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Aging and Exercise: A Health Perspective

Joanna L. Bokovoy and Steven N. Blair

Habitual exercise provides protection against fatal coronary heart disease, extends longevity, and enhances quality of life. National surveys show less physical activity in older men and women compared with middle-aged and younger persons; older women are particularly sedentary. Although there are still few longitudinal studies on exercise and physical activity in older individuals, the data support a positive relationship between physical activity and health and function in older individuals. The data further show that with regular physical activity, health and physical fitness are maintained or even increased over time in older individuals. Studies on physical activity requirements for beneficial health effects in the elderly are reviewed and presented, and exercise recommendations for older individuals are given.

Key Words: physical activity, physical fitness, mortality

The United States Census Bureau estimates that the proportion of Americans who are older than 65 years will double from 12% of the population in 1986 to 24% in 2020 (Kovar, 1977). The increasing size of the elderly population raises numerous public health and social concerns. The impact on both the health care system and on society in general is likely to be profound. The aging of the population will influence such factors as chronic disease mortality and the level of functioning, loss of independence, and the need for long-term care of those living to the oldest ages (Schneider & Guralnik, 1990).

Reports from seven recent conferences or workshops on physical activity, fitness, and health have stressed the importance of an active way of life for adults and have provided recommendations for research, interventions, and policies to evaluate and promote exercise in the elderly population (Bijnen, Mosterd, & Caspersen, 1992; Blair, Powell, et al., 1993; Bouchard, Shephard, & Stephens, 1994; Fletcher et al., 1992; Haskell et al., 1992; King et al., 1992; Public Health Service, 1990; Workshop on Physical Activity and Public Health, 1993).

Table 1 summarizes the principal recommendations that have emerged from these workshops. As can be seen from these recommendations, there is some consensus that a physically active lifestyle should be an integral component of any health promotion program. Indeed the Healthy People 2000 report, prepared by the U.S. Public Health Service to formulate national health objectives for the

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Table 1 Summary of Material Related to Aging and Exercise From 7 Recent Conferences or Workshops on Fitness and Health

Conference	Purpose	Main recommendations
American Heart Association (AHA) Committee on Exercise and Cardiac Rehabilitation of the Council on Cardiology (Fletcher et al., 1992)	To present a current position statement on exercise and health for all Americans	Named inactivity a risk factor with the same status as cholesterol, smoking, and hypertension. Recommendations: (1) Basic knowledge is needed of anatomical, biochemical, and physiological changes that result from various patterns of physical activity in persons of different ages, as well as a determination of whether a certain minimal-intensity threshold of physical activity is required for benefit; (2) evaluation of the biomedical and economic impact of exercise; (3) inclusion of adequate numbers of the elderly and women in future studies; and (4) future advancement and investigation should not only be about the benefits of physical activity but also about the best methods for distributing knowledge to all people.
<i>Review of current research</i>		
American Heart Association Prevention III Conference (Blair, Powell, et al., 1993) <i>A conference titled "Behavior Change and Compliance: Keys to Improving Cardiovascular Health"</i>	To evaluate six major health hazards, summarize state-of-the-art activities for reducing each health hazard, identify gaps in research, and give	Research needs: (1) To develop better ways to measure physical activity, particularly light to moderately intense activities not traditionally considered to be sport or exercise, especially for women; (2) to investigate the relative importance of lifetime variations and current patterns of physical activity in the prevention of coronary artery disease; and (3) to identify factors that facilitate both adoption and maintenance of activity by women and men of all ages, races, and socioeconomic strata. Program and intervention needs: (1) Physical activity education and intervention programs for health care professionals and the public should present alternatives to the traditional exercise prescription; (2) lifestyle interventions in which increased activity

