Special Communication

Physical Activity and Public Health

A Recommendation From the Centers for Disease Control and Prevention and the American College of Sports Medicine

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Objective.—To encourage increased participation in physical activity among Americans of all ages by issuing a public health recommendation on the types and amounts of physical activity needed for health promotion and disease prevention.

Participants.—A planning committee of five scientists was established by the Centers for Disease Control and Prevention and the American College of Sports Medicine to organize a workshop. This committee selected 15 other workshop discussants on the basis of their research expertise in issues related to the health implications of physical activity. Several relevant professional or scientific organizations and federal agencies also were represented.

Evidence.—The panel of experts reviewed the pertinent physiological, epidemiologic, and clinical evidence, including primary research articles and recent review articles.

Consensus Process.—Major issues related to physical activity and health were outlined, and selected members of the expert panel drafted sections of the paper from this outline. A draft manuscript was prepared by the planning committee and circulated to the full panel in advance of the 2-day workshop. During the workshop, each section of the manuscript was reviewed by the expert panel. Primary attention was given to achieving group consensus concerning the recommended types and amounts of physical activity. A concise "public health message" was developed to express the recommendations of the panel. During the ensuing months, the consensus statement was further reviewed and revised and was formally endorsed by both the Centers for Disease Control and Prevention and the American College of Sports Medicine.

Conclusion.—Every US adult should accumulate 30 minutes or more of moderate-intensity physical activity on most, preferably all, days of the week.

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REGULAR physical activity has long been regarded as an important component of a healthy lifestyle. Recently, this impression has been reinforced by new scientific evidence linking regular physical activity to a wide array of physical and mental health benefits.[1-7] Despite this evidence and the public's apparent acceptance of the importance of physical activity, millions of US adults remain essentially sedentary.[8]

If our sedentary society is to change to one that is more physically active, health organizations and educational institutions must communicate to the public the amounts and types of physical activity that are needed to prevent disease and promote health. These organizations and institutions, providers of health services, communities, and individuals must also implement effective strategies that promote the adoption of physically active lifestyles.

A group of experts was brought together by the Centers for Disease Control and Prevention (CDC) and the American College of Sports Medicine (ACSM) to review the pertinent scientific evidence and to develop a clear, concise "public health message" regarding physical activity. The panel of experts also considered the organizational initiatives that should be implemented to help US adults become more physically active.

The focus of this article is on physical activity and the health benefits associated with regular, moderate-intensity physical activity. Physical activity has been defined as "any bodily movement produced by skeletal muscles that results in energy expenditure."[9] Moderate physical activity is activity performed at an intensity of 3 to 6 METs (work metabolic rate/resting metabolic rate)—the equivalent of brisk walking at 3 to 4 mph for most healthy adults. Physical activity is closely related to, but distinct from, exercise and physical fitness. Exercise is a subset of physical activity defined as "planned, structured, and repetitive bodily movement done to improve or maintain one or more components of physical fitness."[9] Physical fitness is "a set of attributes that people have or achieve that relates to the ability to perform physical activity."[9]

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This article summarizes the work of the aforementioned expert panel and has two purposes. First, we recommend the amounts and types of physical activity that are needed by adults for good health and summarize the scientific basis for this recommendation. Second, we recommend the ways that public health organizations, educational institutions, health care providers, communities, and individuals can effectively promote physical activity through more effective educational programs and the creation of programs and facilities that make it easier for people to become and remain more active. This article builds on existing recommendations, including *Healthy People 2000*,[10] the *Guide to Clinical Preventive Services*,[11] the ACSM's "Position Stand on the Recommended Quality and Quantity of Exercise for Developing and Maintaining Cardiorespiratory and Muscular Fitness in Healthy Adults,"[12] and the American Heart Association's recent "Statement on Exercise."[13] This article is not meant to be a definitive review of the many health aspects of physical activity; a thorough discussion can be found elsewhere.[14]

RELATIONSHIP BETWEEN PHYSICAL ACTIVITY AND HEALTH

Cross-sectional epidemiologic studies[15,16] and controlled, experimental investigations[12] have demonstrated that physically active adults, as contrasted with their sedentary counterparts, tend to develop and maintain higher levels of physical fitness. Epidemiologic research has demonstrated protective effects of varying strength between physical activity and risk for several chronic diseases, including coronary heart disease (CHD),[1-3,17,18] hypertension,[4,19-21] non–insulin-dependent diabetes mellitus,[22-24] osteoporosis,[7,25,26] colon cancer,[27] and anxiety and depression.[5,28]

