Physical Activity and Public Health

Updated Recommendation for Adults From the American College of Sports Medicine and the American Heart Association

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Summary—In 1995 the American College of Sports Medicine and the Centers for Disease Control and Prevention published national guidelines on Physical Activity and Public Health. The Committee on Exercise and Cardiac Rehabilitation of the American Heart Association endorsed and supported these recommendations. The purpose of the present report is to update and clarify the 1995 recommendations on the types and amounts of physical activity needed by healthy adults to improve and maintain health. Development of this document was by an expert panel of scientists, including physicians, epidemiologists, exercise scientists, and public health specialists. This panel reviewed advances in pertinent physiologic, epidemiologic, and clinical scientific data, including primary research articles and reviews published since the original recommendation was issued in 1995. Issues considered by the panel included new scientific evidence relating physical activity to health, physical activity recommendations by various organizations in the interim, and communications issues. Key points related to updating the physical activity recommendation were outlined and writing groups were formed. A draft manuscript was prepared and circulated for review to the expert panel as well as to outside experts. Comments were integrated into the final recommendation.

Primary Recommendation—To promote and maintain health, all healthy adults aged 18 to 65 yr need moderate-intensity aerobic (endurance) physical activity for a minimum of 30 min on five days each week or vigorous-intensity aerobic physical activity for a minimum of 20 min on three days each week. [I (A)] Combinations of moderate- and vigorous-intensity activity can be performed to meet this recommendation. [IIa (B)] For example, a person can meet the recommendation by walking briskly for 30 min twice during the week and then jogging for 20 min on two other days. Moderate-intensity aerobic activity, which is generally equivalent to a brisk walk and noticeably accelerates the heart rate, can be accumulated toward the 30-min minimum by performing bouts each lasting 10 or more minutes. [I (B)] Vigorous-intensity activity is exemplified by jogging, and causes rapid breathing and a substantial increase in heart rate. In addition, every adult should perform activities that maintain or increase muscular strength and endurance a minimum of two days each week. [IIa (A)] Because of the dose-response relation between physical activity and health, persons who wish to further improve their personal fitness, reduce their risk for chronic diseases and disabilities or prevent unhealthy weight gain may benefit by exceeding the minimum recommended amounts of physical activity. **(*Circulation*. 2007;116:000-000.)**

Key Words: benefits ■ risks ■ physical activity dose ■ physical activity intensity

In 1995 the Centers for Disease Control and Prevention (CDC) and the American College of Sports Medicine (ACSM) issued a public health recommendation that "Every US adult should accumulate 30 minutes or more of moderate-intensity physical activity on most, preferably all, days of the week" (49). The purpose of the recommendation was to provide a "clear, concise, public health message" that would "encourage increased participation in physical activity" by a largely sedentary US population.

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More than 10 years have passed since this recommendation was issued. New science has added to our understanding of the biological mechanisms by which physical activity provides health benefits and the physical activity profile (type, intensity, amount) that is associated with enhanced health and quality of life. The intent of the original recommendation, however, has not been fully realized. Physical inactivity remains a pressing public health issue. Technology and economic incentives tend to discourage activity, technology by reducing the energy needed for activities of daily living, and economics by paying more for sedentary than active work.

In addition, there are people who have not accepted, and others who have misinterpreted, the original recommendation. Some people continue to believe that only vigorous-intensity activity will improve health while others believe that the light activities of their daily lives are sufficient to promote health (53). Compounding these challenges, physical activity recommendations have been published in the interim that could be interpreted to be in conflict with the 1995 recommendation (4,26,57,71).

Favorable trend data from 1990 to 2004 in the United States based on the CDC Behavioral Risk Factor Surveillance System indicate that over time fewer men and women reported no leisure-time physical activity (13). The prevalence of leisure-time physical inactivity remained fairly constant through 1996, but more recently has declined in both genders (Fig. 1). In 2005 23.7% of adults reported no leisure-time activity (14).