	detailed suggestions on professional and public education programs and public policy initiatives	is integrated into daily routines is encouraged; and (3) intervention strategies to increase physical activity should include modified physical environment to enhance physical activity, stimuli that prompt physical activity, and reinforcement.
Committee on Health Objectives for the Year 2000 (Public Health Service, 1990)	To formulate national health objectives for the year 2000	Policy needs: (1) Technical assistance and demonstration projects should be provided or funded by federal and state agencies to disseminate information to communities, organizations, and individuals; (2) more support for mass transit is needed to reduce auto traffic and encourage more walking and biking; (3) insurance coverage for exercise counseling and rehabilitative services; (4) AHA support to all organizations to meet Healthy People 2000 objectives; and (5) information and materials on physical activity for use by medical professionals.
<i>Compilation of information for the United States Public Health Service</i>		Intervention and research needs: (1) To improve the health span or active life expectancy of all Americans; (2) to see an increase to 40% of the elderly engaging in regular, appropriate physical exercise such as walking, swimming, or other moderate aerobic activities by the year 2000; (3) to prolong the period of independent living, with particular attention to quality of life; (4) to increase public and professional awareness of the benefits of physical activity in the elderly; (5) to provide access to exercise programs for all older adults, yet also stress the importance of building exercise into regular daily activities rather than depending on traveling to distant facilities; (6) to improve surveillance and evaluation systems in the area of physical activity and fitness in the elderly; (7) to implement preventive services in programs and settings that are accessible to older people; and (8) to provide adequate training for health professionals and others who work with the elderly.

(cont.)

Table 1 (Continued)

Conference	Purpose	Main recommendations
<p>International Society and Federation of Cardiology (Bijnen et al., 1992)</p> <p><i>A position statement for the World Health Organization (WHO)</i></p>	<p>To notify the international community of the relationship between physical inactivity and coronary heart disease</p>	<p>Recommendations: (1) Physical inactivity should be considered an important risk factor in coronary heart disease and should be included in prevention policies, particularly in industrialized countries; (2) because physical inactivity is a modifiable risk factor, industrialized countries should set policy objectives to promote physical activity; exercise should be enjoyed and a physically active lifestyle should be promoted worldwide; (3) regular light to moderate physical activity, documented in current studies as having significant health benefits, should be encouraged. This may have a positive effect on inactive people, who are most likely to adopt less intense forms of exercise anyway.</p>
<p>National Heart, Lung, and Blood Institute Workshop on Physical Activity and Cardiovascular Health (Haskell et al., 1992; King et al., 1992)</p> <p><i>Workshop to review state-of-the-art research on physical activity and cardiovascular health, with special emphasis on children and women</i></p>	<p>To review the relationship between physical activity and cardiovascular health and give advice on directions for future research priorities and programs</p>	<p>Recommendations for research: (1) Determinants and methods of changing individual patterns of physical activity, focusing on structure, supervision, frequency, intensity, and units of time; (2) stages of physical activity behavior with interventions specifically tailored to each stage of change; (3) influence of developmental milestones on readiness and ability to be regularly active; (4) effectiveness of existing theoretical models of behavior change for explaining and increasing physical activity; (5) other risk reduction areas and physical activity interventions; (6) evaluation of methods in physical activity assessments and interventions designed to increase adoption and maintenance of physical activity in a variety of settings; and (7) physical environmental, social, and biological factors that influence the adoption and maintenance of physical activity and their relation to other risk factors.</p>

<p>The 1992 International Conference on Physical Activity, Fitness, and Health (Bouchard et al., 1994)</p> <p><i>An international consensus symposium</i></p>	<p>To focus on the relationship among physical activity, fitness, and health</p>	<p>Presents an exhaustive listing of 355 research questions and topics, for example: (a) Can inevitable biological aging be differentiated from secondary aging processes? (b) What are the most appropriate training prescriptions for the various modes of exercise in order to promote health, fitness, and functional capacities in different populations of men and women? (c) To develop programs of regular muscular activity that are affordable, safe, and acceptable to large numbers of sedentary people; (d) To establish the basis for age related deficits that occur in skeletal muscles; (e) What is the effect of gender and age on the acute cardiovascular response and adaptation to exercise? and (f) Can physical activity restore some of the typical declines in cognitive-motor processing that are found in the elderly?</p> <p>Presented a model describing the relationship among habitual physical activity, health related fitness, and health status: Lifestyle behaviors, physical and social environmental conditions, personal attributes, and genetic characteristics all affect this model. Their interrelationships were explored and defined.</p>
<p>Workshop on Physical Activity and Public Health (1993)</p> <p><i>Sponsored by U.S. CDC and ACSM in cooperation with the President's Council on Physical Fitness and Sports</i></p>	<p>To emphasize the important health benefits of moderate physical activity</p>	<p>Recommendations: (1) Every American adult should accumulate 30 minutes or more of moderate intensity physical activity over the course of most days. (2) Physical activity promotions targeted to older adults should emphasize the importance of being physically active by routinely carrying out the activities of daily living with a minimum of assistance. (3) Regular activities that develop cardiorespiratory fitness, muscle strength and endurance, and flexibility are strongly encouraged. (4) Local, state, and federal public health agencies, recreation boards, professional organizations, and fitness and sports organizations should work together to provide critical fitness information and promote programs to help elderly Americans become more active.</p>

