active individuals who have maintained or developed a large aerobic power (Era, Jokela, and Heikkinen 1986; Whitehurst 1991). Tasks with a heavy visuospatial demand seem particularly well preserved in the fit individual (Shay and Roth 1992).

Balance

A progressive loss of cells in the brainstem and cerebellum, a diminution of proprioceptor function in the joints and eye muscles, degenerative changes in the saccule and the utricle, and muscle weakness all limit the ability of an older person to control body movements, including the corrective movements that are needed when the center of gravity is displaced by some external force (Woollacott 1993). Balance thus shows a progressive deterioration with aging (Buchner et al. 1993; MacRae, Feltner, and Reinsch 1994; Pyykko et al. 1988). Older people have particular difficulty in balancing under condition of sensory conflict (for example, when walking near a stream of fast-moving vehicles).

Corrective responses to a loss of balance are initiated more slowly than in a younger individual and are sometimes disorganized, with a response of both agonist and antagonist muscles (a general stiffening of the limbs). Body sway reaches a minimum in the teen years and increases progressively thereafter. At any given age, women show more sway than men, because of a poorer muscle mass/body mass ratio and (possibly) because their shoes provide less ankle support. Poor balance and increased body sway not only increase the risk of falls, but also lead to deterioration in the mechanical efficiency of movement, as discussed earlier.

Conclusion

There are substantial technical difficulties in defining and sampling a healthy population of elderly individuals, and it is even more difficult to follow them longitudinally. Most body systems show an accelerating, age-related decline of function, but the extent to which this is due to a parallel decline in habitual physical activity remains unclear.

Standing height decreases with age, due mainly to kyphosis and compression of intervertebral disks. Body mass increases during middle age, but remains more constant in older age, as lean tissue is replaced by fat. The loss of muscle mass leads to a progressive loss of both minerals and matrix with aging, and they become progressively more vulnerable to fracture. A deterioration in the joint surfaces leads to a high prevalence of arthritis; this often restricts daily activities. Loss of resilience in tendons and ligaments predisposes to strains and sprains. There is a progressive decrease in peak heart rate with age; and increase of stroke volume offers some compensation in submaximal effort, but the peak cardiac output decreases in parallel with the decline in maximal oxygen intake. There is a progressive rise in systolic blood pressure with age, but poor regulation of blood pressure leads to increasing prevalence of postural hypotension. The respiratory system shows a stiffening of the thoracic cage, but a loss of elasticity in the pulmonary tissue. Vital capacity decreased and residual volume increases but there is little change of total lung capacity.

Airway collapse becomes increasing probable during vigorous expiratory effort. Gas distribution also becomes nonuniform, but healthy elderly people are able to maintain their arterial oxygen saturation during vigorous exercise. Age-related gastrointestinal and renal changes have implications for fluid replenishment during exercise in the heat. Aging of the brain leads to difficulties with short-term memory, cognition, and the learning of new tasks. Deteriorations in vision and hearing also handicap some activities. Task performance may be compromised by poor gait, tremor, lack of balance, and a propensity for falls. Aging of the endocrine system hampers maintenance of the *milieu interieur* during prolonged activity, and deterioration in various components of the immune system may limit repair processes following very heavy bouts of exercise.

STAYING FIT OVER FIFTY

Selections From:

Staying Fit Over Fifty

By

Jim Sloan

A Booming Fitness Industry

The marketing experts tell us we Baby Boomers have built our identities on youth and vitality and that we're not about to let our fortieth or fiftieth birthdays change the way we think of ourselves. Maybe that's why fitness is a $3-billion industry in the Untied States. Membership in health clubs is soaring, attendance at community running races is up, and sales of in-home fitness equipment, from treadmills to cross-country ski simulators to stationary bikes, are increasing exponentially. In 1987, 4.4 million Americans exercised regularly on a treadmill. By 1997, 36 million did. Books such as Covert Bailey's *Fit or Fat* and *Smart Exercise* – folksy but at times highly technical looks at the physiological ramifications of diet and exercise – find a place on the best-seller lists. Dr. Kenneth Cooper, the man who coined the term aerobics and today is considered by many to be the father of the modern fitness boom, gives about fifteen speeches a month at $10,000-$15,000 a pop. Cooper has written fourteen books on fitness and in 1997 he became partner in a new $19-million fitness complex in Vero Beach, Florida, that will become the sister institute to his sprawling fitness research center in Dallas.

"We have developed a niche in medicine that, right now, is just exploding," Cooper says.

Never before, it seems, have Americans known so much about the benefits of exercise – how it can prolong life, stave off a wide variety of deadly diseases, and keep your mental and physical faculties as sharp as a teenager's. Never before have people like Rich Abrahams had the knowledge and self-confidence it takes to swim 100 yards in less than 50 seconds. As recently as thirty years ago, physiologists believed you couldn't build muscle in an older person; now exercise experts are buying free weights for their grandmothers and ninety-year olds are working out on weight machines in rest homes. Sixty-year-olds who are put on the same cardiovascular and strength-building programs as twenty-year-olds enjoy the same gains in muscle mass and endurance.

For generations we have believed that the body will slow down and dry up starting sometime after your thirty-fifth birthday. But now we know that isn't true. People who keep exercising won't see any significant physical decline until they are sixty, and even then there is no reason to stop running or climbing mountains. Anything is possible. When you look at it this way, we are in a fitness renaissance, a turning point in history where science is flowing into mainstream attitudes to create a tide rich in health and promise.

The life expectancy of a typical American was forty-seven in 1900; today it's around seventy-five and growing every year. In fifty years, the average life expectancy will be eighty-two years, and there will be more than 1 million people in the Untied States who are over one hundred years old. We are the beneficiaries of medical and social advancements that have nearly wiped out the threat of mass starvation, widespread homicide, unsanitary living conditions, and deadly epidemics. And we are growing old at a time when science has shown that the secret to living better and living longer is exercise. These are not charlatans telling us this. These are scientists.

It's Not All Downhill After Thirty-Five

Until recent years, most studies on aging were done on sedentary people. As people grew older you could document the decline in their strength and flexibility, the hardening of their arteries, the shortening of their breath and muscles. You could measure the thickening of their waists and hips, their increasing awkwardness, and the slow muddling of their minds. This was aging. People who exercised tended to skew the results, so they were left out.

That's changing. Scientists are showing more interest in studying how people like Rich Abrahams age, and what they are fining is quite amazing. In one study at the Center for Evaluation of Human Performance at Mount Sinai Medical Center in Milwaukee, a group of world-class athletes over age forty who continued to train and complete at high levels either maintained or improved their maximal oxygen consumption (VO_2 max) into their fifties. This flies in the face of previous finding that VO_2 max, the amount of oxygen a person can consume at the height of exercise, declines about 1 percent a year among sedentary people and 0.5 percent a year among fit people after their thirtieth birthday.

In fact, researchers found that those who continued to train hard didn't show much decline in general fitness until their late fifties and early sixties, and even then it was fairly minor. Elite athletes can't expect to continue to improve into their fifties because they trained at peak levels at a time early in life when their biological machinery was best suited to accommodate it. But for those of us who have stayed in shape but have been training inconsistently most of our lives, there is no reason why we can't use modern training theory and calculated approaches to get faster or stronger. Not only can we improve our fitness – our muscle strength and endurance, our aerobic capacity, our flexibility – but we can improve our times for a marathon or a 10-kilometer cross-country ski or a mile swim, at least until we're in our late fifties and sixties.

A twenty-year study at the University of Southern California is finding that those who train and work hard can show impressive levels of fitness, even in advanced years. The study is tracking 150 competitive athletes who range in age from forty-something to ninety-one years old, with an average age of fifty-four. Every two years they come to a lab to run on a treadmill, get blood drawn, and get dunked in a body-fat-measuring water tank. It sounds pretty grueling, but most of the subjects in the study volunteered to be in it. Many of them run track and cross-country, but there are also cyclists, basketball players, and avid swing dancers in the group. One-forth of the subjects are women – a group that has been neglected in other studies.

In addition to staying in great competitive shape – some of the athletes have lost only about 2 minutes a year in their marathon times – most of these people are also in excellent general health. Their levels of high-density lipoproteins (HDLs, the good cholesterol) are 40 to 60 percent higher than the average for people their age. Their pulse rates are much lower than average, and so it their blood pressure. They don't get sick as often. They want to live longer and healthier. Not all of the are elite athletes, but one thing they all share is that they have seen what is happening to other people their age and they don't want to have it happen to them.

Stating Motivated

Every day at around noon, Kim Layton, an estimator for an engineering firm who is in his late fifties, pulls away from his des, drags out a small box filled with old running shoes, a wool hat, a paint-stained sweatshirt, and the rest of his workout clothes and heads out for a run along the river near his office. He runs 8 to 10 miles every day. When he returns, he quickly sponges off in the bathroom, puts his street clothes on, and gets back to work at his desk with a sandwich and a drink.

