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Physical Activity in Aging: Changes in Patterns and Their Relationship to Health and Function

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Sedentary behavior is an important risk factor for chronic disease morbidity and mortality in aging. However, there is a limited amount of information on the type and amount of activity needed to promote optimal health and function in older people. The purpose of this review is to describe the change in patterns of habitual physical activity in aging and the relationship of these changes to physical function and selected chronic diseases. We undertook a literature review of large population-based studies of physical activity in older people, and there is encouraging evidence that moderate levels of physical activity may provide protection from certain chronic diseases. Additionally, substantial health effects can be accrued independent of the fitness effects achieved through sustained vigorous activity. Thus, regular participation (i.e., 30 minutes/day on most days of the week) in activities of moderate intensity (such as walking, climbing stairs, biking, or yardwork/gardening), which increase accumulated daily energy expenditure and maintain muscular strength, but may not be of sufficient intensity for improving fitness, should be encouraged in older adults. Public policy should focus on ways of increasing volitional and lifestyle activity in older people, as well as on increasing the availability and accessibility of senior and community center programs for promoting physical activity throughout the life span.

INTEREST in the determinants of successful aging has led to the investigation of the heterogeneity in health and physical performance abilities within groups of higher functioning older people (1). A primary goal of these studies is to determine the modifiable factors related to the plasticity of higher physical function, as opposed to merely the presence or absence of disability (2,3). Exercise and other forms of physical activity are known to provide a myriad of specific physiologic and psychosocial benefits to older people (4,5,6 for review). While data from intervention studies demonstrate the effect of more vigorous aerobic or strength training on changes in physiologic variables in older people (see 7 for review), the benefits of more moderate activity, such as that performed as part of an active lifestyle, are less clear. This is due in part to the difficulty inherent in the assessment of habitual activity in older people. Physical activity in older age tends to be of lower intensity and highly variable. In addition, issues of recall of such activity patterns in older people lead to less than precise estimates. Problems in the definition and measurement of physical activity limit the ability to assess physical activity properly and, therefore, to determine the health consequences associated with a healthy lifestyle.

The purpose of this article is to describe the physical activities common to older people and how patterns of habitual physical activity change with age. Further, the epidemiologic relationship of regular physical activity to physical function and selected chronic disease outcomes, based on data from large population-based studies, will be described.

Demographics of Physical Activity in Older People

The *Healthy People 2010* objectives (8) state the goal "to increase to at least 30% the proportion of people aged 18 and older who engage in moderate physical activity for at least 30 min/day." Approximately 15% of the U.S. adult population met this goal in 1999. For older adults specifically (aged 65 and older), the *Healthy People 2010* objectives indicated the prevalence of no reported activity was 51% in 1999. Surveillance data from 29 states in the United States suggest that inactivity rates (i.e., no reported leisure-time physical activities in the past month) dropped between 1986 and 1990, although this decline was not apparent among nonwhite adults or adults of lower educational attainment (9). When the data are stratified further by age groups, they show that this overall decline in reported inactivity is explained primarily by reduced inactivity among people more than 55 years old.

Race, Gender, and Age Differences

In 1991, nearly 60% of the U.S. adult population reported little or no leisure-time physical activity (10). Level of leisure-time activity appears to vary by gender and race among adults in the United States (11,12). Women are less likely than men to report regular leisure time physical activity (see 13 for review), and the lowest activity levels typically are reported among women of Hispanic or African American descent (11,14–16). Among adults, racial comparisons tend to be distorted by the influence of socioeconomic status and education, however. Results from several studies (14–17) show a strong positive correlation between years of educational attainment and level of habitual physical activity in both men and women, particularly with regard to the prevalence of regular (i.e., ≥20 minutes or more per session ≥3 times/wk) and regular/intense (i.e., ≥60% maximal aerobic capacity [$\dot{V}O_2max$]) activity (10,15,18,19).

A recent report using Behavioral Risk Factor Surveillance System (BRFSS) data (11) shows that in 1992, approximately 27% of adult women in the United States met the newly recommended level of physical activity (i.e., either ≥20 min/day of vigorous activity on ≥3 days/wk or ≥30 min/day of moderate activity on ≥5 days/wk), and this proportion remained somewhat consistent by age category. Reported participation varied substantially by race, income, and education level, with African American women at every age the least likely to participate in these recommended levels of physical activity.