However, there remains a broad range of evidence to underscore concern that US adults are still not active enough. For example, data from 2005 indicate that less than half (49.1%) of U.S. adults met the CDC/ACSM physical activity recommendation (12). Men were more likely to meet the recommendation (50.7%) than women (47.9%). For men and women combined, younger people were more likely to be active than older people, with the prevalence of those meeting the recommendation declining from 59.6% among those 18–24 yr of age to 39.0% among those 65 years and older (Fig. 2). White, non-Hispanics (51.1%) were most likely to meet the recommendation followed by "other" racial or ethnic groups (46.3%), Hispanics, (44.0%) and African-Americans (41.8%). Persons with a college degree were the most likely to meet the recommendation (53.2%) followed by those with some college education (50.2%), a high school education (45.9%), and less than high school (37.8%).

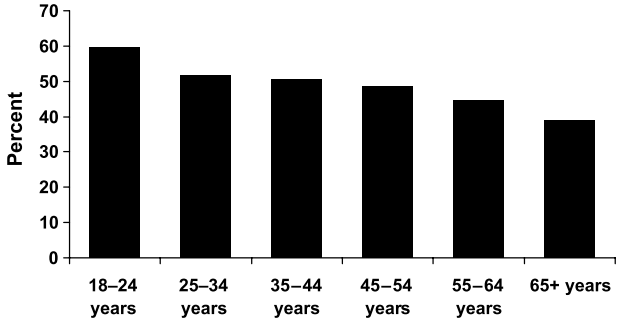

FIGURE 2—Prevalence of U.S. men and women meeting the CDC/ACSM physical activity recommendations by age, 2005.

Disease outcomes inversely related to regular physical activity in prospective observational studies include cardiovascular disease, thromboembolic stroke, hypertension, type 2 diabetes mellitus, osteoporosis, obesity, colon cancer, breast cancer, anxiety and depression (33). Scientific evidence continues to accumulate, with more recent efforts focused on the nature of the relation between physical activity and health, rather than trying to determine if such a relation exists (33). This additional evidence includes compelling new data on women (21,39,40), and more conclusive evidence on stroke (77), some cancers (69), and cognitive function (78,83). The primary limitation of much of the data linking physical activity to morbidity and mortality due to chronic diseases is that for many conditions few randomized trials of adequate design have been conducted. However, this situation is not all that different from data regarding the relation between some other health-related behaviors and clinical outcomes, such as cigarette smoking or saturated fat intake and coronary heart disease (CHD). No adequately designed randomized controlled study in the general population has shown that stopping smoking or decreasing saturated fat or trans-fatty acid intake significantly decreases CHD mortality yet getting the

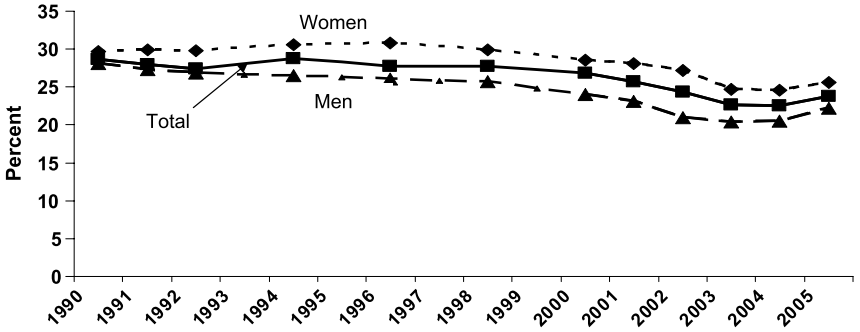

FIGURE 1—Prevalence of no reported leisure-time physical activity among U.S. men and women, 1990–2005.

public to stop smoking or reduce their intake of saturated fat or trans-fatty acids are major components of national public health campaigns (50).

The purpose of this report is to update the 1995 CDC/ACSM recommendation. The intent is to provide a more comprehensive and explicit public health recommendation for adults based upon available evidence of the health benefits of physical activity.