Other epidemiologic studies have shown that low levels of habitual physical activity and low levels of physical fitness are associated with markedly increased all-cause mortality rates.[1,29] A midlife increase in physical activity is associated with a decreased risk of mortality.[30] It has been estimated that as many as 250 000 deaths per year in the United States, approximately 12% of the total, are attributable to a lack of regular physical activity.[31,32]

The conclusions of these epidemiologic studies are supported by experimental studies showing that exercise training improves CHD risk factors and other health-related factors, including blood lipid profile,[33] resting blood pressure in borderline hypertensives,[4,34-36] body composition,[37-39] glucose tolerance and insulin sensitivity,[40,41] bone density,[42] immune function,[43,44] and psychological function.[45]

Epidemiologic criteria used to establish causal relationships can be applied to the association between physical activity and CHD.[46] The following principles of causality appear to have been met: Consistency: The association of physical inactivity and risk of CHD is observed in a number of settings and populations, with the better-designed studies showing the strongest associations. Strength: The relative risk of CHD associated with physical inactivity ranges from 1.5 to 2.4, an increase in risk comparable with that observed for hypercholesterolemia, hypertension, and cigarette smoking.[3,47] Temporal sequencing: The observation of physical inactivity predates the diagnosis of CHD. Dose response: Most studies demonstrate that the risk of CHD increases as physical activity decreases. Plausibility and coherence: Physical activity reduces the risk of CHD through a number of physiological and metabolic mechanisms. These include the potential for increasing the level of high-density lipoprotein cholesterol; reducing serum triglyceride levels; reducing blood pressure; enhancing fibrinolysis and altering platelet function, thereby reducing the risk of acute thrombosis; enhancing glucose tolerance and insulin sensitivity; and reducing the sensitivity of the myocardium to the effects of catecholamines, thereby reducing the risk of ventricular arrhythmias.[4,33,40,48,49]

DESCRIPTIVE EPIDEMIOLOGY OF PHYSICAL ACTIVITY

Physical activity recommendations in *Healthy People 2000*[10] are to "[i]ncrease to at least 30 percent the proportion of people aged 6 and older who engage regularly, preferably daily, in light to moderate physical activity for at least 30 minutes per day." However, only about 22% of adults are active at this level recommended for health benefits, 54% are somewhat active but do not meet this objective, and 24% or more are completely sedentary (ie, reporting no leisure-time physical activity during the past month). Participation in regular physical activity gradually increased during the 1960s, 1970s, and early 1980s, but seems to have plateaued in recent years.[50]

Patterns of physical activity vary with demographic characteristics (Table 1). Men are more likely than women to engage in regular activity,[51] in vigorous exercise, and sports.[52] The total amount of time spent engaging in physical activity declines with age.[53,54] Adults at retirement age (65 years) show some increased participation in activities of light to moderate intensity, but, overall, physical activity declines continuously as age increases.[53,55] African Americans and other ethnic minority populations are less active than white Americans,[51,55,56] and this disparity is more pronounced for women.[56] People with higher levels of education participate in more leisure-time physical activity than do people with less education.[51] Differences in education and socioeconomic status account for most, if not all, of the differences in leisure-time physical activity associated with race/ethnicity.[57]

Table 1.—Proportion of Adults Reporting No Leisure-Time Physical Activity Within the Last Month, 1991 Behavioral Risk Factor Surveillance System*

Demographic Group	Sedentary, % (95% CI)
Sex	
Male	27.89 (27.18-28.60)
Female	31.48 (30.85-32.11)
Race	
White	27.75 (27.24-28.26)
Nonwhite	37.52 (36.27-38.77)
Age, y	
18-34	23.77 (23.01-24.53)
35-54	29.50 (28.70-30.30)
≥55	38.00 (37.10-38.90)
Annual income, $	
≤14 999	40.14 (39.06-41.22)
15 000-24 999	32.00 (30.90-33.10)
25 000-50 000	25.43 (24.63-26.23)
>50 000	18.64 (17.60-19.68)
Education	
Some high school	48.06 (46.75-49.37)
High school/ tech school graduate	33.57 (32.79-34.35)
Some college/ college graduate	20.16 (19.55-20.77)