Changes in Physical Activity with Age

The prevalence of specific higher intensity activities decreases with older age among adults, while the prevalence of reported inactivity shows an age-related increase (20,21), which is especially evident among women (11,22). On the basis of data from the BRFSS, over 40% of U.S. women ≥65 years reported no leisure-time activity in 1992 (11). Recent cross-sectional data from the Aerobics Center Longitudinal Study (23) suggest that exercise-related weekly energy expenditure is significantly lower in higher age groups than in younger groups—especially among the most fit members of this healthy cohort aged 20 to 87 years. Verbrugge and colleagues (24) report a curvilinear pattern in volitional (i.e., leisure and recreational) activity among age groups in the Baltimore Longitudinal Study of Aging, with peak participation reported at ages 30 to 49 years and lower participation reported in younger and older age groups. Time spent in activities such as transportation, socializing, entertainment, sports, and walking for leisure (men only) also showed cross-sectional decreases across age groups. Longitudinal data from this same cohort showed similar patterns of change with aging. Longitudinal data from older men in the Zutphen Elderly Study (25) show a 33% decline (28 min/day; $p < .001$) in total weekly physical activity (min/week) over the 10-year follow-up (Figure 1).

Walking is the most prevalent activity reported among adults of all sociodemographic strata in the United States (14,15,22,23,26), Canada (17,27), and Europe (21,25,28). Following walking, running, team sports, and weight lifting are more common activities among younger men, while participation in aerobics is more prevalent among younger women (22). The most prevalent activities among older adults tend to be lower intensity (but sustained) activities such as walking, yardwork/gardening, golf (21,22,24,26), and bicycling (21,24,25; Figure 2). Among the male Zutphen cohort (25), walking, bicycling, and gardening contributed 76% of the total time spent on physical activity in 1985 and 81% in 1995. Although time spent bicycling and gardening showed a significant 10-year decline, time spent walking remained relatively stable over the survey years (Figure 1).

Physical activity is a complex behavior and is often difficult to describe. There are important sex and race differences in reported physical activity patterns, which are evident even in older adulthood. Typically, reported levels of leisure-time physical activity appear lowest among girls and women of minority status and older adult women. The ever-widening racial disparity in activity level may well be explained by socioeconomic status among children and by level of educational attainment among younger and older adults, although data from the CARDIA Study show that important racial differences remained between women even after adjustment for several important sociodemographic factors (14).

There is encouraging, albeit limited, evidence that the prevalence of reported inactivity is decreasing over time among some sectors (namely, older adults) of the general U.S. population, with an increasing trend in the prevalence of regular leisure-time activity. It is important to consider, however, that leisure-time physical activity is only a portion of total activity. The other components of total activity involve work or household activity and transportation. Although surveillance data are not available for these other components, one can reasonably assume that energy spent in work and household tasks, as well as in transportation, has progressively declined over the years with increasing automation. This time-related decline is further accelerated by aging-related declines in physical activity. It therefore is possible that overall physical activity has declined substan-

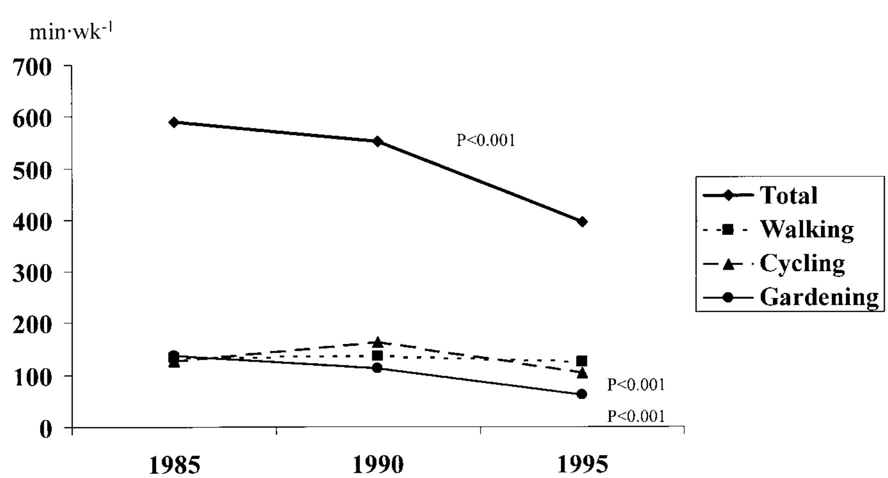

Figure 1. Reported time spent in physical activity between 1985 and 1995 in men participating in the Zutphen Elderly Study. *p* value represents statistical significance across survey years for total activity, cycling, and gardening. Adapted with permission from Bijnen FCH and colleagues (25).

