

DOCUMENT RESUME

ED 434 085

SP 038 770

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TITLE Physical Activity and Aging: Implications for Health and Quality of Life in Older Persons.
INSTITUTION President's Council on Physical Fitness and Sports, Washington, DC.
PUB DATE 1998-12-00
NOTE 9p.; For another Research Digest in this series, see SP 038 771.
AVAILABLE FROM President's Council on Physical Fitness and Sports, HHH Building, Room 738-H, 200 Independence Avenue, S.W., Washington, DC 20201. Tel: 202-690-9000; Fax: 202-690-5211; Web site: <<http://www.indiana.edu/~preschal>>.
PUB TYPE Collected Works - Serials (022)
JOURNAL CIT President's Council on Physical Fitness and Sports Research Digest; Series 3 n4 Dec 1998
EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS Aging (Individuals); Cardiovascular System; *Health Promotion; Muscular Strength; *Older Adults; *Physical Activities; *Physical Fitness; *Psychological Characteristics; Psychomotor Skills; Thinking Skills; Well Being
IDENTIFIERS Balance; Blood Pressure; Endurance; Flexibility (Psychomotor); Lipids; Psychosocial Factors

ABSTRACT

This publication summarizes what is known about the influence of regular physical activity on the health and quality of life of older individuals, addressing both the acute effects of a single bout of physical activity and the more persistent, long-term effects of sustained participation in exercise and physical activity. Section 1 discusses the physiological benefits of regular physical activity, focusing on cardiovascular function, blood pressure, blood lipids, muscle strength and endurance, flexibility, and balance. Section 2 discusses the psychological benefits of physical activity, noting information in a related table that discusses immediate and long-term effects. Section 3 focuses on general psychological well-being, including depression and anxiety, and cognitive functioning. Section 4 discusses the social implications of regular physical activity, referring to a related table that discusses immediate and long-term effects. Section 5 examines who should be physically active. Section 6 focuses on physical activity programs for older adults, discussing the activity mode, training frequency, duration of exercise, and intensity of exercise. The paper concludes that participation in regular physical activity is associated with tangible benefits for almost all older adults. It examines the considerable speculation about why so many seniors choose not to be active and notes the need for additional efforts in this regard. (SM)

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President's Council on Physical Fitness and Sports

Research Digest

Series 3, No. 4

Dec. 1998

ED 434 085

Physical Activity and Aging: Implications for Health and Quality of Life in Older Persons

Introduction

America is aging rapidly. At the beginning of the twentieth century persons over sixty five years of age constituted approximately four percent of the American population, whereas they now represent more than 12 percent of all Americans. By the year 2020 this group is expected to increase to nearly twenty percent of the population (U.S. Census Bureau, 1990). When expressed in absolute number, the statistics are equally impressive, in the United States today there are currently approximately 36 million people over the age of 65. This number is expected to almost double to 70 million by the year 2030 (Geographic Profile, 1993). Even more remarkable is the increase in the number of the very oldest members of our society. The "old-old", that is, individuals over the age of 85 years, constitute the most rapidly growing segment of society (Shephard, 1997). By the year 2030, it is anticipated that over eight million Americans will be 85 years of age or older (Fowles, 1991).

There can be little doubt that such a dramatic increase in the number of older adults will have far reaching implications for society. Advancing age is associated with predictable sensory, motor, and cognitive changes, many of which have the potential to impact on an older person's ability to function effectively in society (Chodzko-Zajko, 1996). Fortunately, although functional decline is an inevitable consequence of old age, aging does not occur at a similar rate in all individuals.

In recent years, researchers have focused considerable attention on increasing our understanding of the factors responsible for the individual differences in the rate and extent at which we age. It is well established that hereditary factors play an important role in determining the pattern of changes observed in senescence (our later years of life). However, in addition to the genetic factors influencing human aging, many aspects of the aging process are also sensitive to modification through environmental factors. Among the environmental factors known to influence human aging are lifestyle interventions, such as, healthy nutrition, stress reduction, smoking cessation, and regular physical activity (Bokoy and Blair, 1994). This review summarizes what is known about the influence of one of these lifestyle factors: regular physical activity.

The Benefits of Regular Physical Activity:

In this section, a brief overview of some of the physiological, psychological, and social benefits of regular exercise is presented. 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, 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) is used.