Layton has been an athlete for years. He was on the U.S. Olympic luge team in 1968. He's raced bicycles on a national level and he's pushed himself to the top ranks of cross-country skiers in his age group in recent years. He's an accomplished swimmer. And in 1998, his fifty-sixth year, he set a personal best in the marathons and achieved a goal he has sought for many years: He broke 3 hours for a 26.2 mile race. But there is nothing boastful or proud about this balding, white haired man you see running through the rail yards and past the factories near his office. There is a quiet, almost monastic devotion to his pursuits. And he doesn't think of age as an obstacle to his athletic pursuits.

"Age is only a number if you're willing to do something about it," he says.

You can talk at length about why some people (an estimated 22 percent of the country) stay with exercise programs and why most people who start exercising quickly drop out. They don't have time. They get injured. But the reason people like Kim Layton stay with exercise and continue to improve long after many have given up is more than plain determination. Kim Layton is an athlete. That is what he is. Being an athlete makes him happy. It makes him proud. He may not say that, but it does. The ancient Greeks, who asked the Persians to hold off their invasion until they were finished competing in their Olympic Games, called it their ethos – their guiding beliefs.

LEGIONS OF OLDER ATHLETES AROUND THE WORLD ARE FINDING WAYS TO STAY FIT AND EVEN GET FASTER AND STRONGER.

Patrick Fontane, a researcher from the St. Louis School of Pharmacology, has been studying older athletes for years. He's surveyed hundreds of older people who have not only stayed in shape but continued to compete in national events. Most of the people he talks to aren't champions – those seventy-year-old genetic aberrations who run a marathon a week – but regular folks who like to stay in shape and go to track-and-field or swim meets occasionally. The common thread he's found is that these people believe in are motivated by what Fontane calls competitive health. When they go to the doctor, they want her to be shocked at how low their cholesterol levels are, how low their resting heart rate is, how voluminous their lungs are. About 55 percent of these people stay healthy because they want to compete, the rest compete because it helps them stay healthy.

And they want to prove something to themselves. This often pushed them to remarkable achievements. The smart ones, according to Fontane, have "a sense of rhythm." They are more tuned into when it's time to push and when it's time to rest. And they find the time to work out.

"People come up with all sorts of excuses not to work out, but in the end It's about how you value your word to yourself," says Bari Beckett, a certified personal trainer, fitness video producer, and all-around high-powered fitness apostle. "It's about making a pact with yourself. You can't be committed to making a change with one foot out the door."

Writer John Jerome believes "staying with it," the title he chose for his book about returning to athletics in his late forties, requires "a leap of faith."

"You have to believe in the training effect," he says. "The training effect is the astonishing physiological principle that says that the organism improves in response to stress. Every athlete has experienced it's gentle galvanization. Athletes come to know that if they are only steadfast, the training effect will rescue them from torpor and temporary discomfort. Dropouts have to relearn this every time.

For most successful older athletes, there is a strong emotional component to their physical pursuits. A fun, a climb, or a ski into the backcountry is a confluence of the body's work with the work of the mind. When we glance down at our watches and see that we have just run a mile faster than ever before and aren't even breathing hard yet, we have a sense that we have figured it out. The work is paying off. The heart is strong, the blood is rich, and the muscles are reliable and willing to do the work. Psychologists say that most people are unhappy because they rush about too much. They worry about what happened this morning while they anticipate what will happen this afternoon. They overlook the here and now, the moment, the liberating pleasure of a bit of food or a sip of cold water on a hot day. This is what sport – exercise – gives back to older athletes. It brings us back to the moment in which we are living and it sharpens its joys and sorrows – just as light rays are gathered in a lens and focused into heat and flame.

Sport forces you to reclaim your body, to reoccupy its outer reaches. Gerontologists tell us that people who are sedentary lose touch with their bodies – they feel broader and heavier than they really are, and activities feel harder than they should be. They aren't sure where their bodies end, and it makes them tentative, clumsy. But humans, psychologist Dan Dervin says, have a need to "stimulate the sense of inner aliveness." We're the only species that's like that. Those who train talk of feeling their bodies stretching out, of feeling their senses of smell and taste sharpen. "One of the most immediate benefits of training was the fine, loose feeling of inhabiting my whole body again," says Jerome of the time he spent training for an attempt to set an age-group record for the 1,650-yard freestyle swim. That's a great feeling.

"Sports' true and lasting victory is over the numbness that comes from fear or boredom or over the deadness that comes from being helpless or inert," Dervin says. "Perhaps we have after all now struck the nerve of motive."

Nikki Rippee, an expert on aging who teaches at the University of Nevada, Reno, keeps a series of photographs in her office to show her students what they've got to look forward to as they get older.

The photographs show a man – a weightlifter – at the end of each decade of his life. There's a photo of him at thirty, one at forty, and so into his sixties. It's a sobering picture. It's humbling. But not for the reason you might think.

You can slow the effects of age, but it takes some work.

From decade to decade, you can barely see any change in the man. You can see he's getting older – his hair is thinning and those wisdom lines around his eyes become more etched as time goes on – but his body hardly changes at all. "Maybe you see a little decline in muscle mass after his sixtieth birthday, but you have to look hard," Rippee says. "People don't realize that our idea of aging is changing. You don't have to grow old like you used to. But it takes some work."

That's the humbling part. The man in the poster didn't put the brakes on time just by having good genes. He worked at it.

Even in this day of antiaging creams, face lifts, and liposuction, aging usually isn't a pretty sight. We're used to seeing people slide into a steady rate of decline as they get older. Their muscles shrink their shoulders and back stoop, and their bones get thin and weak. They lose their balance and flexibility. Their blood pressure goes up as their arteries harden. Their skin gets loose and their minds start to go. Scientists call this homeostenosis, the declining ability of the aging body to adapt to physical stresses and demands. Left untouched – just fed and watered and used for routine tasks – the human body very steadily shrinks, curls up, gets brittle, and wheezes along with an increasingly perceptible limp.

Unless, of course, you stay in shape.

"The rate of decline for an active person is really much more stately than we ever thought before," says Walter Bortz, a gerontologist with the Palo Alto Medical Foundation.

Bortz should know. Although he's in his late sixties, he can run a marathon in just over 4 hours. His wife ran the 100-mile Western States Endurance Run at age sixty in just over 24 hours – a time a lot of young guys never achieve.

Starve Off the Effects of Age

Scientists estimate that a sedentary man – because of muscle loss, a decreasing maximum heart rate (MHR), and stiffening lungs and arteries – loses about 10 percent of his ability to do work every decade after age thirty-five. What does that mean, exactly? Well, if your best time for an all-out mile run at age thirty-five is 6 minutes, your best time for an all-out run thirty years later will be almost 8 minutes. What was once an easy jog will become a lung-searing effort.

But with exercise and smart training, you can cut your losses dramatically. Take a look at a measurement known as VO_2 max, which is the maximum amount of oxygen you use while exercising at your limit for 1 minute. Physiologists determine your VO_2 max by putting you on a treadmill and measuring how much oxygen you are using as you exercise. If you are well trained, your muscles will use a lot of oxygen for energy and your heart will be big and strong and capable of pushing a lot of oxygen-rich blood deep into those working muscles. You'll have a high VO_2 max reading. If you're unfit, your muscles won't have many oxygen-burning enzymes and will tire before much oxygen is put to work.

Sedentary people loose what VO_2 max they have at a rate of about 10 percent per decade. That's because your MHR decreases, the amount of blood your heart pulls in and pushes out decrease, and your arteries become less elastic, increasing your blood pressure as your body struggles to force blood through the body.

But most fit people don't have these problems. Recent studies show they lost VO_2 max at a rate on only 0.5 percent a year – sometimes even less. In one study, a group of fifty-six year-old runners with similar training habits and race times were compared with a carefully matched group of twenty-five year-old runners, and the difference in VO_2 max was only 9 percent, or 0.3 percent per year. In yet another study, older runners between the ages of fifty and eighty-two who had maintained training volumes and intensities over a ten-year period showed no decrease in VO_2 max. The only reason some athletes lose VO_2 max is because their MHRs decrease with age, something no amount of training can change.

And here's another thing to keep in mind. No matter how old you are, you can always improve your aerobic capacity. Elderly people put on an exercise program show the same increases in VO_2 max as young unfit people put on the same program. There is even evidence to discredit the long-held notion that older people need more time to progress and adapt to endurance training.

Women don't lose VO_2 max at the same rate men do. Women typically have lower VO_2 maxes to begin with, but the difference between the two sexes decreases as time marches on, some researchers say. This could be one reason why so many older women seem more vital than their husbands later in life.

In a 1993 study, researchers put a group of sedentary men and women between the ages of sixty and sixty-five on a nine-month training program. Both groups increased their aerobic capacity by 20 percent, but they went about it in different ways. The men developed bigger hearts that pumped more blood. But the women, with their smaller, less adaptive hearts, got their fitness gains by developing more capillaries (the twigs of the blood-delivery branches) and more mitochondria in their muscles.