Expert panel process. In February 2003, an expert panel was convened and charged with reviewing and updating the original CDC/ACSM recommendation for physical activity and public health (49). This panel, which consisted of physicians, epidemiologists, exercise scientists and public health experts, reviewed scientific advances since the publication of the original recommendation, newly issued recommendations provided by other organizations and communications issues such as clarity and consistency.

For scientific input, the panel initially relied heavily on published evidence from a meeting held in 2000 jointly sponsored by CDC and Health Canada on Dose-Response Aspects of Physical Activity and Health (33). The conclusion and consensus statement from this meeting were based on systematic reviews of the literature. Panel members also conducted extensive searches of the literature on physical activity and health to 2006.

In addition to scientific updates, the expert panel considered issues and advances in understanding roles and strategies in communication of health messages in the update and clarification of the prior recommendations. A second CDC-Health Canada workshop on communicating physical activity messages was held in 2001 and identified several key strategies for improving the communication of physical activity recommendations (59). A different expert panel developed a recommendation for older adults as a companion recommendation to that presented in this article (47). Manuscripts describing the recommendation for adults generally and for older adults as a companion were circulated for comments, revised, and edited for consistency before review and approval by ACSM and the American Heart Association (AHA). For current physical activity guidelines directed at school-age youth the reader is referred to the recent publication by Strong and colleagues (65).

UPDATED RECOMMENDATION STATEMENT

This recommendation applies to healthy adults between 18 and 65 yr of age, and to persons in this age range with chronic conditions not related to physical activity (e.g., hearing impairment). During pregnancy and the postpartum period additional precautions may be needed: these issues have been considered by other expert committees (3,7). The present preventive recommendation specifies how adults, by engaging in regular physical activity, can promote and maintain health, and reduce risk of chronic disease and premature mortality. A companion recommendation (47) builds on the information in this paper but specifically applies to adults aged 65 and over, and adults aged 50–64 with chronic conditions or physical functional limitations (e.g., arthritis), that affect movement ability or physical fitness. The following recommendation reflects a review of evidence published since the issuance of the CDC/ACSM recommendation in 1995 and considers key issues not fully clarified in the original recommendation. Classification of recommendations (COR) and level of evidence (LOE) are expressed in American College of Cardiology/American Heart Association (ACC/AHA) format as defined in Table 1 and the *Methodology Manual for ACC/AHA Guideline Writing Committees* (2).

Aerobic Activity

To promote and maintain health, all healthy adults aged 18–65 yr need moderate-intensity aerobic physical activity for a minimum of 30 min on five days each week or vigorous-intensity aerobic activity for a minimum of 20 min on three days each week. [I (A)] Also, combinations of moderate- and vigorous-intensity activity can be performed to meet this recommendation. [IIa (B)] For example, a person can meet the recommendation by walking briskly for 30 min twice during the week and then jogging for 20 min on two other days. Moderate-intensity aerobic activity, which is generally equivalent to a brisk walk and noticeably accelerates the heart rate, can be accumulated toward the 30-min minimum from bouts lasting 10 or more minutes. [I (B)] Vigorous-intensity activity is exemplified by jogging, and causes rapid breathing and a substantial increase in heart rate. This

TABLE 1. ACC/AHA approach to assigning the classification of recommendations and level of evidence.

Classifications of recommendation (COR) I, II, and III are used to summarize indications (suggested phrases for writing recommendations)
- **Class I:** Conditions for which there is evidence and/or general agreement that a given procedure or treatment is useful and effective (should; is recommended; is indicated; is useful. effective, beneficial)
- **Class II:** Conditions for which there is conflicting evidence and/or a divergence of opinion about the usefulness/efficacy of a procedure or treatment
  - IIa: Weight of evidence/opinion is in favor of usefulness/efficacy (is reasonable; can be useful, effective or beneficial; is probably recommended or indicated)
  - IIb: Usefulness/efficacy is less well established by evidence/opinion (may/might be considered, may/might be reasonable, usefulness/effectiveness is unknown, unclear/uncertain or not well established)
- **Class III:** Conditions for which there is evidence and/or general agreement that the procedure/treatment is not useful/effective and in some cases may be harmful (is not recommended; is not indicated; should not; is not useful/effective, beneficial; may be harmful)