*A population-based random-digit-dial telephone survey with 87 433 respondents aged 18 years and older from 47 states and the District of Columbia. Data are weighted, and point estimates and confidence intervals (CIs) are calculated using the SESUDAAN procedure to adjust for the complex sampling frame.[10]

DETERMINANTS OF PARTICIPATION IN PHYSICAL ACTIVITY

Physiological, behavioral, and psychological variables are related to physical activity.[58-60] A lack of time is the most commonly cited barrier to participation in physical activity,[61] and injury is a common reason for stopping regular activity. Cigarette smoking is only weakly inversely related to participation in physical activity, but smokers are more likely than nonsmokers to drop out of exercise programs.[62] Body composition (percentage of body fat) is not a powerful predictor of physical activity habits; however, persons who are obese are usually inactive.[37]

An intention to exercise and awareness of the benefits of exercise are weakly related to participation in physical activity.[63] Confidence in the ability to be physically active, perceived barriers to activity, and enjoyment of activity are strongly related to participation.[64] Low- to moderate-intensity physical activities are more likely to be continued than high-intensity activities.[65] Self-regulatory skills, such as goal set-

Table 2.—Examples of Common Physical Activities for Healthy US Adults by Intensity of Effort Required in MET Scores and Kilocalories per Minute*

Light (<3.0 METs or <4 kcal·min^{-1})	Moderate (3.0-6.0 METs or 4-7 kcal·min^{-1})	Hard/Vigorous (>6.0 METs or >7 kcal·min^{-1})
Walking, slowly (strolling) (1-2 mph)	Walking, briskly (3-4 mph)	Walking, briskly uphill or with a load
Cycling, stationary (<50 W)	Cycling for pleasure or transportation (≤10 mph)	Cycling, fast or racing (>10 mph)
Swimming, slow treading	Swimming, moderate effort	Swimming, fast treading or crawl
Conditioning exercise, light stretching	Conditioning exercise, general calisthenics	Conditioning exercise, stair ergometer, ski machine
. . .	Racket sports, table tennis	Racket sports, singles tennis, racketball
Golf, power cart	Golf, pulling cart or carrying clubs	. . .
Bowling	. . .	. . .
Fishing, sitting	Fishing, standing/casting	Fishing in stream
Boating, power	Canoeing, leisurely (2.0-3.9 mph)	Canoeing, rapidly (≥4 mph)
Home care, carpet sweeping	Home care, general cleaning	Moving furniture
Mowing lawn, riding mower	Mowing lawn, power mower	Mowing lawn, hand mower
Home repair, carpentry	Home repair, painting	. . .

*Data from Ainsworth et al,[69] Leon,[70] and McCardle et al.[71] The METs (work metabolic rate/resting metabolic rate) are multiples of the resting rate of oxygen consumption during physical activity. One MET represents the approximate rate of oxygen consumption of a seated adult at rest, or about 3.5 mL·min^{-1}·kg^{-1}. The equivalent energy cost of 1 MET in kilocalories·min^{-1} is about 1.2 for a 70-kg person, or approximately 1 kcal·kg^{-1}·hr^{-1}.

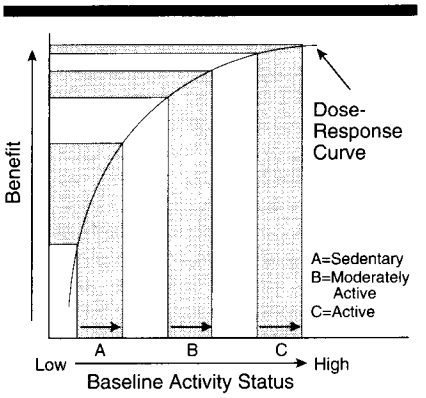

Figure 1.—The dose-response curve represents the best estimate of the relationship between physical activity (dose) and health benefit (response). The lower the baseline physical activity status, the greater will be the health benefit associated with a given increase in physical activity (arrows A, B, and C).

ting, self-monitoring progress, and self-reinforcement, contribute to continued physical activity.[66]