Note. This table is adapted from an earlier version: Blair, S.N. (1993). 1993 C.H. McCloy Research Lecture: Physical activity, physical fitness, and health. *Research Quarterly for Exercise and Sport*, **64**, 365-376.

year 2000, focuses on the need to prolong the period of independent living in the elderly. Particular attention is focused on the quality of life and the need to increase to at least 40% the proportion of participation in regular, appropriate physical activity by the year 2000 in adults over 65 years of age (Public Health Service, 1990).

Examination of the 1990 Established Populations for Epidemiologic Studies of the Elderly (EPESE) data base suggests that 42% of the study population were unable to do heavy housework, 26% were unable to walk 1/2 mile, and 19% were unable to climb stairs (National Institute on Aging, 1990). Women were more likely than men of the same race to report that they were unable to do specific activities, and black persons were more likely than white persons of the same sex to report that they were unable to do the activity in question. For each sex-race group, the ability to do these activities declines with advancing age. Consistent with this finding, the Healthy People 2000 report indicates that among people 65 and older, more than two of every five have essentially a sedentary lifestyle (Public Health Service, 1990). In summary, inactivity and poor functional status is prevalent in older adults in the U.S.

In this paper we review current research in the area of aging, exercise, and health. We examine the association between physical activity and a variety of disease states, as well as examining epidemiological evidence that has assessed the relationship between activity levels and mortality. Finally we discuss exercise requirements for health benefits in the older population.

Relationship Between Sedentary Lifestyle and Disease

Sedentary lifestyle and aging increase a person's risk of many chronic diseases. Most studies include both middle-aged and older individuals, but in many cases the data were not presented separately by age group and many studies did not include women. Therefore, additional specific studies on activity or fitness and disease risk in older men and women are needed. In this section we focus on our understanding of the relationship between physical activity and risk factors for certain diseases.

CORONARY HEART DISEASE

A position statement by the American Heart Association (Fletcher et al., 1992) named inactivity as a risk factor for coronary artery disease, along with elevated cholesterol, smoking, and hypertension. One important recommendation of this committee was to include adequate numbers of elderly in future studies on physical activity and health and fitness.

Haskell et al. (1992) present a critical discussion on the potential cardiovascular health benefits and risks of physical activity and physical fitness. From their comprehensive review of current observational studies containing data on primary preventive effects of increased physical activity or physical fitness, they concluded that active or fit people tend to develop less coronary heart disease than inactive people. Also, if active individuals do develop coronary heart disease, it occurs at a later age and tends to be less severe. Other literature surveys also indicate an inverse relationship between amount of physical activity and incidence

of coronary heart disease (Paffenbarger & Hyde, 1984; Siscovick, LaPorte, & Newman, 1985).

The Framingham Study shows that overall morbidity and mortality due to cardiovascular and ischemic heart disease are inversely related to the level of physical activity in men (Kannel & Sorlie, 1979). Physically active men in Framingham have a lower incidence of ischemic heart disease and a lower incidence of all forms of cardiovascular disease.

A British autopsy study on 3,800 men who had died from causes other than coronary heart disease showed a strong relationship between ischemic myocardial fibrosis and the amount of physical activity required in one's occupation. The authors concluded that ischemic myocardial fibrosis is more common in men in physically less demanding occupations than in the men doing active and heavy work (Morris & Crawford, 1958).

HYPERTENSION

Increased physical activity reduces systolic and diastolic arterial blood pressure by an average of 13 and 10 mm mercury, respectively, in adults with mild to moderate hypertension (Cade et al., 1984; Duncan et al., 1985; Nelson, Jennings, Esler, & Korner, 1986). Moderate intensity training may be at least as effective as, or perhaps even more effective than, high intensity training. Hagberg, Montain, Martin, and Ehasani (1989) recently compared the effect of training at 53% or 73% of $\dot{V}O_{2\max}$ in hypertensive men and women who averaged 64 years of age. Both regimens were similarly effective in reducing diastolic blood pressure (11 to 12 mm mercury), but the decrease in systolic blood pressure was significantly greater for the lower intensity group (20 vs. 8 mm mercury).