Walter Bortz looked at the effects of aging from another angle. He analyzed performance data for running, rowing, and swimming events from national organizations, plotted winning times according to age groups after age thirty-five, and found that curves for all three sports followed the same slope. After comparing these results with other physiological markers, such as VO_2 max, he concluded that the rate of decline for extremely physically fit people is just 5 percent per decade. "anything more than that," Bortz said, "must be due to inactivity."

Another researcher, Stephen Seiler in Norway, suggests that the decline in VO_2 max in hard-charging master athletes who aren't yet fifty might be even less: on the order of 1 to 2 percent per decade after age twenty-five.

So if you can run a 6-minute mile in your thirties and you keep training hard into your sixties, what will your mile time be when you're sixty-five? Well, if it's true that you don't lose much of anything until you're fifty and that after that the decrease is 0.5 percent annually; you should be able to run that mile in 6:27.

Not bad for a senior citizen.

What Is It About Exercise That Helps?

If your VO_2 max is high, it means your heart is strong, your lungs and arteries are accommodating and elastic, and your muscles are lean, hungry, and ready to burn oxygen to create energy and power for contraction. Some of that is hereditary, but exercise helps. An average sedentary man in his mid-thirties will have a VO_2 max of 40-45 milliliters of oxygen per minute per kilogram of body weight. That same man can increase his VO_2 max to 50-55 milliliters per minute per kilogram with an endurance training program. The exercise trains all the elements of the fitness equation, right down to the body's cellular and chemical functions. To give you a better idea of how all this works, let's look at how training benefits your heart, lungs, muscles, bones, and nervous system – all the elements that contribute to how fast you'll run that mile.

How the Heart Adapts to Training

The heart is a muscle and it responds to the same stresses of training as any other muscle does: It gets stronger. The heart is a muscular balloon, and when you exercise, the balloon is filled by the extra blood being squeezed back into it by exercising muscles. The heart has to work harder to push the extra blood back out to the body, and in that process it gets stronger. When the pressure is off, your heart beats slower and stronger, fueling the body with fewer beats than before it became trained. At a rest, a typical sedentary person's heart beats 70 times a minute, pushing out about 70 milliliters per beat. But after three months of endurance training, an average person's resting heart rate may decrease to 55 beats per minute. At the same time, his or her stroke volume might increase to 90 milliliters.

Although your MHR will decline, your advancing age should not diminish your hard-won stoke volume if you continue to work out. Your heart will be as big as a younger opponent's and much larger than that of another person the same age who doesn't work out. Keep in mind that stroke volume is hard to measure and not all researchers agree that you can maintain the same volume as you age. But one thing is clear: If your volume is maintained, it's probably because all that exercise you are doing is helping keep your arteries supple so the blood can move more easily through the body. Exercise also increases your number of capillaries, which take the blood from vessels and distribute it to the muscles.

Strengthening Muscles and Bones

We've all had sore muscles before. You wake up after your first good cross-country ski workout and your back and shoulders feel like gremlins have been pounding them with little hammers all night. How does the muscle respond to the abuse you heaped on it? By getting stronger. Although researchers aren't sure what causes muscle soreness – whether it is caused by small tears or free radicals or something else – they do know that the muscle, after it's repaired, becomes more resistant to injury and learns to repair itself faster from future gremlin attacks. And that does not change as you age. Studies have shown that even sedentary people in their eighties and nineties can vastly improve their muscular strength with resistance training.

Men start losing muscle after age twenty-five, and the rate of decline is about 7 pounds a decade if they don't do anything to halt this withering process. Both the size and number of muscle fibers decrease after age thirty, and the fast-twitch group is especially hard hit. You may not notice a loss of strength until after age forty, but you'll lose 5 percent of your strength every decade after that. Unless you recruit your fast-twitch fibers (that is, do sprints), there is evidence that you'll start losing those motor units at the rate of 10 percent a decade after age fifty. This means that a twenty-five year old man who weighs about 170 pounds and has about 89 pounds of muscle will lose 14 pounds of lean body mass – mostly muscle – by the time he's forty-five. His metabolic rate will decline accordingly, and if his caloric intake is not reduced at the same rate, his body fat will increase dramatically. He might weigh the same twenty years later, but he won't look the same.

According to one study in 1981, most people gain0.2-0.8 kilograms of fat a year after ages twenty to thirty, which means there are a lot of people tripling their body fat by the time they reach age sixty. Women who don't exercise and do strength work loose about 5 pounds of muscle a decade after age thirty-five, and after menopause the losses accelerate to about a pound a year.

You can head off most of these changes – and even get stronger – with regular upper – and lower-body strength training. After age sixty, however, both testosterone and growth hormone seem to drop more dramatically, and muscle fibers begin to atrophy. But your losses in strength won't be as great if you continue to lift weights into your sixties.

Working a muscle encourages the body to push more capillaries into the fibers of that muscle. This increases the flow of blood, oxygen, and fuel into the working muscle. You don't lose this ability as you age; in face, one study showed that fit older runners had the same number of capillaries in their funning muscles as much younger runners. An exercised muscle will also increase its number of mitochondria, the little energy factories in the muscle needs to produce fuel for contractions. Mitochondria increase your aerobic capacity and reduce your rate of lactic acid production. But if the training stops, the mitochondria slowly disappear; in sedentary people, activity in the muscles mitochondria – as measured by the enzymes that do the work – declines 25 to 40 percent as they get older.

And there's no reason why you can't keep those muscles as limber as they were when you were younger. Although time tends to tighten us up – our muscles shorten as the elastin and collagen in our connective tissues become frayed and more dense – there is reason to believe that this effect can be delayed. When researches put a group of teenagers in a stretching program with a group of seniors between the ages of sixty-three and eighty-eight, both groups saw the same improvement in flexibility after six weeks. The price you pay for not stretching become more severe with age; your flexibility can decline as much as 30 percent, shortening your stride and forcing you to work harder to maintain the same speed you once took for granted.

Bones respond to stress the same way muscles do: by getting stronger. Although lifting weights and exercising can't make bones any denser than they naturally are, they can offset the slow decline that starts to affect women after age thirty-five and men after age fifty.

Osteoporosis is a chronic and often crippling condition caused by thin, brittle bones. It affects an estimated 25 million Americans, mostly white women over age sixty, and is the twelfth leading cause of death in the United States. More than 700,000 fractures a year among women are linked to osteoporosis.

Our bones are metabolically active, building and rebuilding themselves with the nutrients we give them. Collagen fibers form a web throughout the bone and such minerals as calcium phosphorus, sodium, magnesium, copper, chloride, potassium, zinc, iron, and manganese attach to that mesh. Bones need constant nourishment to carry out this work.

A woman's bone mass peaks in her late twenties or early thirties and states to wane by age forty. The rate of bone loss, left unchecked, increased when women reach age fifty and their estrogen levels decrease during menopause. At this point, the mineral content of the bones declines and bones become thinner and weaker. It usually reaches a critical stage for sedentary women at age sixty. Some women's upper spines bend and bulge into a "dowager's hump" just below the neck.

A July 1998 study published in the *Annals of Internal Medicine* found that the more active a woman is, the less likely she is to break a hip. Those who benefit the most are the women doing more vigorous stuff like aerobic dance, tennis, and weightlifting. Even fit women who run or walk benefit from adding upper-body resistance training to their workouts.

The Nervous System

Your ability to send and receive neural messages diminishes as you age and results in slower reaction time – probably by about 10 percent slower after the age of fifty. That's why major league baseball players usually don't stay in the game longer.
We also experience a decline in sensory perception, such as hearing and vision, because the brain doesn't use glucose as well as we age. This all adds up to losses in agility, balance, and coordination.

INDIVIDUALS WHO TRAIN BECOME MORE SELF-CONFIDENT, PRECISE, AND PRESISTENT.

But the exercise you're doing can keep all these changes at bay. Studies have shown that training increased the blood flow to the cerebral region, and that alone helps improve coordination, balance and overall readiness. Studies in the late 1980's confirmed that aerobic exercise could also improve an aging person's visual organization, memory, and mental flexibility. That's because exercise postpones structural changes in the nerve cell and the loss of dendrites in the aging brain.

How Fitness Can Redefine Aging

In many ways, those of us who exercise are helping change the way the world looks at aging. For years researches have had a hard time determining what changes to the body are caused by aging and which ones are caused by inactivity. The decreases in physical ability that we've always associated with aging also show up in healthy astronauts sent into space for an extended period of time. It also happens to athletes who get injured and are forced to rest in bed. They lose strength, flexibility, and stamina. Their blood pressure goes up and so does their resting heart rate. Their muscles shorten and their bones weaken.