A number of physical and social environmental factors can affect physical activity behavior.[59] Family and friends can be role models, provide encouragement, or be companions during physical activity. The environment often presents important barriers to participation in physical activity, including a lack of bicycle trails and walking paths away from traffic, inclement weather, and unsafe neighborhoods.[67] Excessive television viewing may also deter persons from being physically active.[68]

PHYSICAL ACTIVITY RECOMMENDATION FOR ADULTS

The current low-participation rate may be due in part to the misperception of many people that to reap health benefits they must engage in vigorous, continuous exercise. The scientific evidence clearly demonstrates that regular, moderate-intensity physical activity provides substantial health benefits. After review of physiological, epidemiologic, and clinical evidence, an expert panel formulated the following recommendation:

Every US adult should accumulate 30 minutes or more of moderate-intensity physical activity on most, preferably all, days of the week.

This recommendation emphasizes the benefits of moderate-intensity physical activity and of physical activity that can be accumulated in relatively short bouts. Adults who engage in moderate-intensity physical activity—ie, enough to expend approximately 200 calories per day—can expect many of the health benefits described herein. To expend these calories, about 30 minutes of moderate-intensity physical activity should be accumulated during the course of the day. One way to meet this standard is to walk 2 miles briskly. Table 2 provides examples of moderate-intensity physical activities.

Intermittent activity also confers substantial benefits.[1,17,72,73] Therefore, the recommended 30 minutes of activity can be accumulated in short bouts of activity: walking up the stairs instead of taking the elevator, walking instead of driving short distances, doing calisthenics, or pedaling a stationary cycle while watching television. Gardening, housework, raking leaves, dancing, and playing actively with children can also contribute to the 30-minute-per-day total if performed at an intensity corresponding to brisk walking. Those who perform lower-intensity activities should do them more often, for longer periods of time, or both.

People who prefer more formal exercise may choose to walk or participate in more vigorous activities, such as jogging, swimming, or cycling for 30 minutes daily. Sports and recreational activities, such as tennis or golf (without riding a cart), can also be applied to the daily total.

Because most adults do not currently meet the standard described herein, almost all should strive to increase their participation in physical activity that is of at least moderate intensity. Those who do not engage in regular physical activity should begin by incorporating a few minutes of increased activity into their day, building up gradually to 30 minutes per day of physical activity. Those who are active on an irregular basis should strive to adopt a more consistent activity pattern.

The health benefits gained from increased physical activity depend on the initial activity level (Figure 1). Sedentary individuals are expected to benefit most from increasing their activity to the recommended level. People who are physically active at a level below the standard would also benefit from reaching the recommended level of physical activity. People who already meet the recommendation are also likely to derive some additional health and fitness benefits from becoming more physically active.

Most adults do not need to see their physician before starting a moderate-intensity physical activity program.[74] However, men older than 40 years and women older than 50 years who plan a vigorous program (intensity >60% individual maximum oxygen consumption; Table 1) or who have either chronic disease or risk factors for chronic disease should consult their physician to design a safe, effective program.[74]

PREVIOUS EXCERCISE RECOMMENDATIONS

The recommendation presented in this article is intended to complement, not supersede, previous exercise recommendations. In the past, exercise recommendations (including those from the ACSM) were based on scientific studies that investigated dose-response improvements in performance capacity after exercise training, especially the effects of endurance exercise training on maximal aerobic power (maximum oxygen consumption). The recommendations usually involved 20 to 60 minutes of moderate- to high-intensity endurance exercise (60% to 90% of maximum heart rate or 50% to 85% of maximal aerobic power) per-

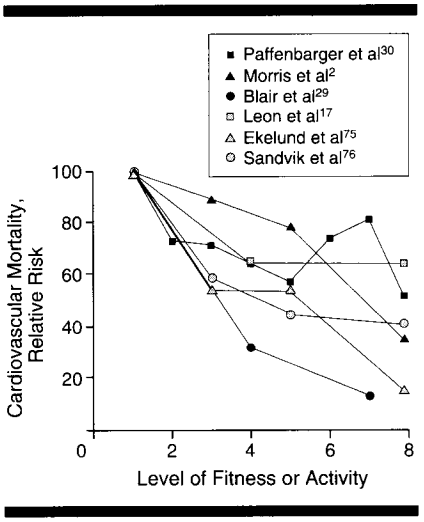

Figure 2.—The relationship between level of physical activity (Paffenbarger et al,[30] Morris et al,[2] and Leon et al[17]) or exercise capacity (Blair et al,[29] Ekelund et al,[75] and Sandvik et al[76]) and coronary heart disease mortality. Values for more active or fit persons are expressed as the ratio of the event rate for more active or fit divided by the event rate for least active or fit.

formed three or more times per week.