Levels of evidence (LOE) for individual class assignments
- A: Data derived from multiple randomized clinical trials
- B: Data derived from a single randomized trial or from nonrandomized studies
- C: Consensus opinion of experts

For details about this classification system see reference (2).

recommended amount of aerobic activity is in addition to routine activities of daily living of light intensity (e.g., self care, cooking, casual walking or shopping) or lasting less than 10 min in duration (e.g., walking around home or office, walking from the parking lot).

Muscle-Strengthening Activity

To promote and maintain good health and physical independence, adults will benefit from performing activities that maintain or increase muscular strength and endurance for a minimum of two days each week. [IIa (A)] It is recommended that 8–10 exercises be performed on two or more nonconsecutive days each week using the major muscle groups. To maximize strength development, a resistance (weight) should be used that allows 8–12 repetitions of each exercise resulting in volitional fatigue. Muscle-strengthening activities include a progressive weight-training program, weight bearing calisthenics, stair climbing, and similar resistance exercises that use the major muscle groups.

Benefits of Greater Amounts of Activity

Participation in aerobic and muscle-strengthening physical activities above minimum recommended amounts provides additional health benefits and results in higher levels of physical fitness. [I (A)] Many adults, including those who wish to improve their personal fitness or further reduce their risk for premature chronic health conditions and mortality related to physical inactivity, should exceed the minimum recommended amounts of physical activity (33). In addition, to further promote and maintain skeletal health, adults will benefit by engaging in extra weight-bearing activity and higher-impact activity such as stair-climbing or jogging, as tolerated. [IIa (B)] To help prevent unhealthy weight gain, some adults will need to exceed minimum recommended amounts of physical activity to a point that is individually effective in achieving energy balance, while considering their food intake and other factors that affect body weight. [IIa (B)]

CLARIFICATIONS TO THE 1995 RECOMMENDATION

Although fundamentally unchanged from the 1995 recommendation, the updated recommendation is improved in several ways. First, the recommended frequency for moderate-intensity physical activity has been clarified. The 1995 document simply specified "most, preferably all days per week" as the recommended frequency while the new recommendation identifies five days per week as the recommended minimum.

Second, vigorous-intensity physical activity has been explicitly incorporated into the recommendation. To acknowledge both the preferences of some adults for vigorous-intensity physical activity and the substantial science base related to participation in such activity (4), the recommendation has been clarified to encourage participation in either moderate- and/or vigorous-intensity physical activity. Vigorous-intensity physical activity was implicit in the 1995 recommendation. It is now explicitly an integral part of the physical activity recommendation.

Third, the updated recommendation now specifies that moderate- and vigorous-intensity activities are complementary in the production of health benefits and that a variety of activities can be combined to meet the recommendation. This combining of activities is based on the amount (intensity $\times$ duration) of activity performed during the week and uses the concept of METs (metabolic equivalents) to assign an intensity value to a specific activity (See Table 1 and section regarding *Activity Dose* below).

Fourth, the updated recommendation now clearly states that the recommended amount of aerobic activity (whether of moderate- or vigorous-intensity) is in addition to routine activities of daily living which are of light intensity, such as self care, casual walking or grocery shopping, or less than 10 min of duration such as walking to the parking lot or taking out the trash. Few activities in contemporary life are conducted routinely at a moderate intensity for at least 10 min in duration. However, moderate- or vigorous-intensity activities performed as a part of daily life (e.g., brisk walking to work, gardening with shovel, carpentry) performed in bouts of 10 min or more can be counted towards the recommendation. Although implied, this concept was not effectively communicated in the original recommendation.