Physiological Benefits of Physical Activity:

Participation in regular physical activity is associated with a number of physiological benefits (see Table 1).

Cardiovascular Function:

Maximal oxygen consumption ($\dot{V}O_{2max}$) during exercise is often considered to be the single best measure of cardiovascular fitness (McArdle, Katch & Katch, 1994). It was initially thought that $\dot{V}O_{2max}$ declines at a constant rate with advancing age (about 10% per decade). However, a number of recent studies have suggested that age-related changes in

Published quarterly by the
President's Council on
Physical Fitness and Sports
Washington, D.C.



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SPC 38 770

VO₂max may be more variable than initially thought (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 VO₂max over time periods of a decade or more (Kasch, Wallace & VanCamp, 1985; Pollock et al., 1987). 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.

Blood Pressure:

Hypertension is a serious medical problem which afflicts more than 20 million older Americans (Kannel and Vokonas, 1986). On average, both systolic and diastolic blood pressure increase significantly with advancing age (Shephard, 1997). Several exercise training studies have shown that physical activity can reduce systolic and diastolic blood pressure in patients with borderline hypertension (Goldberg & Hagberg, 1990; Kasch et al., 1988). For example, Hagberg et al., (1985) found that a six month program of low-intensity walking significantly lowered both systolic and diastolic blood pressure in hypertensive adults ranging in age from 60-65 years. These data suggest that exercise may have similar anti-hypertensive effects in older individuals as those previously reported in younger populations.

Blood Lipids:

Aging is associated with increases in both total cholesterol and serum triglycerides (Shepherd, 1997). Hypercholesterolemia and hyperlipidemia are major medical problems which lead to the premature development of coronary artery disease (Castelli et al., 1977). It is now well known that exercise training is associated with a reduction of coronary heart disease risk. Indeed the American Heart Association (AHA) has recognized that sedentary living is 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 (Shephard, 1997). These problems notwithstanding, there appears to be 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 lipids return to pre-exercise values within a few days of cessation of physical activity.

Muscle Strength and Endurance:

Muscle strength and endurance decline significantly with advancing age (Tzankoff & Norris, 1978; Lexell et al., 1983). Until fairly 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 which, if incorrectly performed, can result in sharp increases in blood pressure due to a physiological mechanism known as the valsalva maneuver. Since these acute elevations in blood pressure are potentially dangerous for hypertensive individuals, in the past, most professional organizations have chosen to de-emphasize the importance of strength training for older adults. Recently, however, a number of studies have examined the effect of dynamic strength training in elderly

Table 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 norepinephrine 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 which 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.

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adults. In one such study, Frontera et al. (1988) demonstrated that older adults who trained with weights for 12 weeks were able to gain appreciable increases in muscular strength and endurance. No adverse consequences associated with weight training were reported in this study. In another widely reported study, Fiaterone et al. (1990) demonstrated that men and women as old as ninety years of age can safely lift very heavy weights (80 percent of 1 repetition maximum). Remarkable gains in strength in excess of 100 percent were reported for some of the muscle groups trained in this study.

Since the maintenance of adequate levels of muscular strength is critical for the successful performance of many of the activities of daily living (Bassey, Bendall & Pearson, 1988; Phillips & Haskell, 1995), exercise scientists have begun to reevaluate the importance of strength training as a component of exercise programs for elderly adults. Both the American College of Sports Medicine and the Surgeon General's Report on Physical Activity and Health recommend that muscle strengthening exercises be included as part of the exercise training regimen for older adults (ACSM, 1995; US Surgeon General's Report, 1996).

Flexibility:

Aging is associated with changes in the elasticity and compliance of connective tissue (Spirduso, 1995). This results in significant decreases in flexibility and range of motion (Kuhlman, 1994; Nigg et al., 1992). 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, in part due to decreased physical activity, and that not all older individuals lose flexibility at the same rate (Campanelli, 1996; Morey et al., 1991). Stretching exercises which emphasize range of motion and flexibility have been shown to increase ankle, knee joint and lower back flexibility in older adults (Frekany & Leslie, 1975). The importance of pre-exercise stretching is reflected in the fact that almost all structured exercise programs advocate the inclusion of calisthenic exercises prior to the commencement of aerobic exercise (Spirduso, 1995).