The constrictions of age – the decreased range of motion in the joints, the shortening of muscles and breath, the increased pressure within as blood pushed against stiffening passageways – are in may ways a metaphor for what happens to the mind and personality of an unfit person as he or she ages. Studies that go back more than twenty years have found that middle-aged men who never exercise lose some of their physical courage. The fear more for their health and safety, and there is more tension in their lives. They tend to become introverted. Increasingly, it seems, they fall into the role society has carved out for them and they become tentative, cautious, maybe even a little suspicious.
Those who train, on the other hand, become more self-confident, precise, and persistent. They take on big projects and they aren't crippled by the prospect of failure. They are better at relaxing, possibly because of the "natural opiates" of enkephalin and beta-endorphin released by hard exercise, but more likely because their fitness gives them a sense of accomplishment. That's no small thing in a world like ours where the results of our professional work are often fleeting and evanescent. There has been a debate going on for more than two decreases over whether running improves someone's mental health. Some say there is a direct link; other argue there is just the appearance of one because runners are taking a break from the day's stress and gaining mastery over time and their body. If the result is the same, who cares?

According to a Harvard University study, women who run produce a less potent form of estrogen than sedentary women, which cuts their risk of breast or uterine cancer in half. Other studies show that exercise does not reduce the risk of breast cancer in younger women but may play a role in protecting postmenopausal women from the disease.

Will exercise help us live Longer? It's hard to say. There are a lot of factors that affect our lifespans: Medical advances will help keep us alive, as will our own native curiosity about life and our keen interest in continuing our enjoyment of it. A Harvard alumni study published in AMA in April 1995 concluded that vigorous exercise, like running, "helps to prolong the lives of middle-aged men," but easy stuff like gardening won't keep you around longer. Perhaps the only thing you can say with certainty is that the quality of your life will improve if you stay fit: You will stay strong and active later in life, you won't get sick as often, and you're less likely to wind up in a hospital in your later years. You will sleep better. Your food will taste better.

Ironically, studies show that people who live a long time tend to be people who don't give much thought to living a long time. Unlike the Struldbruggs – the people in Gulliver's Travels who obsessed about their immortality and went slowly insane because of it – modern-day nonagenarians think less about the length of life than they do about the content of life. They read and take classes. They exercise because they want to continue to enjoy the things they love: hike into the mountains, swims in cold alpine lakes. They keep their minds nimble and engaged. They stay alive.

LIVING A LONG LIFE

Barring unforeseen circumstances – like pneumonia or a heart attack – the reasons we die can be traced to three processes within the body. The first is genetic and the second two are chemical.

All cells, whether in turtles or humans, reproduce only a certain number of times. After that, their metabolism fades and their skin collapses and they die. We don't know why and we don't know how to stop it. And until we do it's likely that everyone – even a hundred-year-old marathoner who always practiced safe sex – will die by age one hundred twenty years.

But what takes most of us well before then are two chemical reactions in our body. One involves free radicals, the detritus left over from energy production. This gunk of oxygen molecules binds to anything it can find, weakening internal tissues and organs and sometimes leading to cancer. The body can fight off the ravages of free radical oxidation only so long before it caves in.

The other reaction is call glycosylation. That's where sugar bonds with protein and causes things to plug up: joints, arteries, the lenses of the eye. The process is very similar to the browning that occurs in cooking, and there's isn't much you can do to prevent it.

Although scientists haven't perfected free radical therapies and drugs to counter the effect of glycosylation, there is still hope for those who want to live a very very long life. All they have to do is cut their calorie intake to near starvation levels.

Clive McCay; a scientist at Cornell in the 1930's, found that could extend the life of mice by 50 percent by cutting their diets way, way back, so that they barely had enough to live. Later researchers learned that putting other animals on scant but nutritious diets not only prolonged their lives but kept them youthful into a very old age.

Roy L. Walford, a professor of pathology at the University of California, Los Angeles, took up where McCay left off and has found that these spare diets improve an animal's immune system, lower blood pressure and cholesterol, and reverse arteriosclerosis. Cancer in these animals is rare. Walfore, age seventy-one, got such good results from so many different animals that he put himself on the diet and now plans to live another half-century. His book, The Anti-Aging Plan, includes more than 100 recipes that are primarily vegetarian.

Walford was one of eight researchers who followed the diet while living in Biosphere 2. The men lost 33 pounds on average and the women who followed the diet lost 17 pounds. Their cholesterol and blood pressure readings all went down, too. The only drawback to the diet, it seems, was that the dieters had recurring and elaborate fantasies about the food they were being denied.

Why does near starvation help? It probably decreases the production of free radicals by decreasing the amount of food being burned up by your cells and lowering your body temperature by a degree or two.
If you can't picture yourself reducing your caloric intake 30 percent, here's hope: Gerontologist with the National Institute on Aging's Gerontology Research Center in Baltimore say a drug may be developed to allow you to eat but still gain the benefits of starvation. But that drug is still twenty years away.

If you're impatient for a sip form the fountain of youth, you might try hormone replacement therapy. This therapy counters the effects of menopause – and estrogen losses that accompany it- and has been shown to increase life expectancy by eight years, particularly among women who have one or more risk factors for heart disease. The hormone therapy can also prevent colon cancer, reduce wrinkling and keep your teeth strong. The therapy apparently can help men, but most don't want to put up with the side effects, such as increased breast size.

MENOPUASE

The first 38 million femal Baby Boomers has just turned fifty-two, one year after the average age of menopause, and doctor's offices are filling up with women in their forties complaining of hot flashes, insomnia, unpredictable bleeding, and mood swings. These women are experiencing perimenopause, the period of declining estrogen levels that leads up to the time when they stop menstruating altogether. An increasing number are turning to their doctors for hormone treatments and other drugs to alleviate their symptoms.

Although doctors rarely used to prescribe estrogen before menopause, many are handing out pills and patches for women in their thirties and forties, despite studies showing that long-term use raises the risk of breast and uterine cancer. There is also growing concern in the medical world that doctors are wrongly medicalizing what for centuries has been a natural transition that causes most women little or temporary discomfort. Doctors argue that if it makes people feel better, why not use it? However, most doctors are quick to tell their patients that proper diet and exercise are a good treatment for many of the symptoms of perimenopause, including hot flashes and insomnia.

Women who are approaching menopause, event those who increase their exercise and improve their eating habits find that they get thicker and heavier. IT starts in your mid-thirties and keeps going until your mid-forties. It's a time in which metabolism slows down and muscle slowly converts to fat. What's happening is that as you approach age forty, you start producing less estrogen. And because estrogen is produced in the fat cells, the fat cells get bigger in an effort to maintain production. And these larger fate cells, which congregate around your waist because those are the cells that are best equipped to produce estrogen, are more resistant to dieting.

Ironically, these fat cells help you out once you reach menopause. According to Debra Waterhouse, the author of Outsmarting the Midlift Fat Cell, these fat cells help control hot flashes, mood swings, and PMS. They also help you sleep better during menopause and reduce the risk of osteoporosis.

Does that mean you should leave the weight on? No. Waterhouse says you can lose some of the weight while still holding off the effects of menopause. She suggests doing aerobic exercise and strength-building workouts and eating a wide variety of foods, including fruits, vegetable and foods high in protein and calcium.

Waterhouse has studied menopausal women for nearly twenty years and has found that those who survive menopause with the least amount of discomfort have these seven habits:

- They don't worry about weight loss, but about body composition (percentage of body fat). Forget weight-loss clinics and throw out your scale. Pinch your skin to see whether you are losing fat.
- They have accepted their bodies if they are pear-shaped and stocky they don't expect to be tall and lanky.
- They exercise for at least an hour at least 4 days a week at mode rate levels. And they do a variety of activities from jogging and swimming to in-line skating and aerobic dance.
- They drink water throughout the day
- They eat every few hours to keep blood sugar levels stable and moods tempered.
- They eat their big meal at lunch and lightest meal in the evening, when caloric needs of a menopausal woman drop off dramatically.
- They still enjoy their favorite foods.

Many experts agree that the top priority for postmenopausal women is exercise. Doctors often prescribe estrogen supplements as well, and many women are exploring unproven nutritional supplements such as soy powder, wild yam, red clover, black cohosh, chasteberry, don quai, licorice root, yarrow, motherwort, and milk thistle. Studies of women in Asia indicate that soy products may help relieve menopausal symptoms, although most doctors will tell you more study is needed.

WHY ARE WE SO FAT?

Dozens of surveys have been conducted in recent years in an effort to gauge just how fit the United States is, and none has been very promising. The Journal of the American Association (JAMA) estimates that 33 percent of American adults are overweight, and the Institute of Medicine reported in 1995 that 59 percent of the American population is too heavy. There have been other estimates, but most experts agree that at least half the nation is overweight and that in four meets the definition for clinically obesity, defined as 20 percent above ideal body weight.