Although the earlier exercise recommendations were based on documented improvements in fitness, they probably provide most of the disease prevention benefits associated with an increase in physical activity. However, it now appears that the majority of these health benefits can be gained by performing moderate-intensity physical activities outside of formal exercise programs.

UNIQUE ASPECTS OF THE NEW RECOMMENDATION

The new recommendation extends the traditional exercise-fitness model to a broader physical activity–health paradigm. The recommendation is distinct in two important ways. First, the health benefits of moderate-intensity physical activity are emphasized. Second, accumulation of physical activity in intermittent, short bouts is considered an appropriate approach to achieving the activity goal. These unique elements of the recommendation are based on mounting evidence indicating that the health benefits of physical activity are linked principally to the total amount of physical activity performed. This evidence suggests that amount of activity is more important than the specific manner in which the activity is performed (ie, mode, intensity, or duration of the activity bouts).

The health benefits of physical activity appear to accrue in approximate proportion to the total amount of activity performed, measured as either caloric expenditure or minutes of physical activity (Figure 2). For example, observational studies have shown a significantly lower death rate from CHD in people who perform an average of 47 minutes vs 15 minutes of activity per day,[17] and in men who expend an estimated 2000 or more calories per week vs those who expend 500 or fewer calories per week.[1] Five of the six studies shown in Figure 2 included men only; however, the relationship between physical fitness and cardiovascular disease mortality was identical for men and women in the one study that included both.[29]

There is a clear association between total daily or weekly caloric expenditure and cardiovascular disease mortality. In most of the epidemiologic studies that have demonstrated this association, physical activity was assessed by questionnaires, and total activity was summed during periods ranging from 1 day to 1 year and then reported as average daily or weekly levels of physical activity. For example, among Harvard alumni the summed activity consisted of blocks walked, flights of stairs climbed, and moderate and vigorous sports play.[1] In the Multiple Risk Factor Intervention Trial,[17] the most frequently reported activities were lawn and garden work (80% of men), walking (65%), and home repairs (60%). It is not possible to ascertain with certainty whether the activity reported in these studies was performed in single, continuous daily bouts or was accumulated in multiple episodes. However, the nature of the most frequently reported activities suggests that it is unlikely that most of the activity was performed continuously. It is more likely that the daily or weekly caloric expenditures reflect accumulation of activity, most of which was performed intermittently. Also, the activities most commonly reported in these studies (eg, walking, lawn work, and gardening) typically are performed at moderate intensity (Table 2).

Two published experimental studies have addressed the effects of continuous vs intermittent activity on fitness.[72,73] DeBusk et al[72] examined the effects of three 10-minute bouts of moderate to vigorous activity daily compared with a single 30-minute daily period of exercise of equal intensity in men. Ebisu[73] studied the effects of running on fitness and blood lipids in three groups of men. Subjects were divided into three exercise groups and one inactive control group. Each exercise group ran the same total distance, but in one, two, or three sessions daily. In both studies, fitness (measured as maximal oxygen uptake) increased significantly in all exercise groups, and the differences in fitness across the exercising groups were not significant. In the latter study, high-density lipoprotein cholesterol levels increased significantly only in the group that exercised three times per day.[73]

Although more research is needed to better elucidate the health effects of moderate- vs high-intensity activity and intermittent vs continuous activity, clinicians and public health practitioners must rely on the most reasonable interpretation of existing data to guide their actions. We believe that the most reasonable interpretation of the currently available data is that (1) caloric expenditure and total time of physical activity are associated with reduced cardiovascular disease incidence and mortality; (2) there is a dose-response relationship for this association; (3) regular moderate physical activity provides substantial health benefits; and (4) intermittent bouts of physical activity, as short as 8 to 10 minutes, totaling 30 minutes or more on most days provide beneficial health and fitness effects.