STROKE

We recently reviewed the few epidemiological reports on physical activity or fitness and incidence of stroke (Blair, Kohl, Gordon, & Paffenbarger, 1992). These studies did not distinguish between hemorrhagic and nonhemorrhagic (thromboembolic) stroke, and thus any conclusions from these studies should be accepted with caution. Because coronary heart disease and thromboembolic stroke have a similar pathogenesis, physical activity and fitness might be expected to have the same inverse relationship to this type of stroke as it does to coronary heart disease. Activity and fitness may protect against stroke, but additional studies are needed to confirm the hypothesis.

CANCER

Physical fitness, as assessed by maximal exercise tolerance on a treadmill test, is inversely associated with cancer mortality in the Aerobics Center Longitudinal Study (Blair et al., 1989). There were 64 deaths from cancer in 10,224 men and 18 deaths from cancer in 3,120 women who were followed for an average of 8 years (total of 110,842 person-years of observation). Age-adjusted rates for death from cancer per 10,000 person-years of observation across low, moderate, and high physical fitness categories are progressively lower with higher fitness.

Physical activity was significantly inversely associated with risk of cancer death in a study examining 7,735 middle-aged men drawn from general practices

in 24 British towns (Wannamethee, Shaper, & Macfarlane, 1993). Subjects were examined and completed questionnaires in 1978–1980. A follow-up period of 9-1/2 years (to December 1989) saw 334 deaths from noncardiovascular causes, including 225 cancer deaths. There was a strong positive association between high heart rate and cancer mortality even after adjustment for age, blood cholesterol, body mass index, heavy alcohol consumption, physical activity, preexisting ischemic heart disease, smoking, social class, and systolic blood pressure ($p < 0.01$).

There are several studies on sedentary habits and certain cancers (Albanes, Blair, & Taylor, 1989; Gerhardsson, Norell, Kiviranta, Pedersen, & Ahlbom, 1986; Severson, Nomura, Grove, & Stemmermann, 1989; Vena et al., 1985). The strongest evidence of a beneficial effect of activity is for colon cancer; in fact, rectal cancer is not associated with physical activity (Lee, 1994).

METABOLIC DISORDERS

Meyers et al. (1991) examined the relationship of obesity and physical fitness to cardiopulmonary and metabolic function in older men and reported that glucose tolerance and insulin secretion are more strongly correlated with $\dot{V}O_2$ max and indices of body composition than with age. This study indicates that factors other than aging (e.g., low physical fitness as reflected in a person's $\dot{V}O_2$ max, and obesity) place a person at high risk for the development of metabolic disorders.

Direct evidence of a protective role of physical activity against noninsulin dependent diabetes (NIDDM) is available from a prospective study of University of Pennsylvania alumni (Helmrick, Ragland, Leung, & Paffenbarger, 1991; Paffenbarger & Wing, 1973). Physical activity patterns and other lifestyle habits were examined in relation to the incidence of NIDDM in 5,990 men. The disease developed in 202 of these men in 15 years of follow-up. Leisure time physical activity, expressed as kilocalories (kcal) in walking, stair climbing, and recreational activities, was inversely related to the development of NIDDM, and the incidence of NIDDM decreased as energy expenditure increased from less than 500 kcal to 3,500 kcal or more per week. The protective effect of physical activity was strongest with moderate to vigorous sports. The effect was also strong in individuals who were considered at higher risk of NIDDM because they were hypertensive, overweight, or had a family history of diabetes.

OSTEOPOROSIS

Exercise is often used as part of the treatment to prevent osteoporosis and subsequent fracture. A study by Jaglal, Kreiger, and Darlington (1993) shows evidence of independent protective effects of past physical activity and of moderate levels of recent physical activity on the risk of hip fracture in postmenopausal women. A study using older women with a history of osteoporotic fractures shows a 3.8% increase in bone mineral density in women who performed simple resistance exercises, using their own or a partner's body weight, compared with a 1.9% loss in a matched control group who did no resistance exercises over the same 5-month period (Simkin, Ayalon, & Leichter, 1987). The influence of physical activity on bone mineral density is related to hormonal status. Menstrual

irregularity in young women may be associated with a reduction in peak bone mass, and postmenopausal women can achieve a greater increase in bone mineral density from physical activity if they also take estrogen (Drinkwater, 1994).