And people aren't kidding themselves; a survey by the Calorie Control Council, a nonprofit association of companies that manufacture low-calorie foods, revealed manufacture low=calorie foods, revealed that 60 percent of Americans feel they need to lose weight. And by almost any measure, the number of fat folk in our land is increasing-the JAMA study estimates that obesity has increased 25 percent since the 1960's.

When you look at all the studies done on exercise, you can see why. One study found that only 22 percent of Americans are doing any kind of meaningful exercise. When the Centers for Disease Control surveyed 106,000 adults in all fifty states in 1994, it found that 30 percent of the country does nothing – no walking, no golf, not even any gardening. Prevention magazine does an annual index of America's health habits, and each year it gets about the same result: Only 37 percent of American adults are doing enough work to gain aerobic benefits. The numbers decline as people age; less the 10 percent of those over sixty-fie engage in any strenuous exercise.

These distressing numbers come despite an all0out effort by several health organizations to get Americans exercising. Scientists have published study after study showing that inactivity leads to heart disease, diabetes, colon cancer, high blood pressure, obesity, osteoporosis, joint problems, and general malaise. Exercise is the only way to counter all these problems. Consequently, everybody from the Public Health Service, which has devised a user-friendly exercise pyramid to help people understand how much they should exercise, is trying to get the word out. But it's not working.

The problem, the experts agree, is that messages are mixed. When scientist recommended that people accumulate their exercise over the course of the day in short bursts – a strategy devised to get people doing something – many misinterpreted the advice and thought walking to the coffee pot ten times a day was as good as a 30 minute job. Another problems the public's unrealistic expectations about exercise. The image of fitness created by the exercise industry emphasizes lean, sculpted bodies, and when people start an exercise program and don't get bulging muscles, they figure they are wasting their time and quit.

The cost? As many as a quarter of a million Americans are dying every year because they consume far more calories than they burn up in exercise. Epidemiologists at Harvard University estimate that treating obesity and the diabetes, heart disease, high blood pressure, and gall stones caused by it accounted for $45.8 billion in health care costs in 1990, the latest year studied. Indirect costs because of missed work contributed another $23 billion. All of these costs have a direct bearing on your insurance premiums and your income.

America's inertia has experts scratching their heads. Here you have millions of people faced with the prospect of living longer than many ever dreamed possible. And they know that the one thing that they can do to forestall every effect of aging is to exercise. But hardly any of them are doing it.

It seems Americans will do anything to fight fat except exercise. According to 1994 congressional study, Americans spent about $33 billion that year on weight-loss products and services, many of which have only short- term benefit if they help at all. Many of these programs boast that you can drop weight without ding any exercise, ignoring careful scientific research that shows the only way to take weight off and keep it off is through a combination of diet and exercise.

KEEPING YOUR MIND NIMBLE AND STRONG

While researchers are breaking new ground in studying physical aging, there is growing interest among scientists in changing long-held notions about how our minds age. According to one report, a revolution in attitude about aging is coming from an increasing number of scientists who want us to stop thinking age is an incurable disease that has to be treated with face-lifts and high blood pressure medicine. A team of European scientists is even attempting to define wisdom and characterize the patterns of insight and judgment that combine to create it.

Many of us come to believe that older people are frail, stubborn, and somewhat senile. We start developing these stereo-types at an early age and we grow old accepting them as the truth. And, according to one theory, we live down to them. We see old age as a sexless, immobile and decaying period of our lives.

But study after study has shown that if we respond creatively to change, look for ways to reduce anxiety, keep a positive outlook, and use our creative and inventive resources, we can keep our minds nimble and live longer. This is great news. Not only do we have new solid evidence that we can maintain our physical prowess later in life, but we're also getting old at a time when society is increasingly aware of how wise we are. It's a great time to be getting older.

The men and women who are staying fit into their fifties are getting the most from their wisdom and physical strength. They have learned that fitness is not about thundering heart rates and buckets of lactic acid. Its about finesse, economy. It's about using your mind to squeeze a few extra horsepower in technique and smart, analytical training. You find it in rest. You find it in diligence and method, but also in experimentation and spontaneity. You find it in the right application of your mental strength, concentration, and your sense of when to push it and when to back off.

The young ultramarathoners who go out on mountain runs with Joe Braninburg, a fifty-something contractor who has finished in the top ten at the 100-mile Western States Endurance Run, are often amazed at how quickly he moves across the rocky paths he trains on in the Sierra Nevada range outside his home in Reno. He doesn't look like he's running all that fast until you try to keep up with him. Then you realize how you are hopping over rocks and skidding down slopes while Braninburg is quietly moving over the terrain without any wasted effort. When you ask how he does it, he says, "Simply pick a line and follow it."

Easier said than done. But why should it be easy? Braininburg has been training for years. There has to be some advantage to his experience, and it is here, on these rocky traces at 9,000 feet, where it comes into play. Braninburg routinely beats guys twenty years younger, and it's not raw strength and VO_2 max that make the difference. It's his mental toughness, his experience that makes the difference.

YOU CAN TEACH AN OLD DOG NEW TRICKS

Studies have shown that older people don't learn new sports as well as younger people do. There is often a physical reason for this: Sedentary people aren't as supple or strong as they once were and have lost reaction time a result.

But even in forty – or fifty year olds who have stayed fit, the learning curve is a little steeper. A study in Sweden found that middle-aged golfers on a miniature golf course did worse than younger people when games were played with a soccer game broadcast in the background. Our ability to handle distractions like that declines with age.

Many older athletes may find the need or the desire to pick up a new sport later in life. This could happen if you get injured in your primary sport or jest get the itch to try something new. If that's the case, the secret will be to pick a sport similar to one you're already skilled at. You already have some neural grooves carved out. If you're a downhill skier, consider inline skates, for instance.

Also, try visualization. Sit in a quiet spot and picture yourself doing the activity successfully. Picture a perfect conclusion. Researchers have found that blood rushes to the same areas of both the cortex (where conscious actions are regulated) and the cerebellum (where unconscious movements such as walking are stored), regardless of whether the athlete was performing or just thinking about their performance.

But above all else, practice. More and more, the movements of a new sport will be stored in the cerebellum. Practice makes perfect but it also makes it permanent.

SKIING CONCEPTS – ALPINE TEAM TRAINING

We are concept specific in forming the images of American Skiing. The details are manifested in the individual expression of our performance in creating desired outcomes. These concepts have a spectrum of movements that are tied to tactical applications.

STANCE, BALANCE AND DIRETINOAL MOVEMENTS

- The skier is in balance when they can have a positive, selective effect on any of the skills with either leg at any time.
- The entire body is involved and participates in balancing. The focus is on balancing in the future.
- Versatile/adaptable stance: relates to the functionality of the feet and the desired outcome rather than a specific measured distance of separation.
- The position of the hips over the feet (fore/aft) will play a major role in the parallel relationship of the skies and promotes the ability to use corresponding edges. Understand that you may adjust this relationship as you encounter changes in terrain and snow conditions.
- The flexing activity originates from the ankle to support movements through the boot cuffs. Setting in the knees and hips could necessitate a re-centering mover, diverging ski tips and/or a sequential edge release.
- Note: Insufficient forward movement promotes inclination of the upper body and weaker lower body angles. In addition you may see over-pivoting of the skies, late pressure application and a divergence of the ski tips. Avoid pressure control movements at the end of the turn originating from the knees and hips.

FUNCITONAL BODY ALLIGNMENT

- Functional body alignment (strong inside half) refers to the ability to maintain the entire inside half of the body (foot, knee, hip, arm, hand and shoulder) in an appropriate alignment for the desired outcome. The amount of lead in the ski tips should match the alignment of the body and is influenced by the pitch of the slope.
- As the turn develops, the focus should be to keep the inside half of the body higher and ahead of the outside half.
- The relationship of the upper and lower body is a key factor in creating the alignment that allows maximum strength of the outside leg. This will help produce a turn that can be quick and accurate to develop to the apex and a power stance throughout he finish.
- The core supplies the strength and functional tension to the inside half of the body to facilitate the steering activity of the legs
- Strongest angles are developed at the apex of the turn.
- Turn transitions: the lower body releases and realigns with the upper body.
- We create the image of arcing into the apex versus just arcing away from it.
- Ski into and out of counter rather than making a stronger counter movement.

EDGE RELEASE / EDGE ENGAGEMENT

- Focus on moving forward, in the direction of the new turn and through the boot cuffs.
- Both skies should move to the new edges simultaneously versus sequentially, while striving to maintain ski/snow contact.
- Edge release and re-engagement should happen in one fluid movement.

- The positive engagement of the skis' tips should draw you into the turn versus displacing the tails to start the turn.
- Strive to use the skis' design as effectively as possible.
- Note: look for reasons why the skier may be forced into a sequential edge release pattern. It could be because the center of mass has not moved forward enough. Is there excessive lead change to initiate edge release.