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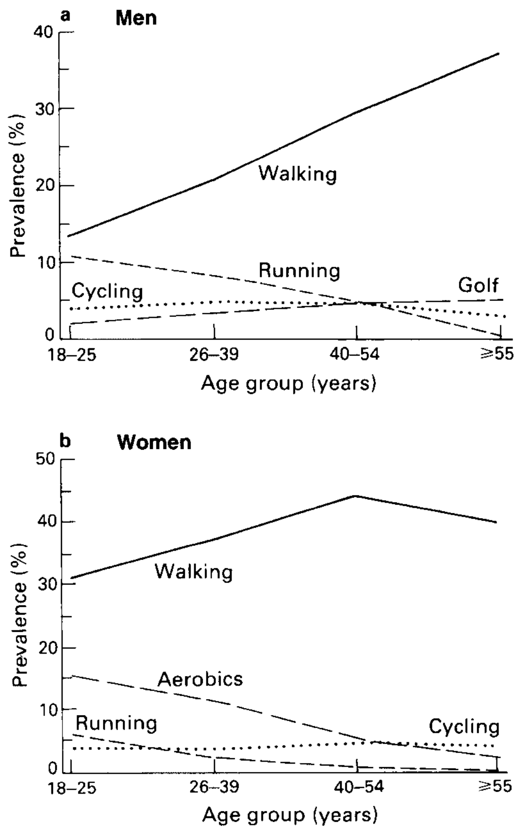

Figure 2. Prevalence of popular activities by age and sex among persons trying to lose weight: Behavioral Risk Factor Surveillance System, 1989. DiPietro L and colleagues (22).

tially among our older population in spite of increases in their leisure-time activity (29).

The decline in overall physical activity has tremendous public health implications for older people, since there is increasing evidence that the health effects of physical activity are linked specifically to the total amount of kilocalorie expenditure or activity time accrued per day or week, rather than the actual duration or intensity of the exercise bout (30). Recommendations for adults (30) call for a lifestyle approach to increasing activity levels among the public by incorporating any activity of at least moderate intensity into the day. Indeed, the new Centers for Disease Control and Prevention/American College of Sports Medicine (CDC/ACSM) recommendations are unique and especially useful for older people in that they emphasize the value of moderate-intensity activity, as well as the daily accumulation of physical activity in intermittent bouts, as sufficient for achieving the CDC/ACSM recommendations and the associated health benefits. Thus, the recommended accumulated expenditure of 200 kcal/day can be achieved easily by most older people through short bouts of activities such as stair climbing, gardening, brisk walking, playing with children, or housework.

Determinants of Physical Activity

Of recent interest in the study of physical activity and exercise among the general population are the determinants of regular participation (see 31–33 for reviews). These determinants (e.g., physiological, psychosocial, and environmental), which may vary by age, sex, and socioeconomic status, must be clearly identified and subsequently managed before the public health potential of physical activity can be fulfilled (31,33).

Physiological Factors

Heredity, or genetic predisposition, is an important component of physical fitness or functional capacity (34), which contributes substantially to physical activity level in older people (35,36). Among adults, especially older adults, speed, flexibility, balance, and strength may also be important determinants of participation in a particular activity as simple as walking (37). Indeed, the relationship between muscle strength and preferred walking speed has been reported for both men and women (38), and the magnitude of this relationship is especially strong among frailer institutionalized adults over age 85 (39,40). Thus, physiological differences may be associated with age differences in physical activity level and choice of activity, since they may act as incentives for persons to participate in activities at which they are more competent and in which they feel safe (41).