OSTEOARTHRITIS (OA)

Lane and Buckwalter (1993) reviewed the current literature on exercise and its relationship to osteoarthritis and concluded that individuals of all ages with established OA or rheumatoid arthritis can benefit from supervised exercise programs. They noted that short-term studies have documented improved functional status, decreases in medication use, and psychological benefits from supervised group exercise programs. However, they cautioned that individuals with underlying problems should restrict themselves to physical activities that will not aggravate their condition.

An 8-week randomized controlled trial was recently done of supervised walking in older patients with moderate OA of the knee (Kovar et al., 1992). Subjects with moderate OA of the knee were randomized to either a supervised walking program with patient education or to standard routine medical care. Subjects in the walking group increased their walking distance by 70 m or 18.4%, and controls decreased their walking distance by 17 m. Improvements in functional status, as measured by the Arthritis Impact Measurement Physical Activity Subscale, were seen in the walking group but not in the control group, and medication use was less frequent in the walking group than in the control group ($p = 0.08$).

In summary, a supervised low-intensity walking program did not exacerbate moderate OA of the knee, and it even improved functional status without worsening pain or arthritis related symptoms. These results must be interpreted with caution, however, since these subjects did not have severe OA of the knee and the study was short term.

DEPRESSION

In a recent comprehensive critical review of the literature, O'Connor, Aenchenbacher, and Dishman (1993) noted that the weight of the available population based survey evidence on noninstitutionalized elderly suggests a moderate relationship between self-reported physical inactivity and symptoms of depression. However, they also note that there is no compelling experimental evidence that exercise alone is effective in preventing or treating depressive disorders in the elderly. This promises to be a fruitful area of research for exercise science.

Studies of the Relationship Between Sedentary Lifestyle and Mortality

HARVARD ALUMNI STUDY

Paffenbarger et al. (1993) recently examined the middle-aged and older men of the Harvard alumni group; they report that beginning moderately vigorous sports activity is associated with substantially lower rates of death from all causes and from coronary heart disease than for those who remain sedentary. An earlier

study showed increased risk of mortality in sedentary individuals (Paffenbarger, Hyde, Wing, & Hsieh, 1986). This relationship could be confounded by preexisting disease or other factors. Paffenbarger et al.'s current study on the benefits of increased activity in initially sedentary men provides stronger evidence of a causal relationship between activity and mortality than has been available to this time.

LONGITUDINAL STUDY OF AGING (LSOA)

Recently, Rakowski and Mor (1992) evaluated self-reported physical activity and mortality among adults age 70 and over using data drawn from the 1984–1988 LSOA. Their results indicate that low activity is associated with an increased risk of mortality.

ALAMEDA COUNTY STUDY

The Alameda County Study, which has followed 6,928 adult residents of Alameda County, California, since 1965, shows that having little leisure time activity was associated with increased risk of death for men and women who were 60 to 94 years at baseline. It also shows a relative risk of 1.38 for all-cause mortality in sedentary compared with physically active individuals after adjustment for other risk factors and demographic characteristics (Kaplan, Seeman, Cohen, Knudsen, & Guralnik, 1987).

ADVENTIST MORTALITY STUDY

The Adventist Mortality Study, which had 9,484 males complete a lifestyle questionnaire in 1960 and then followed them for 26 years, showed that inactivity was associated with a mean age at death of 76.3 years for all-cause mortality, while moderate activity was associated with a mean age at death of 79.1 years (Lindsted, Tonstad, & Kuzma, 1991).

AEROBICS CENTER LONGITUDINAL STUDY (ACLS)

We continue to follow men and women who received medical examinations at the Cooper Clinic in Dallas, Texas. An earlier report from this study showed a steep inverse gradient for all-cause and cardiovascular disease mortality across low, moderate, and high levels of physical fitness (Blair et al., 1989). Although the numbers of deaths in age-group-specific strata were relatively small, especially for women, it appears there was an inverse relationship between fitness and mortality in all age groups. We now have an additional 5 years of mortality data in this cohort, which enables us to further examine fitness and mortality in older men and women.