Balance:

Postural stability and dynamic balance are effected by the integrity of the vestibular, visual, and somatosensory systems, all of which undergo structural and functional changes with advancing age (Woollacott & Schumway-Cook, 1996). Age-related declines in postural stability and dynamic balance are risk factors for falls and fall-related injuries in older adult populations (Lord et al., 1994; Tinetti, Doucette, & Claus, 1995). Although falling occurs due to a complex combination of factors including medication use, cognitive status, environmental hazards, sensory decline, and decreased muscle strength and coordination, there is some evidence to suggest that improving postural stability reduces the likelihood of falling (MacRae, Feltner & Reisch, 1994; Tinetti et al., 1994). Improvements in balance and body sway have been reported following participation in a general exercise program emphasizing walking, flexibility, and

strength exercises (Lord & Castell, 1994), as well as in response to specialized balance training (Wolfson et al., 1996; Ian, 1998).

Psychological Benefits of Physical Activity:

In addition to its effects on physiological variables, physical activity can also have significant psychological consequences. A summary of the long and short term benefits of physical activity for psychological functioning is included in Table 2.

General Psychological Well-being:

Although psychological health consists of both positive and negative components, until recently, research in the exercise sciences has tended to focus 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 and Rudolph, 1995) have argued that it is important to also examine the relation between physical activity and more positive elements of psychological functioning, including self-esteem, self-efficacy, and general well-being. In a review of 38 studies which have examined the relation between regular physical activity and general psychological well-being in older adult populations, McAuley and Rudolph (1995) found that the vast majority of studies report a positive association between physical activity and well-being. This relationship appears to be independent of the mode of exercise employed (Mihalko & McAuley, 1996), however, the strength of the association is greatest in programs of more than ten weeks in duration.

Depression and Anxiety:

It is generally accepted that the incidence of depression increases significantly with age (LaRue, Dessonville & Jarvik, 1985). When statistical procedures are used to control for differences in fitness between individuals, the association between advancing age and depression is substantially reduced (Chodzko-Zajko, 1990). Accordingly, data which suggest that 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.

With respect to the effect of exercise training on depression, a number of authors have shown that participation in regular exercise reduces depression in patients with mild to moderate levels of clinical depression (Greist et al., 1979, Martinsen, Medhus & Sandvik, 1985). Similarly, studies with non-clinical populations have also reported beneficial effects of exercise on mood state and anxiety (Morgan & O'Connor, 1987). Despite the presence of an association between physical activity and depression, it has yet to be demonstrated conclusively that exercise plays a causal role in the reduction of depression (O'Connor, Aenchenbacher, & Dishman, 1995).

Cognitive Functioning:

Age-related decrements in cognitive performance are now well established. However, cognition is not a unitary phenomenon

and there are wide variations between cognitive tasks with respect to the magnitude of changes observed with advancing age. Age-related changes in cognitive performance appear to be maximized for tasks which require rapid and complex processing, and are minimized for tasks which are more automatic or which can be performed at a self-paced rate (Chodzko-Zajko & Moore, 1994).

Despite the presence of a cross-sectional association between fitness and cognitive performance, no clear picture has emerged with respect to the effect of exercise on cognitive performance. Several well controlled studies have 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 not been able to replicate these findings (Blumenthal et al., 1989; 1991; Panton et al., 1990). There is some reason to believe that the magnitude of the improvement in aerobic capacity, as well as the demand-level of the cognitive task may be important factors in determining the presence or absence of training effects. However, it is important to point out that when changes in cognitive performance have been observed following exercise training, the magnitude of these changes has always been small.

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 people. In recent World Health Organization Guidelines for Promoting Physical Activity in Older Persons (WHO, 1997) a number of significant short and long-term effects of physical activity on socio-cultural variables are discussed (see Table 3).

Who should be Physically Active?

Until fairly recently physical activity programming for older adults has tended to focus on a relatively small and healthy subgroup of the older adult population (Chodzko-Zajko, 1995). However, it is now clear that beneficial effects of regular physical activity can be observed in almost all older persons regardless of their physical health. Several excellent and well publicized studies have focused our attention on the benefits of regular physical activity in those cohorts of seniors who were previously thought to be "too old" or "too frail" to partake in structured exercise programming (Fiatarone & Evans, 1990).