Psychosocial Factors

Personality.—Characteristics such as motivation, stress tolerance, social adequacy, and independence do not strongly influence physical activity levels in children (42), although self-motivation has consistently correlated with physical activity level in several adult populations (43–45). On the other hand, self-efficacy, or confidence in one's abilities, is a factor strongly associated with both the adoption and adherence to physical activity among adolescents (46,47), younger adults, and especially older adults (37,48; see 49 for review). Affective disorders such as anxiety and depression tend to be inversely associated with physical activity participation at any age (50–52). While limited data show that various mood disturbances and depressive personality are associated with inactivity, or actually predictive of adherence to fitness or rehabilitation programs in middle-aged and older people (53–55), it remains unclear whether affective states are a determinant or a consequence of physical activity behavior.

Knowledge and beliefs.—Studies among adults suggest that knowledge and beliefs about the health effects of physical activity are positively associated with current physical activity levels (37). Conversely, a less than favorable perception of one's own health status is associated with reduced participation in cardiac rehabilitation programs (56) and at the community level as well (57). Perceived enjoyment and satisfaction are positive predictors of physical activity in both men and women of all ages (58); however, intentions to be physically active do not necessarily predict subsequent participation (59).

Social support.—Social influences on physical activity patterns appear to be strong throughout the life span. Peer reinforcement is especially important to physical activity

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patterns in youth (60), and social support from friends and spouses has correlated with vigorous activity in younger and older adult populations (60,61).

Environmental Factors

Safety and accessibility.—Safety and accessibility are two important environmental factors associated with activity participation across the age span, although these two factors have not been studied extensively (14,33). Walking/running on bicycle paths and recreational areas, which are set away from traffic and are patrolled and well-lighted, are very important for older people—especially older people living in underserved urban environments where sidewalks are often in disrepair. Fear of crime is an important barrier to physical activity and functional ability in older populations (62, DiPietro and Hartman, unpublished data, 1999). Also, among older adults, membership fees or lack of transportation often present insurmountable barriers to supervised programs in health clubs or recreational facilities. Thus, unequal access to safe, supervised exercise programs and facilities may serve as an important mediating factor in the relationship between age, sex, and race and physical activity level.

Thus, an array of physiological, psychosocial, and environmental factors may determine physical activity behavior throughout the life span, and these factors become even more important in older age. Many of these determinants, particularly some of the psychosocial and environmental factors, are particularly amenable to change and should be the focus of community intervention efforts. Strategies for increasing physical activity among the older sectors of the community include the following: (i) increased public education about the health effects of moderate physical activity; (ii) increased senior and community center programs that are supervised and provide social support and other incentives for exercise; and (iii) increased community availability and accessibility of safe physical activity and recreational facilities such as hiking, biking, and fitness trails, public swimming pools, and acres of park space.

Physical Activity, Chronic Disease, and Disability

Physical activity and fitness have been associated with a lower incidence of morbidity and mortality from a number of major chronic diseases affecting older people (see 63 for review), namely, coronary heart disease (CHD; see 7 for review and 64), breast cancer (65–67), and type 2 diabetes (68,69; see 70 for review). Physical activity has also demonstrated a significant, independent protective effect on the risk of being overweight (see 71 for review; 72,73), bone loss (see 74,75 for reviews and 76), hip fracture (77–79), and factors associated with falls (80,81), as well as on the rate of functional decline (see 6,82,83,84 for review) so common with aging. There is evidence to suggest that *current* activity is more protective than *past* activity; however, *cumulative, lifetime activity patterns* may be a more influential factor for most of these diseases, especially those with a long developmental period, such as cancer, bone integrity, or long-term weight regulation.

Indeed, the evidence clearly indicates that sedentary behavior is a major risk factor for chronic disease morbidity and mortality (85; Table 1). Since such a large proportion of the general older adult population reports no activity, the public health impact of a sedentary lifestyle may be considerable in older age. This inverse association between physical activity and disease or decline is consistently strong, graded, and independent, and it is biologically plausible and specific (86)—thereby meeting most criteria for inferring a causal relationship. The challenge often encountered in epidemiologic research relying on self-reported measures of physical activity, however, is that of establishing temporal sequencing (i.e., does sedentary behavior truly precede the onset of decline or disease?).

Dimensions of Physical Activity

It is difficult to determine the characteristics of physical activity related most specifically to different aspects of health, since there are several dimensions of physical activity behaviors. These dimensions, which are neither exclusive to any one type of activity nor to each other, include aerobic intensity, energy expenditure, weight bearing, flexibility, and muscular strength (87). Certainly, the dimensions are interrelated since, for example, activities that increase aerobic capacity also require energy expenditure; any sustained weight-bearing activity will also expend energy, and if done vigorously enough, will increase aerobic capacity.