The analyses presented here are from 6,878 men and 2,054 women ≥ 50 years of age at baseline. A wide range of clinical, demographic, psychosocial, and health behavior variables were measured, including physical fitness assessed by a maximal exercise test. Details of the examination and measurement techniques are available from earlier reports (Blair et al., 1989; Blair, Kohl, & Barlow, 1993). Treadmill test time was used to estimate maximal aerobic power, and

study participants were assigned to low (least fit 20%), moderate (next 40%), and high (most fit 40%) physical fitness categories.

Participants were followed from the date of their baseline examination until the date of death, or until December 31, 1989. The average length of follow-up was approximately 8 years. There were 77 deaths during 15,386 woman-years of follow-up, and 513 deaths during 57,878 man-years of follow-up. Mortality data were compiled through the use of the National Death Index and other methods. Death certificates were obtained from state departments of vital records and were coded by a nosologist for underlying and up to four contributing causes of death using the *International Classification of Diseases*, 9th edition, revised (ICD-9). Analyses presented here are for all causes combined and for cardiovascular diseases (ICD-9, 390-448).

Death rates per 10,000 person-years of follow-up were calculated for low, moderate, and high physical fitness categories for men and women. Age-adjusted rates were calculated for the total group, and age-specific death rates were calculated within 5-year age groups.

The association between baseline physical fitness and subsequent mortality in participants 50 years and older is shown in Table 2 for both sexes. A steep inverse gradient was seen for men, with the low fit men having a more than threefold increased risk of dying than the high fit men. There was no difference in death rates between moderate and high fit women, but the unfit women were more than twice as likely to die as the fit women. Table 3 presents cardiovascular disease death rates across fitness groups. The low fit men were five times more likely to die during follow-up than the high fit men, and the cardiovascular disease death rate in low fit women was approximately three times that for the high fit women.

Men in the study were classified as healthy or unhealthy at the time of baseline examination. Healthy men had no evidence of coronary heart disease, stroke, diabetes, hypertension, or cancer. Men who had at least one of these conditions were classified as unhealthy. There were not enough women to allow

Table 2 Physical Fitness and All-Cause Mortality in Women and Men ≥ 50 Years of Age in the Aerobics Center Longitudinal Study

Fitness category	Person-years	No. of deaths	Age-adjusted rate/10,000 PY	Relative risk	95% CI
Women ($n = 2,054$)					
Low	3,847	34	86.7	2.37	1.61–3.48
Mod.	6,650	25	36.9	1.0	0.64–1.59
High	4,889	18	36.6	1.0	
Men ($n = 6,878$)					
Low	15,162	258	163.2	3.32	2.41–4.57
Mod.	25,057	168	68.9	1.40	0.97–2.02
High	17,659	87	49.2	1.0	

PY = person years.

Table 3 Physical Fitness and Cardiovascular Disease Mortality in Men and Women ≥50 Years of Age in the Aerobics Center Longitudinal Study

Fitness category	Person-years	No. of deaths	Age-adjusted rate/10,000 PY	Relative risk	95% CI
Men (<i>n</i> = 6,581)					
Low	13,433	120	86.1	5.23	3.09–8.86
Mod.	23,871	67	28.8	1.75	0.96–3.21
High	17,064	29	16.5	1.0	
Women (<i>n</i> = 1,999)					
Low	3,563	11	31.5	2.98	1.49–5.98
Mod.	6,431	6	9.1	0.86	0.36–2.09
High	4,729	5	10.6	1.0	

PY = person years.

Table 4 Physical Fitness and Cardiovascular Disease Mortality in Men ≥50 Years of Age in the Aerobics Center Longitudinal Study

Fitness category	Man-years	No. of deaths	Age-adjusted rate/10,000 MY	Relative risk	95% CI
Healthy men (<i>n</i> = 3,762)					
Low	4,704	14	30	4.46	1.92–10.34
Mod.	13,825	19	14	2.17	0.86–5.43
High	12,050	9	7	1.0	
Unhealthy men (<i>n</i> = 2,819)					
Low	8,729	106	119	3.05	2.12–4.38
Mod.	10,046	48	49	1.25	0.82–1.91
High	5,014	20	39	1.0	

MY = man years.

us to perform health status group-specific analyses. Comparisons across health status groups are presented in Table 4 for men. Results were comparable to the overall analyses.