Fifth, the new recommendation emphasizes the important fact that physical activity above the recommended minimum amount provides even greater health benefits. The point of maximum benefit for most health benefits has not been established but likely varies with genetic endowment, age, sex, health status, body composition and other factors. Exceeding the minimum recommendation further reduces the risk of inactivity-related chronic disease. Although the dose-response relation was acknowledged in the 1995 recommendation, this fact is now explicit.

Sixth, although the original recommendation introduced the concept of accumulating short bouts of physical activity toward the 30-min goal, there was confusion regarding how short these episodes could be. For consistency and clarity, the minimum length of these short bouts is clarified as being 10 min.

Seventh, muscle-strengthening activities have now been incorporated into the physical activity recommendation. Although the 1995 recommendation mentioned the importance of muscular strength and endurance, it stopped short of making specific declarations in this area. Available evidence now allows the integration of muscle strengthening activities into the core recommendation.

Finally, minor wording changes in the recommendation have been made to enhance clarity in communications. For example, the term "aerobic" or endurance has been added to clarify the type of physical activity being recommended

and to differentiate it from muscle-strengthening exercises, which are now part of the core recommendation.

Activity Dose

The term *dose* is used frequently in descriptions of physical activity, but it can be interpreted in several ways—as the total amount of physical activity (i.e., total energy expended) or as the intensity, duration, or frequency of activity. Although many studies have included a measure of the total amount of physical activity (which may be used to characterize participants as "active," "moderately active," or "inactive" for example), relatively few observational studies have included details on the kinds of activity carried out or the duration and frequency of each bout of activity (36,37). In brief, the total amount of physical activity is a function of its intensity, duration and frequency. Accordingly, vigorous intensity activities (those having > 6.0 metabolic equivalents or METs) carried out for a particular duration and frequency generate greater energy expenditure than moderate-intensity activities (3.0 to 6.0 METs) of the same duration and frequency.

Since the 1995 recommendation, several large-scale prospective observational studies, enrolling thousands to tens of thousands of persons, have clearly documented a dose-response relation between physical activity and risk of cardiovascular disease and premature mortality in men and women, and in ethnically diverse participants (38,40,48,55, 67,84). These studies include the College Alumni Health Study (48), the Health Professionals' Follow-up Study (67), the Nurses' Health Study (41), the Women's Health Initiative (40), and the Women's Health Study (37). All observed significantly lower levels of risk with greater amounts of physical activity. Readers should note that the physical activity assessed in these studies was intentional; (i.e., it was in addition to the usual activities of daily living).

Very few studies have been conducted to examine the effects of intensity, duration, or frequency of physical activity independent of their contribution to the total amount of physical activity. Based on recent data, there is some indication that vigorous-intensity activities may have greater benefit for reducing cardiovascular disease and premature mortality than moderate-intensity physical activity, which is independent of their contribution to energy expenditure (35,61,66). In addition, the results of a single observational study suggest that duration of activity bouts does not influence risk after accounting for the total amount of energy expended (36).

Significantly lower risks of coronary heart disease or cardiovascular disease have been associated with as little as 2.6–5.0 MET·h·wk^{-1} of walking (approximately 45–75 minutes per week of brisk walking) in the Women's Health Initiative (40), 60–90 min·wk^{-1} of walking in the Women's Health Study (38), and 3.9–9.9 MET·h·wk^{-1} of walking (approximately 60–150 min·wk^{-1} at a brisk pace) in the Nurses' Health Study (39). With higher "doses" of physical activity, risks for cardiovascular disease have been lower but the exact magnitude of the additional reduction in risk remains uncertain.

Thus, a body of evidence has grown since the 1995 recommendation that reaffirms a dose-response relation between physical activity and health benefits, in particular the lowering of risk of cardiovascular disease and premature mortality. That significantly lower risks have been observed with as little as 45–150 min·wk^{-1} of brisk walking reinforces the original 1995 recommendation for ≥30 min·d^{-1} of moderate-intensity activity on most days. Also, it is well documented that physical activity of longer duration or higher intensity is associated with additional risk decrements, but the exact shape of the dose-response curve remains unclear and may vary depending on health outcome of interest and the baseline physical activity level of the population being evaluated.