MUSCULAR STRENGTH AND FLEXIBILITY

The preceding recommendation addresses the role of endurance exercise in preventing chronic diseases. However, two other components of fitness—flexibility and muscular strength—should not be overlooked. Clinical experience and limited studies suggest that people who maintain or improve their strength and flexibility may be better able to perform daily activities, may be less likely to develop back pain, and may be better able to avoid disability, especially as they advance into older age. Regular physical activity also may contribute to better balance, coordination, and agility, which in turn may help prevent falls in the elderly.[77]

CALL TO ACTION

Successfully changing our sedentary society into an active one will require effective dissemination and acceptance of the message that moderate physical activity confers health benefits.

Public Health Agencies

The public health community will need to strengthen its leadership role if improvement in population levels of physical activity is to occur. The CDC, the ACSM, the President's Council on Physical Fitness and Sports, and the American Heart Association have been leaders in promoting physical activity and will continue to be crucial in this effort. However, new partners must also be enlisted. State and local health departments, departments of public transportation and planning, parks and recreation associations, state and local councils on physical fitness, environmental groups, and the sports and recreation

industry all have interests that coincide with the public health goal of making our society more active.

Health Professionals

Physicians and other health professionals should routinely counsel patients to adopt and maintain regular physical activity. Physicians can be effective proponents of physical activity because patients respect physicians' advice and change their exercise behaviors as a result.[78] The large number of primary care physicians and the frequency with which Americans visit them[79] suggest that even modestly effective physician counseling would have a substantial public health impact.

Inadequate reimbursement, limited physician knowledge of the benefits of physical activity, lack of training in physical activity counseling, and inadequate knowledge of effective referral are barriers to achieving these goals. While policymakers work to improve reimbursement for preventive services, educators of physicians and other health professionals should develop effective ways to teach physical activity counseling and incorporate them into curricula for health professionals. In response to this need, the PACE (Physical Activity Counseling and Evaluation) program was recently developed. This approach relies on providing specific counseling protocols matched to the patient's level of activity and readiness to change.[80] Preliminary evidence indicates that the PACE program is practical and effective in increasing physical activity among patients counseled in the primary care setting.[81]

The personal physical activity practices of health professionals should not be overlooked. Health professionals should be physically active not only to benefit their own health but to make more credible their endorsement of an active lifestyle.

Special Populations

Special efforts will be required to target populations in which physical inactivity is particularly prevalent. These groups include the socioeconomically disadvantaged, the less educated, persons with disabilities, and older adults.

Interventions should be designed with input from the target population. Physical activity promotional efforts targeted to people with disabilities, or chronic disease, or to older adults should emphasize the importance of being physically active by routinely carrying out their daily activities with a minimum of assistance. There is clear evidence demonstrating that physiological and performance capacities can be improved by regular physical activity in older adults[82-84] and in persons with disabilities and/or chronic disease.[85]

Communities

Institutions such as schools, worksites, and the medical community are specifically targeted in *Healthy People 2000*[10] because they offer the means to reach most of the US population. Facilities in these institutions and the broader community can be used to a much greater extent. Corporate, government, school, and hospital policies should be restructured to encourage individuals to be active by making time and facilities available.

Organized programs emphasizing lifelong physical activity should be promoted in schools, worksites, and community organizations. Efforts should be made to develop walking trails and other exercise facilities, and to encourage walking and bicycling for transportation.

Educators

Schools should deliver comprehensive health and physical education programs that provide and promote physical activity at every opportunity.

Physical education curricula should be developmentally appropriate, provide youngsters with enjoyable experiences that build exercise self-efficacy, provide significant amounts of physical activity, and promote cognitive learning related to lifelong participation in physical activity. These curricula also should acquaint youngsters with physical activity resources in their community. The school environment should encourage physical activity for all students and promote development of physically active lifestyles. Educators at all levels should be good models of physical activity behavior.

Individuals and Families

Individuals can make modest adaptations in their physical and social environment to enhance their participation in physical activity. Parents should be physical activity role models for their children and support their children's participation in enjoyable physical activities.

CONCLUSIONS

If Americans who lead sedentary lives would adopt a more active lifestyle, there would be enormous benefit to the public's health and to individual well-being. An active lifestyle does not require a regimented, vigorous exercise program. Instead, small changes that increase daily physical activity will enable individuals to reduce their risk of chronic disease and may contribute to enhanced quality of life.

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