Figures 1 and 2 show death rates for all causes and for cardiovascular diseases by 5-year age groups for men; there were not enough women to allow us to perform these analyses. Physical fitness was inversely associated with mortality in all age groups. A high level of fitness appears to provide protection against mortality, even in the oldest men. In summary, the analyses presented here support the hypothesis that life may be extended in men and women who are physically fit. The consistency of results for the age-group-specific analyses suggests that physical fitness appears to provide protection well into the later years.

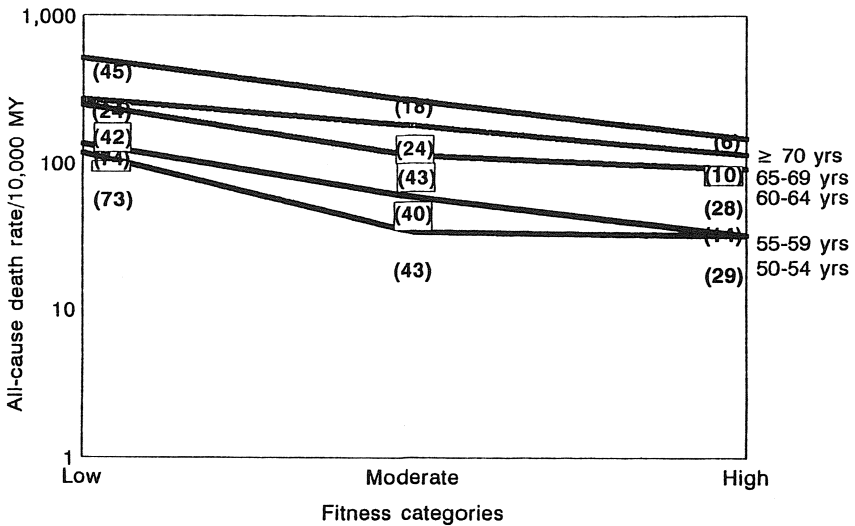


Figure 1. All-cause death rates for 5-year age groups across physical fitness categories in 6,878 men 50 years of age and older in the Aerobics Center Longitudinal Study. Numbers in parentheses are the number of deaths in the specific group.

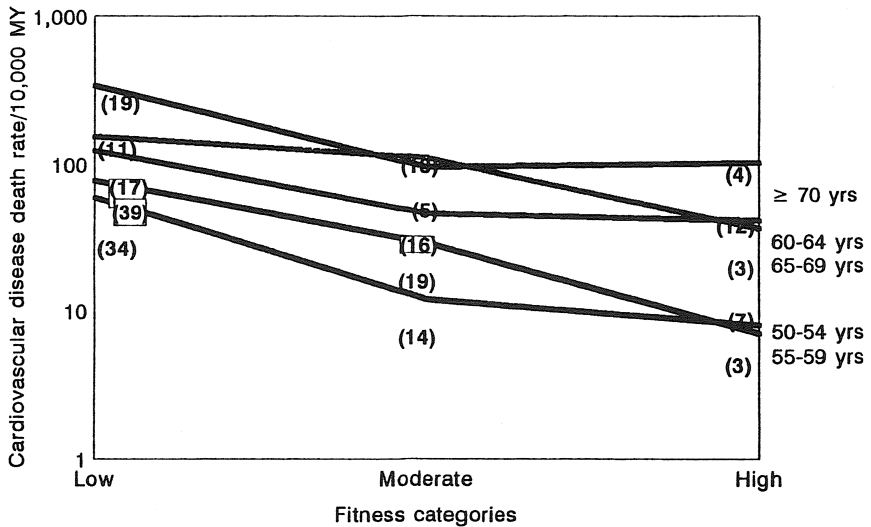


Figure 2. Cardiovascular disease death rates for 5-year age groups across physical fitness categories in 6,581 men 50 years and older in the Aerobics Center Longitudinal Study. Numbers in parentheses are the number of deaths in the specific group.

Exercise Recommendations for the Elderly

Over the past several decades exercise scientists have promoted a scientific approach to exercise prescription for all ages that specifies exercise intensity, duration, and frequency (American College of Sports Medicine, 1991; American College of Sports Medicine Position Stand, 1990). These recommendations are based on many controlled trials of exercise training that describe the shape of the dose-response relationship of exercise to short-term improvements in physical fitness. The traditional exercise prescription emphasizes activity that is relatively vigorous and involves large muscles for at least 20 min three times a week.