PRESSURE MANAGEMENT

- Lateral weight transfer is a component of pressure management. It can happen progressively or abruptly, depending on the desired outcome.
- Maintain the "strength in length" of the outside leg during the highest loading portion of the turn unless yielding to the influence of terrain and snow conditions or releasing the turn.
- Tactics, terrain, speed, snow conditions and turn shape will alter the timing, intensity and the amount of weight distribution along the length of the ski and foot to foot.
- Pressure management incorporates aspects of fore/aft adjustments as well as lateral movements.

POLE USAGE / ARM MOVEMENTS

- Appropriate pole usage can help us secure/maintain the resent turn or initiate the next turn.
- Proper pole usage requires discipline and accuracy of arm movements and pole swing but not always a pole plant.
- It is the upper body and core that positions the arms and the arms that can take the upper body out of position.
- A rotary type pole swing holds on to the old turn. A more linear swing helps to accurately direct movements into the new turn.

UTILIZING THESE CONCEPTS

Keep in mind how we would use the above outline to adjust the skiing focus for different age groups, equipment types, personal style and desired outcomes. The purpose is not to create and exact template, but rather a conceptual outline. The concepts will evolve with industry trends to support the needs of our customers while assisting the teaching pro in creating lesson plans.

WE TEACH PEOPLE, NOT A SYSTEM

CREATED AND DEVELOPED BY THE MEMBERS OF THE PSIA NATIONAL ALPINE TEAM

STRENGTH BASICS

Muscular strength is one of the three major components of fitness. Strength training provides benefits which complement the other two fitness components, aerobic conditioning and flexibility.

STRENGTH CONDITIONING BENEFITS

- Improves muscular strength in both muscles and tendons
- Improves joint stability
- Increases lean body weight
- Increased basal metabolic rate
- Improves muscular coordination
- Improves muscular balance
- Increases bone density
- Enhances aerobic performance
- Improves body awareness and postural alignment
- Increases self confidence

STRENGTH BASICS PROGRAM

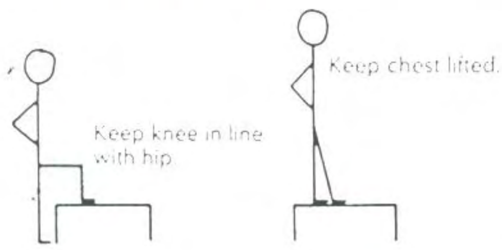
- Begin your first 4 to 6 week introduction program with 2 or 3 sets of 8 to 12 repetitions of each exercise you choose. Progressively increase the weight you're lifting as it becomes easy to execute each set. Once you can easily perform 3 sets of 12 repetitions, increase the weight. Remember to lower the number of repetitions you perform in each set whenever you increase the weight you are lifting.
- During the next 6 to 8 weeks after the introduction program, lower the number of repetitions in each set (as you should be lifting slightly heavier weights). Do 2 to 3 sets of 6 to 10 repetitions.
- Different strength-training programs produce different muscual adaptations. By varying your basic program, optimal fitness is more easily obtained. **Proper form and technique must be observed to gain maximum benefit from any strength training program.**
- **Pace:** Total of 6 seconds to perform each repetition. 2 seconds to lift the weight; 4 seconds to lower the weight. Pause at the top and the bottom of each movement to insure 100% muscle power and control.
  Breathing: Exhale as you lift the weight. Initiate each movement from the prime mover (the muscle group for which the exercise was designed). Inhale as you lower the weight.

CAUTIONS

- Check with your doctor prior to beginning any strength program.
- Consider aqua resistance if you have a significant condition, such as severe arthritis, that may prohibit use of weights.
- If you have low back soreness, disc related problems, joint problems, or scoliosis, you need to modify or leave out certain weight training exercises.
- Watch alignment and form closely when using weights

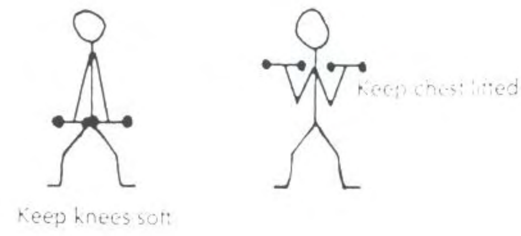
STEP UP

Lower Body Exercise



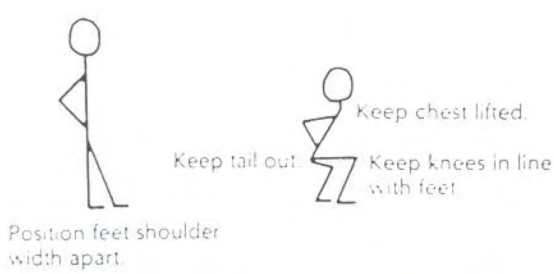
BICEP CURLS

Bicep Exercise



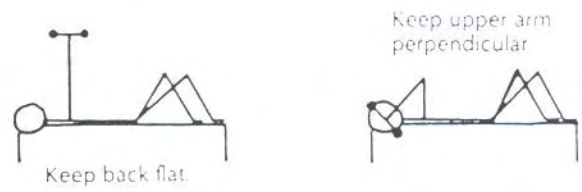
SQUAT

Lower Body Exercise



TRICEP EXTENSION

Tricep Exercise

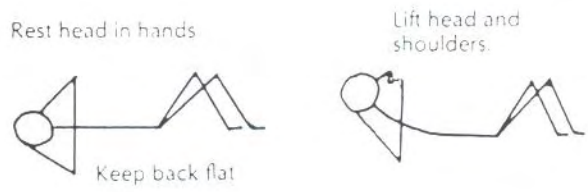


LUNGE

Lower Body Exercise

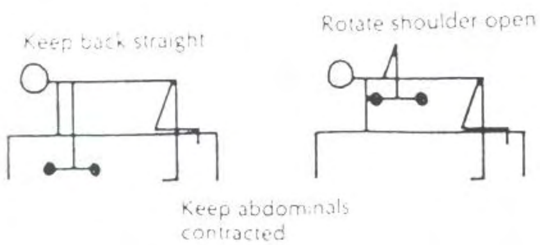
ABDOMINAL CURL

Abdominal Exercise



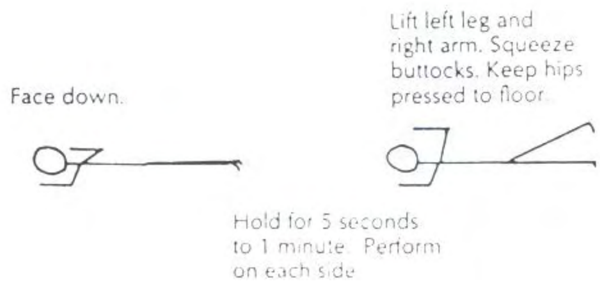
SINGLE-ARM ROWS

Back Exercise



BACK CONDITIONER

Back Exercise



DUMBBELL CHEST PRESS

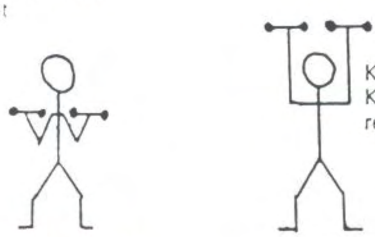
Chest Exercise

FLAT BENCH FLYS

Chest Exercise

OVERHEAD DUMBBELL PRESS

Shoulder Exercise



LATERAL RAISES

Shoulder Exercise

PERSONAL NOTES

Before and After – STRETCHING

Skiing (Downhill)

Approximately 10 Minutes

20 seconds
each leg
(page 71)

30 seconds
(page 53)

30 seconds
(page 52)

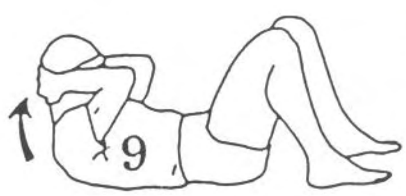
10 times
each direction
(page 31)

20 seconds
each leg
(page 33)

25 seconds
each leg
(page 36)

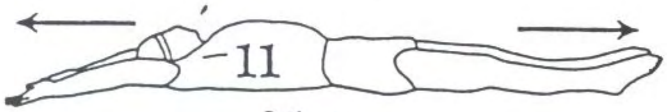
30 seconds
(page 93)

30 seconds
(page 56)

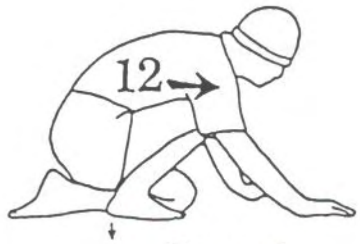


3 times
5 seconds each
(page 25)

25 seconds
each side
(page 24)



2 times
5 seconds each
(page 28)

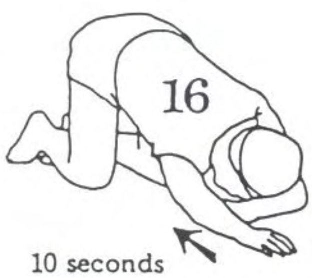


10 seconds
each leg
(page 47)

20 seconds
each leg
(page 48)

20 seconds
(page 65)

20 seconds
(page 40)



10 seconds
each arm
(page 40)

15 seconds
(page 43)

10 seconds
each arm
(page 41)

WEIGHT TRAINING
&
STRETCHING
EXERCISES

Prescribed by the
American Council on
Exercise

Many older adults can safely benefit by progressing to the use of dumbbells during the following eight shoulder, back, arm and chest exercises:

✓ Perform shoulder lifts and circles (Fig. 5.37).