Physical Activity Programs for Older Adults:

It is not possible to formulate generic exercise prescriptions which can be applied across the board for all older adults. Individual differences in health status, physical fitness and previous exercise experience require that exercise prescription be

Table 2

A SUMMARY OF THE PSYCHOLOGICAL 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 the age associated declines in both fine and gross motor performance.
- **Skill Acquisition:** New skills can be learned and existing skills refined by all individuals regardless of age.

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tailored to meet the specific needs of each person. Older adults should be encouraged to seek advice from a health or exercise professional, who can assist them in the preparation of an optimal program designed to meet their individual needs. It is recommended that previously sedentary individuals over the age of 40 years should obtain a thorough medical examination before embarking on an exercise program (ACSM 1995). In cases where a physician's examination is not possible, pre-exercise screening questionnaires have been developed which can assist

in identifying contraindications to exercise (Cardinal and Cardinal, 1995).

In the past, a large percentage of the elderly population has remained sedentary due to the mistaken belief that they were not candidates for participation in regular physical activity. While there is an extremely small number of individuals for whom exercise is medically contraindicated, the vast majority of the elderly populations can benefit from participation in some form of physical activity (WHO, 1997). The major absolute contraindications to exercise training are recent ECG changes or myocardial infarction, unstable angina, uncontrolled arrhythmias, third degree heart block, and congestive heart failure (ACSM, 1995). The emergence of specialized programs for specific clinical populations, such as cardiac rehabilitation programs, the Arthritis Foundation's PACE program and programs for diabetics, are a testament to the realization that the benefits of physical activity apply across the continuum of health levels and exercise need not be restricted to "jocks" and exercise fanatics.

The WHO Guidelines for Promoting Physical Activity acknowledge the wide diversity of different exercise regimens which can be followed by older adults. Exercise can be an individual or group activity, it can be carried out in supervised or unsupervised settings. It is not necessary to have expensive facilities and equipment, and that successful programs are quite possible with very limited resources (WHO, 1997). While recognizing the importance of individualized exercise prescription, it is nonetheless possible to make some comments about general principles of exercise prescription which may be of value when designing exercise programs for older adults.

Activity Mode:

Low and moderate intensity, rhythmic activities which utilize large muscle groups are optimal for the enhancement of aerobic capacity. Common examples of such activities are walking, jogging, bicycling, and swimming. The particular activity selected by an individual is often a matter of personal preference. However, among many older persons, orthopedic and/or other medical factors may restrict the number of available options. In addition to these exercises, an increasing number of older adults participate in other activities, such as, various forms of dancing and weight training. While these activities may not be appropriate for all older individuals, there is little doubt that many people can obtain significant physiological benefits and much enjoyment from these forms of activity (ACSM, 1995).

Training Frequency:

In order to obtain a reliable training effect, it is generally recognized that a frequency of training two to three times per week is required. However, habitual exercisers often exercise five or six days per week without adverse consequences (ACSM, 1995). It is important to note that many of the physiological, psychological and social benefits of physical activity require regular and continuous participation and can be rapidly reversed by a return to inactivity.

Table 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 environment 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 which provides opportunities for intergenerational contact thereby diminishing stereotypic perceptions about aging and the elderly.

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Duration of Exercise:

Most structured exercise programs are designed to last about 45 minutes - 1 hour. This time period is typically divided up into 15-20 minutes of warm up and stretching, 20-30 minutes of aerobic activity and 5-10 minutes of cool down. While this format is flexible, there is some evidence to suggest that the aerobic

component of exercise programs should last at least 20 minutes in order to obtain optimal cardiovascular benefits (Spiriduso, 1995). For many sedentary and frail individuals, continuous activity for 45-60 minutes may be an unrealistic goal, at least at the onset of an exercise program. For these individuals more modest exercise targets should be set. As these individuals slowly become accustomed to renewed physical activity, exercise prescriptions can be adjusted accordingly.

Intensity of Exercise:

It is a popular misconception that high intensity exercise is required for significant physiological gain. The saying "no pain, no gain" is simply not true. Such misconceptions perpetuate inappropriate attitudes about exercise and result in large numbers of individuals avoiding potentially beneficial and enjoyable behaviors. Many older adults first learned to exercise at a time when high intensity exercise was widely considered to be more effective than more modest levels of activity. In recent years there has been extensive debate regarding the utility of traditional exercise prescriptions when applied to the sedentary population (Blair, 1994). Rather than adopt an absolutist stance regarding the minimum frequency, duration, and intensity of exercise necessary to achieve a training effect, it may be more prudent to encourage individuals to simply increase or maintain their activity levels without setting rigid (and frequently intimidating) exercise prescriptions.