In 1985 a group of scientists noted that aerobic training in high-risk groups such as the elderly was unlikely to be adopted on a large scale (LaPorte, Dearwater, Cauley, Slemenda, & Cook, 1985). They stated that it was more reasonable to increase the activity levels of such groups with a walking program. People often dislike the regimented, somewhat complicated instructions of the traditional exercise prescription and may avoid regular, vigorous exercise. An important goal for exercise scientists and sports medicine clinicians is to discover new ways to encourage physical activity in the most sedentary and unfit people.

The recommended amount of exercise for health benefits is not completely understood. Most current research shows that regular physical activity reduces the risk of heart disease, but very few studies indicate the need for highly intensive exercise. It appears that high intensity exercise is not necessary to noticeably reduce the risk of coronary artery disease.

We recently reviewed five prospective studies and found that there is a gradient of risk across activity or fitness levels, and that even moderate levels of activity or fitness are associated with important and clinically significant reductions in risk (Blair, Kohl, Gordon, & Paffenbarger, 1992). This dose-response relationship shows that a moderate physical activity program is likely to give important health benefits and indicates that some activity is better than none, and that more is better than less.

A major recommendation for the sedentary elderly is to increase activities such as walking, mowing the lawn, climbing stairs, and gardening. A recent randomized clinical trial suggests that three 10-min walks over the course of the day have about the same impact on physical fitness as one 30-min walk (DeBusk, Stenestrand, Sheehan, & Haskell, 1990). This study indicates that accumulation of activity over the course of the day may produce physiological adaptations that are comparable to the same amount of activity in a single session. This may make it easier for the elderly to incorporate activity into their daily routine than if they attempt to get all their activity in one session.

Lifestyle exercise focuses on getting individuals to integrate multiple short bouts of physical activity into their everyday lives (Blair, 1991; Blair, Kohl, & Gordon, 1992; Gordon, Kohl, & Blair, 1993). An important aspect of this method of exercise is to help individuals act as their own exercise counselors and to develop behavioral skills that incorporate activity into their lifestyle. It represents one approach that may be beneficial to sedentary elderly persons who are not ready to make the transition needed, or who are physically unable, to comply with a more formal and vigorous exercise training program.

A study that examined the difference between moderate and low intensity endurance training in elderly women found significant improvement in measures

of $\dot{V}O_{2\max}$ for both groups, but no significant difference between groups (Foster, Hume, Byrnes, Dickinson, & Chatfield, 1989). These results suggest that even low intensity exercise provides fitness benefits in elderly women.

An encouraging finding for the inactive elderly is that even people who have been inactive for several years will see health benefits after they begin exercising (Paffenbarger et al., 1993). This recent information suggests that people who increase their activity level during adulthood reduce their risk to the level of those who have been regularly active for many years.

STRENGTH AND FLEXIBILITY TRAINING

Developing endurance, joint flexibility, and muscle strength is important as part of a balanced exercise program, especially as people age. A recent cross-sectional study of 50 elderly women showed that flexibility of the hip and spine (assessed using the sit-and-reach test) was significantly better in the more physically active women (Voorrips, Lemmink, Van Heuvelen, Bult, & Staveren, 1993). This indicates that simply being physically active may maintain strength and flexibility. Other strength and flexibility studies in the elderly have generally yielded favorable results (Fiatarone et al., 1990; Topp, Mikesky, Wigglesworth, Holt, & Edwards, 1993). More specific research is needed in this area to determine the type of strength and flexibility training that would be most appropriate and most beneficial for the elderly.

Summary

Current studies suggest that the health and functional benefits of physical activity that have been convincingly documented in middle-aged persons also are likely to occur in older men and women. Physically active and fit older individuals are less apt to develop chronic diseases and are less likely to be part of the mortality statistics in follow-up studies. A balanced activity program appears to make important contributions to functional status and quality of life in the elderly. New approaches to physical activity interventions that focus on moderate amounts of intensities, and that allow for more flexibility in accumulating a sufficient dose of exercise, may increase the likelihood of permanent and positive changes in activity habits.

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