✓ Perform bent-arm lateral raises (only to a height below shoulder level and if well tolerated) (Fig. 5.38).

FIGURE 5.37
Shoulder lift

FIGURE 5.38
Lateral raise

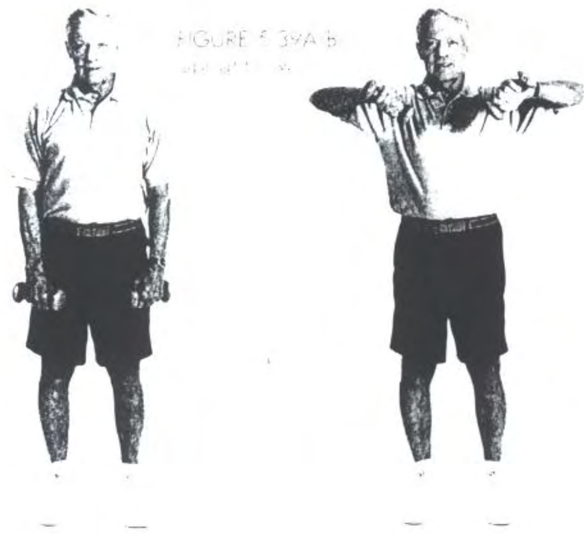


FIGURE 5.39A,B
Upright row

✓ Include upright rowing if well tolerated (not recommended for participants who may be susceptible to shoulder impingement) (Fig. 5.39).

✓ Perform military presses (being cautious not to permit excessive vertical loading of the spine, particularly for participants with back problems) (Fig. 5.40).

✓ Perform biceps curls (Fig. 5.41).

✓ Perform triceps extensions (to the back for lighter intensity; higher intensities can be achieved through upward extension) (Fig. 5.42).

✓ Perform supine chest presses (Fig. 5.43).

✓ Perform scapular retraction.

✓ Incorporate chest/back exercise variations: Additional chest and back exercises that do not require the use of weights, bands or other forms of resistive equipment include bent-knee push-ups on the floor, wall push-ups and cat curls on the floor or in a back-supported standing position (Fig. 5.44).

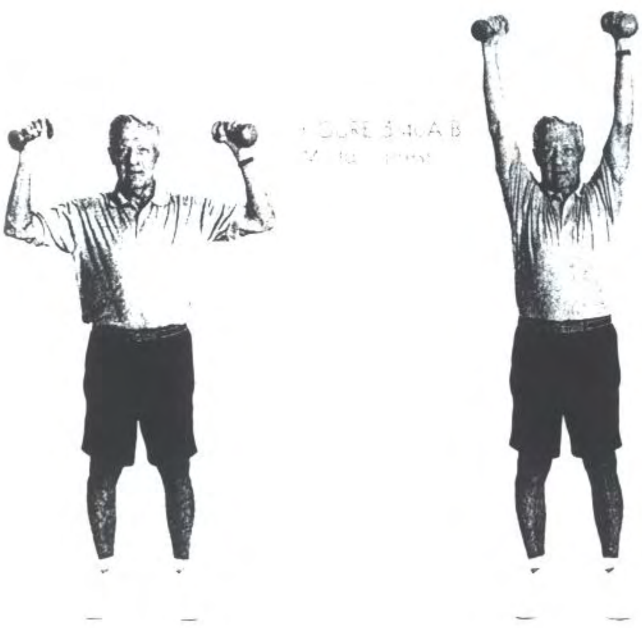


FIGURE 5.40A,B
Military press

FIGURE 5.41
Biceps curl

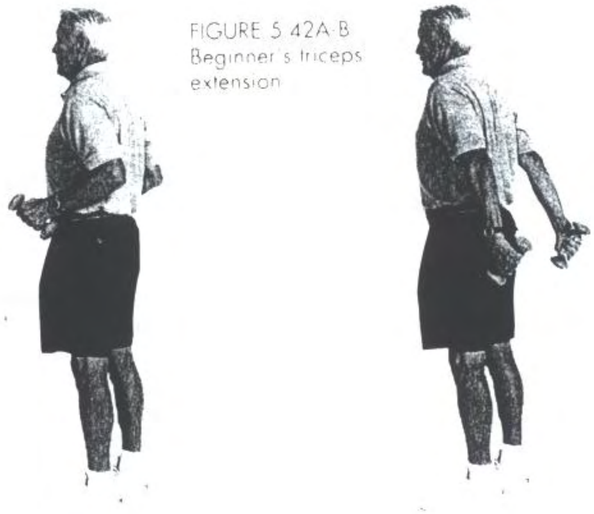


FIGURE 5.42A-B
Beginner's triceps extension

FIGURE 5.43A-B
Chest press

FIGURE 5.44
Cat curl

FIGURE 5.45
[illegible]

FIGURE 5.46
Buttocks lift

FIGURE 5.47
Buttocks squeeze

FIGURE 5.48

✓ Perform modified vertical and diagonal curl-ups (smoothly rolling the upper body forward to raise it just high enough to clear the shoulder blades off the floor. Take care not to hyperflex the neck.) (Fig. 5.45).

✓ Include lower abdominal exercise: Lie on back with arms at sides, palms on floor and legs held above body. Being careful not to swing or rock the legs, lift buttocks slightly off the floor, then return to starting position (Fig. 5.46). If an easier alternative is needed, perform pelvic tilts: With knees bent and feet on floor, lift buttocks slightly while pressing lower back to floor and contracting the abdominals.

✓ Perform buttocks squeezes: Alternately squeeze and relax the buttocks muscles (Fig. 5.47).

Many older adults can safely benefit by progressing to the use of leg weights during the following five exercises:

✓ Condition back of the thigh: In a prone position, perform small leg lifts. The knee also may be flexed and extended in this position. If needed, a towel or thin pillow may be placed beneath the abdominal/hip area to maintain a neutral spine position (Fig. 5.48).

✓ Condition front of the thigh: Alternately flex and extend the leg forward (Fig. 5.49).

FIGURE 5.49A-B
Bend/extend forward

✓ Condition the inner thigh: Perform lifts with lower leg (not recommended following hip replacement surgery until specific medical clearance is granted) (Fig. 5.50).

✓ Condition the outer thigh: Perform lifts with the upper leg (Fig. 5.51).

✓ Condition shins and calves: Alternately raise heels and then toes (utilizing balance support as necessary) (Fig. 5.52).

Aerobics Class Standing and Floor Exercises for Stretching

Note: Many of the stretches described in chair-seated exercise section can be adapted to either a standing and/or floor-exercise position.

✓ Perform range-of-motion work for the neck: Perform head turns, tilts to the sides (but not back, which may over-compress cervical vertebrae), and nods (Fig. 5.53). Nods should be performed conservatively without pressing the chin toward the chest (which may put excessive pressure on the neck area or over-stretch muscles of the cervical spine area). The safest approach for persons with cervical spinal osteoporosis or arthritis is to avoid nodding exercises.

✓ Perform shoulder stretch: While resting one arm in the bend of the opposite elbow, allow it to stretch gently across the chest (Fig. 5.54).

✓ Perform chest stretch: With fingertips touching shoulders, move elbows back (Fig. 5.55).

FIGURE 5.50
Lower-leg lift

FIGURE 5.51
Upper-leg lift

FIGURE 5.52
Heel raise

FIGURE 5.53
Nod

FIGURE 5.54
Shoulder stretch

FIGURE 5.55
Chest stretch

✓ Perform biceps stretch: Extend both arms upward or downward (Fig. 5.56).

✓ Perform triceps stretch: Place hand at back of neck. Grasp the elbow with opposite hand, then pull it gently and slowly toward the back of the head (only so far as feels comfortable) (Fig. 5.57).

✓ Perform midsection and back stretch: With knees bent, reach both arms overhead. Older adults who are able to keep their lower back from arching upward from the floor can maximize this stretch by simultaneously stretching the legs in the opposite direction on the floor (Fig. 5.58).

✓ Perform hamstrings/buttocks stretch: Gently pull legs toward chest (being careful to place hands behind, rather than around, the knees) (Fig. 5.59).