Conclusions And Recommendations:

The scientific and medical evidence reviewed above clearly demonstrates that participation in regular physical activity is associated with tangible health benefits for almost all older adults.

The disappointingly low rates of participation in physical activity among older persons has led to considerable speculation with respect to why so many seniors choose not to be active. Commonly cited reasons for the failure to engage in regular physical activity include lack of time, money, or motivation (Lee, 1993). Additionally, the lack of safe, accessible facilities that are nearby and convenient to attend are often mentioned as perceived barriers to physical activity (Lee, 1993). There are also other reasons that pertain more specifically to older adults. These include societal stereotypes about aging and activity and the lack of social support for physical activity (Duncan & McAuley, 1993). A number of researchers have suggested that society holds certain attitudes about what is or is not appropriate behavior for particular age groups (Lee, 1993; Ostrow, Jones, & Spiker, 1981). For example, the disengagement theory of aging suggests that society encourages older adults to slow down and take it easy and, thus, acts to discourage participation in physical activity (McPherson, 1990). Others have suggested that older women, in particular, often lack meaningful role models who are physically active (O'Brien & Vertinsky, 1991).

Although it is beyond the scope of this paper to propose specific strategies for increasing the physical activity levels of the older adult population, there can be little doubt that considerable additional efforts are needed. Within the area of education, there is a need to increase awareness of the role of physical activity in healthy aging throughout all segments of society. In most countries, physicians are presently inadequately prepared to advise their older patients in the area of exercise and physical activity. Medical school curricula pay insufficient attention to the importance of preventive medicine in general, and almost no attention to specific issues such as exercise prescription and evaluation. Similarly, few allied health professions have developed comprehensive curricula focusing on the special activity needs of older persons. For example, within exercise science and physical education, almost all universities offer specialist degrees and concentrations in childhood physical education, in contrast, very few offer courses in physical activity and aging (Jones & Rikli, 1994).

In addition to educating health professionals, it is also important to disseminate information to health policy makers in both the public and private sectors. Elected representatives at all levels of government should be informed about the many benefits associated with promoting physical activity. Leaders of the health insurance industry must be educated about the cost effectiveness of preventative exercise interventions (Shephard, 1997). Unless we are able to successfully disseminate information to this segment of our society, it is doubtful that we will be able to develop a truly cooperative and comprehensive strategy for successful aging.

Finally, but most importantly, we must not forget that the most important people in the education process are the older people themselves. A large number of senior citizens remain unaware of the health benefits of physical activity. Many older adults continue to believe that physical activity is only for the physically fit and elite seniors. On the contrary, there is now strong evidence that virtually all older adults, even the sedentary and physically frail are candidates for some form of physical activity. Extensive efforts are needed to spread the word about physical activity and successful aging to the population at large.

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Chodzko-Zajko, W.J. (1998). The Physiology of Aging and Exercise, in R.T. Cotton & C.Ekeroth (Eds). Exercise for Older Adults, Champaign, IL, Human Kinetics

Physical Activity and Fitness Quote

**“Physiological responses of elderly
adults to exercise training
are essentially similar to those
experienced by younger individuals.**

**Some of the more common physiological adaptations
are improved cardiovascular function,
an increase in muscular strength and endurance,
and lowered blood pressure.”**

Wojtek J. Chodzko-Zajko, Ph.D.
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The President's Council on Physical Fitness and Sports Research Digest.

The President's Council on Physical Fitness and Sports

The President's Council on Physical Fitness and Sports (PCPFS) was established in 1956 through an Executive Order by President Dwight D. Eisenhower as part of a national campaign to help shape up America's younger generation. Today, the PCPFS serves as an advisory council to the President and Secretary of the Department of Health & Human Services on matters involving physical activity, fitness and sports to enhance and improve the health of Americans of all ages.

The PCPFS enlists the active support and assistance of individual citizens, civic groups, private enterprise, and voluntary organizations to promote and improve the physical activity and fitness of all Americans and to inform the public of the important link which exists between regular activity and good health.

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