It is important to consider that the relative importance of each of these dimensions to health shifts with age. For example, among adolescent girls and younger women, dimensions of physical activity related to muscle and bone growth may be of primary interest, whereas among middle-aged people, the influence of energy expenditure on weight regulation or of aerobic intensity on cardiovascular health becomes more important. Among older adults, the influence of weight-bearing, strength, and flexibility aspects of activity on bone and lean mass preservation and balance assumes highest priority with regard to maintaining functional ability and independence.

How Much Physical Activity Is Enough?

The level of exercise both necessary and sufficient to achieve health benefits is of recent interest (30,88,89). In

Table 1. Weekly Moderate and Vigorous Physical Exercise and 5-yr Mortality in Men and Women Aged 65 and Older: The Cardiovascular Health Study ($N = 5201$)

Physical Exercise (kcal/wk^{-1})	No. of Deaths	No. at Risk	Adjusted RR	95% CI
<67.5	130	566	1.00	
67.5–472.5	130	846	0.78	(0.60–1.00)
472.6–980.0	127	936	0.81	(0.63–1.05)
980.1–1890.0	129	1168	0.72	(0.55–0.93)
>1890.0	128	1669	0.56	(0.43–0.74)

Notes: RR = relative risk based on Cox Proportional Hazards Modeling adjusted for demographic characteristics, body weight, smoking, alcohol intake, blood pressure, lipid characteristics, fasting blood sugar, and other serum characteristics, chronic disease, functional ability, cognitive function, and self-assessed health. RR is the decrease in risk with increasing level of exercise relative to the reference catagory (<67.5 kcal/wk).

Source: Adapted with permission from Fried and colleagues (85).

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the past it was proposed that exercise of sufficient frequency, intensity, and duration to achieve improvements in physical fitness was necessary to promote resistance to disease. While the effects of physical activity on health status may be mediated primarily by the physiologic changes that accompany increased aerobic fitness (90), recent data suggest that such changes may have an independent positive impact on various health indicators. Indeed, a growing epidemiologic literature shows significant relationships between low- and moderate-intensity activities and reduced all-cause mortality (85), as well as morbidity and mortality from cardiovascular disease, stroke, cancer, and respiratory disease (91–99).

To determine the comparable roles of walking and more vigorous activity with regard to coronary disease risk, Manson et al. (64) examined the joint contribution of the metabolic equivalent (MET)-h/wk spent in these activities to the incidence of coronary events. The data in Table 2 suggest that women who reported both walking and vigorous exercise had greater reductions in coronary events than those who participated in either type of activity alone. However, the authors did not observe a greater magnitude of risk reduction with vigorous exercise compared to walking when the two activities were considered simultaneously in a multivariable model. For instance, for each 5 MET-h/wk spent in vigorous activity (about 45 min/wk of jogging, bicycling, swimming laps, or playing tennis), risk was reduced by 6% (relative risk [RR] = 0.94; 95% confidence interval [CI] 0.89–0.99), but for each 5 MET-h/wk spent walking (about 1.5 h/wk of brisk walking), risk was reduced by 14% (RR = 0.86; 95% CI 0.74–0.99). Thus, when total energy expenditure was similar, vigorous exercise was no more effective than brisk walking in significantly reducing the risk of coronary events in older women. In contrast, recent data from older men and women in The Cardiovascular Health Study (100) support the notion of an inverse graded relationship of exercise *intensity* to selected subclinical disease factors, such as fasting insulin, serum fibrinogen, lower extremity arterial disease, and myocardial injury score, that was independent of total energy expended in the exercise.

Table 2. Multivariable Relative Risks of Coronary Events According to Categories of Vigorous Exercise and Walking

Walking Score (MET-hr/wk)	Vigorous Exercise Score (MET-hr/wk)[†]		
	0	0.1–6.9	≥7.0
0–0.6	1.0	0.78 (0.55–1.09)	0.76 (0.49–1.17)
0.7–6.9	0.85 (0.67–1.06)	0.86 (0.65–1.13)	0.59 (0.42–0.82)
≥7.0	0.74 (0.57–0.97)	0.56 (0.36–0.88)	0.70 (0.51–0.95)

Notes: Values are relative risk (95% confidence interval). Based on multiple logistic regression models adjusted for age, study period, smoking, body mass index, menopausal status, hormone replacement therapy, family history of myocardial infarction (MI), vitamin supplementation, alcohol intake, history of hypertension or hypercholesterolemia, and aspirin use. Coronary events included nonfatal MI and death due to coronary causes. Women with the lowest score for each type of activity served as the referent group. MET = metabolic equivalent.