✓ Perform quadriceps stretch: Lying on the stomach, bend leg upward until a pleasant stretch is felt at the front of the thigh. It is easier to relax into an effective stretch if one holds the foot of the bent leg with the hand on the same side of the body; however, trying to do so may exceed arm reach and thereby hyperflex the knee joint. A practical alternative is to loop a towel around the leg to extend the participant's range of motion and

FIGURE 5.56

FIGURE 5.57
Triceps stretch

FIGURE 5.58

FIGURE 5.59
Leg hug

allow the control necessary to ease into an optimally stretched position. The quadriceps may also be stretched in a side-lying position (Fig. 5.60).

✓ Perform inner-thigh stretch: With relaxed knees, separate legs as far apart as feels natural. If this position is uncomfortable, extend one leg at a time slightly toward the side while bending (but not hyperflexing) the opposite knee toward the front. Stretch several parts of the body by placing both hands on the floor in front of you for support while relaxing the upper body slightly forward (Fig. 5.61).

✓ Perform outer-thigh stretch: With one leg bent and crossed over the other, press the knee gently toward the floor with the opposite hand. Press conservatively so that only a pleasant stretch, not a pulling sensation, is felt along the outer thigh. Variation #1: If the hip is allowed to cross over, the lower back will be stretched (Fig. 5.62). Variation #2: Increase the stretch for the hip area by gently pulling the bent, crossed leg toward the chest (a supine piriformis stretch). This exercise is not recommended following hip replacement surgery until specific medical clearance is granted.

✓ Perform wall calf stretch: With both hands on the wall, lean forward keeping both heels on or near the floor. (Avoid sinking into a swayback posture and hyperextending the knees or elbows.) Note: The shins and calves can be stretched in a floor-exercise position by slowly performing and holding open kinetic chain point/flex movements with the feet (Fig. 5.63). Likewise, ankle range of motion can be promoted in various positions, including on the floor, by performing slow open kinetic chain circular movements of the feet.

Note: If desired, incorporate activities from the following balance training and relaxation sections or from the posture/breathing portion of the preceding chair-seated section into the final cool-down stretch period.

FIGURE 5.60
Quadriceps stretch

FIGURE 5.61
Wide leg stretch

FIGURE 5.62
Cross-over stretch/supine piriformis stretch

FIGURE 5.63
Toes-pointed stretch

A BETTER WAY TO STRETCH

You still see runners who spread their legs, bend at the waist, and start bouncing up and down over their knees. They are stretching, they say.

What they are really doing is yanking and, in some cases, tearing their muscles. It's called ballistic stretching and if the name conjures up images of warfare and destruction, then so be it. Although ballistic stretching was popular for decades, we've come a long way in recent years and we've learned some far more effective ways to keep your muscles supple.

Stretching not only helps prevent injuries, but it can improve performance and help you maintain balance and peace of mind. Your workout may be a thumping, clenched period of tough exertion, but it should always be followed by a quiet period where you coax new length and elasticity out of the cords that give you strength.

Stretch is particularly important as we get older. As we age, we lose some water in our cells and this makes us stiffer and less supple. Exercise counters some of that effect, but exercise combined with stretching is, the best strategy to forestall those changes.

One of the effects of exercise is to shorten a muscle. When you work a muscle, you lengthen it and then contract it, and the result is a tighter bundle of fibers. But this is one training effect you don't need. A longer more elastic muscle does work more efficiently and can be pulled farther during exercise before tiny tears are made. Runners who can maintain the frequency of their leg turnover but add an inch to the length of their stride can carve 30 seconds off their times for a 10-kilometer run. Those who can add 2 inches will take a minute off.

A longer muscle also reduces the stress on your tendons, which attach muscles to bones. Whereas a muscle can stretch to 130 percent of its resting length, a tendon can only go 4 percent. And you don't want to push tem past that pint; tears in tendons don't heal as quickly as muscle tears. And loose tendons and ligaments don't work as well as taut ones and can cause ankle sprains and other joint instability problems.

Most people stretch their quadriceps, hamstrings, buttocks, and hip flexor muscles with static stretching, in which you lean into stretches and hold them until the discomfort goes away. It's a simple and safe technique, but the best technique is called proprioceptive neuromuscular facilitation (PNF) stretching. This method takes advantage of the muscles' and tendons' natural protective reflexes and tricks the muscle into getting longer. It also involves isometric contractions, the tightening of a muscle without any movement occurring, as when you push against a wall.

Every muscle has a stretch reflex. When the muscle is stretched past the point of comfort, the muscle spindle – a receptor in the muscle fiber – orders the muscle to contract to protect it from tearing. The spindle also jumps into action during exercise. When the muscle is contracted while running for instance, the spindle sends out orders to the muscle group located just opposite to it (called the antagonist muscle group) to relax. When you are running up a hill, for instance, your quadriceps contract right after your foot lands and starts to push your body up against gravity. While this is happening, the spindle is telling the hamstring to relax. This is called reciprocal innervations The tendon also has a

PNF tricks all these mechanisms into helping you become more limber. The technique is to put the muscle into a mild stretch (similar to the easy stretch portion of the static stretch), hold it for 10 seconds, and then contract the muscle being stretch isometrically for 3 – 6 seconds before relaxing the muscle again and pulling it deeper into the stretch for 20-30 seconds. The isometric contracting halfway through the stretch triggers the signal from the GTO and allows the muscle to stretch out even further.

USE PNF STRETCHING TO BECOME MORE LIMBER.

An advanced form of PNF stretching takes the trickery another step further. After you begin the third step – the second, deeper stretch – you isometrically contract the muscles opposite the muscle being stretched. This takes advantage of that reciprocal innovation reflex. The spindle in the contracting muscle sends a signal out to the muscle being stretched and tells it to relax. Voila! Your stretched muscle starts to get longer and you begin making some permanent gains in flexibility and suppleness.

Healthwise

DON'T WAIT; WHATEVER OUR AGE, IT PAYS TO LIFT WEIGHTS

Weight lifting may be the closest thing ordinary people have to a fountain of youth. Between the ages of 20 and 50, healthy adults have essentially a fixed amount of muscle mass. At about 50, it starts to go. By age 80, sedentary adults may have only 60 percent of the muscular strength they had as young adults.

The results can be seen in nursing homes everywhere. "In our research, we have found elderly women who didn't have enough muscle mass to pick five pounds up off the floor." says William J. Kraemer, Ph.D. professor of kinesiology at the University of Connecticut. "What puts the majority of people in convalescent homes is their inability to use their hip flexor muscles to get out of a chair or off the toilet."

Nothing can completely stop age-related loss of muscle, but weight lifting comes close. "People who resistance-train in their 50s, 60s, or 70s may have more muscle mass than people the same age who don't," says Glenn A. Gaesser, Ph.D., professor of kinesiology at the University of Virginia. "You can have a 60 or 70-year-old as muscularly fit as a 30-year-old." Weight training can also slow the loss of bone mass.

Clearly, it's never too late to start lifting weights. Suggestions from the experts:

Get Good advice. It's worth hiring a personal trainer to help you set up a weight training program and to monitor your progress periodically.

Weight-train two to three days a week. Especially as you are building muscle, rest a day or two between workouts. If you want to work out daily, focus on different muscle groups.

Start Slowly; be thorough. A good set of beginning exercises covers all major muscle groups – chest, upper back, shoulders, arms, abdominals, lower back, thighs, and calves. As you get stronger, add weight slowly.

Consider using free weight and machines. Both strengthen muscles, but there's evidence that free weights also help with balance which worsens with age.

Don't expect bulging muscles. Some men who try for six pack abs and Popeye arms may never quite get them. And do matter how hard women work out they lack enough testosterone to build he-man muscles. Still, anyone who works with weights should get stronger.

CONSUMER REPORTS – January 2005

Adult Development & Aging
STUDY QUESTIONS

1. What is the difference between chronological age and biological age?

2. How does each of the Functional Consequences referred to in the General Model of Aging affect a senior skier?

3. What are the Physiological benefits of physical activity for older persons?

4. What are the Psychological benefits of physical activity for older persons?

5. What are the Social benefits of physical activity for older persons?

6. What are the benefits of weight training for seniors and how can it affect skiing performance?

7. Changes occur in the following areas as people age:

Vision	Balance & Coordination
Bones	Pulmonary Function
Cardiovascular Function	Reaction Speed & Central Processing
Hearing	Muscles, Tendons, Ligaments
Renal Function	Nerves

   How do these changes affect
   (a) senior skier performance
   (b) how the teacher structures the lesson?

8. (a) What are the differences in traditional and contemporary skiing movements?
   (b) How can contemporary ski equipment enhance senior skier performance and enjoyment?
   (c) Discuss specific lesson ideas as well as all the implications of getting senior skiers to make more contemporary skiing movements.

9. (a) How can regular stretching benefit the senior skier?
   (b) What is PNF stretching?

10. How might a ski teacher structure/modify a lesson for seniors in consideration of the following:

"Coffee" Breaks	Motivation	Terrain Selection	Feedback
Teaching Styles	Pacing	Goal Setting	Class Handling