Source: Adapted with permission from Manson and colleagues (64).

[†]Vigorous exercise was defined as participation in activity that required at least 6 METS per hour and included jogging, running, bicycling, lap swimming, tennis, squash, and calisthenics.

The exercise prescription (i.e., frequency, duration, and intensity) for optimal achievement of one type of health outcome (e.g., weight loss) may be very different from that necessary to achieve another (increased bone mineral content or muscular strength). Age may also be an important variable in modifying the effects of a given exercise stimulus on health and functioning. That is, the amount of exercise related to disease-specific morbidity in middle-age may be very different from that related to successful aging and overall longevity. Overall, there is a paucity of information relating to the exercise prescriptions for health outcomes other than CHD; this is especially true among older women and children in general. Nonetheless, the limited evidence for the amount of activity appropriate to several other important areas of older people's health is discussed below (please see 7 for additional discussion).

Type 2 Diabetes

Physical activity is inversely associated with both the prevalence (101–103) and incidence (68,69) of type 2 diabetes (see 70 review). Although data are limited, they also suggest that it is regular lifetime physical activity that is most protective against type 2 diabetes (104,105). Moreover, data from the Harvard Alumni Study (68) support the notion that overall activity (i.e., kilocalorie expenditure/week) is the important factor in the prevention of type 2 diabetes, and while vigorous activities (e.g., sports, running, swimming, and other activities) were most protective, moderate activities were also associated with decreased risk. Indeed, DiPietro and colleagues (106) also report improvements in glucose response to an oral glucose tolerance test after only 4 months of moderate-intensity aerobic training in a healthy older population. Therefore, since moderate activities can be sustained regularly for longer periods of time by older people, thereby maximizing the calorigenic benefits, their merits should be encouraged in the prevention and/or management of type 2 diabetes.

Excess abdominal adiposity is an important predictor of type 2 diabetes in aging (68,101) and a primary condition for insulin sensitivity and glucose intolerance (107,108), and these relationships may be stronger among older women than among older men (101,109). Thus, the protective effects of increased physical activity on type 2 diabetes may be due in part to the relationship between exercise, adiposity, and glucose/insulin metabolism. Special consideration should be given to the study of how this relationship may vary by age and sex. The aforementioned improvements in glucose response reported by DiPietro and colleagues (106) were independent of changes in abdominal adiposity; improvements in insulin response would most likely have required a longer training period and a loss of abdominal fat in this particular study sample.

Bone Mineral Density

Regular physical activity is associated with greater peak bone mass in adolescents and younger women, and slower decline in bone mineral density in middle-aged and older women (110; see 75,76 for reviews). Among women, childhood physical activity (111) and lifetime physical activity (112,113) have been shown to be more important than cur-

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rent levels of activity in affecting bone integrity. The type and amount of exercise that best promotes bone growth has not been established (114), although weight-bearing exercise (e.g., walking, jogging, and dancing) has been the type of exercise most often prescribed to women following menopause. The effects of exercise on bone growth may be heterogenous, with higher loads at more specific sites providing a more effective osteogenic stimulus than lower loads that are generally distributed. In fact, the loads placed on the lumbar vertebrae with brisk walking and jogging are up to 1.75 times body weight (115), whereas weight lifting may load on the lumbar vertebrae as much as 5 to 6 times the body weight (116). Muscle strength actually may be a better correlate of bone mineral density than is age (117,118). Recent data provide evidence of a relationship between the strength of a specific muscle group and the surrounding bone (119,120) and that this relationship is site-specific (e.g., hip strength would predict hip bone mineral density). Therefore, programs of regular, sustained, resistance exercise, which overloads the muscular system at specific sites, may provide the optimal stimulus for bone growth and maintenance in aging.

Musculoskeletal Function

Sarcopenia (i.e., loss of muscle mass) in aging is well documented. Between the ages of 20 and 90 years, there is nearly a 50% decline in urinary creatinine excretion (121), thereby reflecting the decline in muscle creatinine content and total muscle mass with increasing age. These changes are most notable in women (122) and may result from the gradual loss of selective muscle fibers—namely Type II fibers. There is evidence that Type II fiber content of the *vastus lateralis* may decline from about 60% in young sedentary men to below 30% in adults over age 80 (123), resulting in a substantial loss of strength with age.

Musculoskeletal weakness and disability is especially common among older women and, along with compromised flexibility and balance, contributes substantially to functional disability and the risk of falling (81,124). Two landmark studies by Frontera and colleagues (125) and Fiatarone and colleagues (126) heralded a growing body of evidence of the benefits of higher intensity (i.e., 80% of 1 repetition maximum) resistance training to muscle hypertrophy and strength in older persons (see 6 for review). Indeed, these studies demonstrate that older people can safely tolerate higher intensity strength training with improvements comparable to those seen among younger persons.

The epidemiologic data linking physical activity or specific exercise training to outcomes of activities of daily living (e.g., basic self-care activities; 127) or more necessary components of independent living (e.g., shopping; 128) are equivocal. Prospective observational studies suggest an inverse relationship between reported physical activity and risk of disability, with several studies finding that moderate to higher levels of recreational activity are necessary for risk reduction (129–132, see 83 for review). Intervention studies, however, which tend to focus more on the impact of strength training on gait and balance, report conflicting results (133–135). More randomized controlled interventions are needed to determine the exercise prescription sufficient to cause the adaptations in aerobic capacity, muscle strength and endurance, flexibility, and balance that translate into improved daily functioning for older persons.

Cognitive Function

The relationship of physical activity and structured exercise to various aspects of cognitive function (e.g., memory, attention, reaction time, and crystallized and fluid intelligence) has been documented extensively (see 7,136 for reviews). The hypothesis is that increased physical activity and exercise can counter the age-related decline in cardiovascular function related to brain hypoxia and consequent cognitive decline. Several epidemiologic studies report higher cognitive skills with higher levels of reported activity (137–139) in their healthy older samples; however, the design of these studies, the various definitions of physical activity, and a host of other methodologic concerns make the interpretation of these data difficult. Level of educational attainment and health status are both important confounders of the relationship between physical activity and cognitive function (137) and often are the primary determinants of any relationship observed at the population level.

Unfortunately, the results from experimental training studies that test the impact of increased fitness on specific cognitive and neurological tasks have provided findings that are equivocal at best (see 136,140 for review). Again, issues of study design, sample size, and physical fitness assessment may explain these inconsistent results among studies. There is evidence, however, that the length of the exercise intervention and the degree of improvement in fitness are key components of any exercise-related improvements in neurological function (136,141).

In summary, there is limited information on amount of exercise needed to promote optimal health and function in older people. Prescribing levels of exercise necessary to achieve aerobic fitness may no longer be appropriate in older age; rather, public health policy should focus on *sufficient levels* when promoting physical activity among the more sedentary older or frailer sectors of the general population. Given that health benefits may accrue independently of the fitness effects achieved through sustained vigorous exercise, a new lifestyle approach should be emphasized from childhood through older adulthood. This approach calls for incorporating at least 30 minutes of any activity (sustained or accumulated) into the daily schedule. Thus, regular participation in activities of moderate intensity (such as walking, climbing stairs, biking, or yardwork/gardening), which increase accumulated daily or weekly kilocalorie expenditure and maintain muscular strength, but which may not be of sufficient intensity for improving fitness, should be encouraged in the community (30,88,89). This is especially important for older people who may be at risk from more vigorous exercise.

Summary

Sedentary behavior is an important risk factor for chronic disease morbidity and mortality; however, there is encouraging evidence that moderate levels of physical activity may provide protection from certain chronic diseases. More

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research is needed to determine the exercise prescriptions relating to optimal health for older people.

Physical activity choices and the physiological, psychosocial, and environmental determinants of activity participation vary by the sociodemographic characteristics of age, sex, and education level. Therefore, these characteristics should be fully considered by professionals when educating the older public about the health effects of daily, accumulated activity. Similarly, healthy public policy (142) should focus on ways of increasing volitional activity among older people, as well as on increasing the availability and accessibility of senior and community center programs for promoting physical activity.

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