The 1995 recommendation advocated the accumulation of physical activity in "intermittent bouts of physical activity, as short as 8–10 min, totaling 30 min or more." Since publication of the original recommendation, experimental research has been conducted evaluating the effects of increasing physical activity in short bouts on chronic disease risk factors. As a risk factor, these variables are typically in the causal pathway of the disease process and by altering these risk factors in a favorable direction, it is assumed that increases in physical activity will eventually reduce risk of adverse clinical outcomes.

Although existing research addressing the accumulation issue of physical activity in short bouts is less than complete, a summary of the experimental findings suggests that moderate-intensity physical activity in shorter bouts (usually lasting 10 min) that is accumulated toward the 30-min minimum can be as effective as single, longer bouts in affecting chronic disease risk factors. Cardiorespiratory fitness (17,28,44,46), lipid/lipoprotein profiles (17,46), blood pressure (44), fasting plasma insulin (17), postprandial lipidemia (45) and weight control (28) all appear to be affected beneficially with intermittent bouts of physical activity. In several studies the effects of accumulated short bouts are similar to those seen with continuous bouts of physical activity lasting ≥30 min.

A question raised frequently about physical activity dose is how various amounts of moderate-and vigorous-intensity aerobic activity that individually are below the recommended thresholds might be combined to meet the intent of these recommendations. For example, can two or three bouts of moderate-intensity physical activity be combined with two bouts of vigorous-intensity physical activity to meet recommendations? Existing scientific literature does not allow a direct answer to this question. However, the data are strongly suggestive: there is a large body of evidence from observational studies showing that higher levels of energy expended—which in a free-living population likely derives from a combination of moderate- and vigorous-intensity activities—are associated

with numerous health benefits (25,36,37,39,40,55,67,78). The health benefits of various combinations of moderate- and vigorous-intensity activity have not been sufficiently examined in observational studies nor investigated using randomized controlled trials. However, based on health outcome data from observational studies and an extensive database on the energy costs of various activities, the following approach is recommended for determining what combinations of moderate- and vigorous-intensity activities meet the dose recommendation.

A shorthand method for estimating energy expenditure during physical activity is the MET or *metabolic equivalent* (1). One MET represents an individual's energy expenditure while sitting quietly. An adult walking at 3 mph on a flat, hard surface is expending about 3.3 METs and while jogging/running on a similar surface at 5 mph (12 min per mile pace) is expending approximately 8 METs (see Table 2 for the MET values of selected activities). Thus, if a man or women walked at 3 mph (moderate-intensity) for 30 min they would accumulate 99 MET·min of activity (3.3 MET × 30 min = 99 MET·min), but if they jogged at 5 mph for 20 min they would accumulate 160 MET·min (8 MET × 20 min = 160 MET·min). So, if a man or women was to meet the minimum moderate intensity recommendation by walking for 30 min at 3 mph on 5 days of the week, they would accumulate about 495 MET·min (99 × 5), or to meet the minimum vigorous-intensity recommendation by jogging at 5 mph for 20 min on 3 days they would accumulate about 480 MET·min (160 × 3). Also, they could meet the recommendation by walking at 3.0 mph for 30 min on 2 days (3.3 MET × 60 min = 198 MET·min) and then jogging at 5 mph for 20 min on 2 other days (8 MET × 40 min = 320 MET·min) for a total during the week of about 518 MET·min (320 + 198).

Using METs as an indicator of activity intensity allows generally healthy adults to accumulate credit for the various moderate or vigorous intensity activities they perform during the week. When combining moderate and vigorous intensity activity to meet the current recommendation, the minimum goal should be in the range of 450 to 750 MET·min·wk^{-1}. These values are based on the MET range of 3 to 6 for moderate-intensity activity and 150 min·wk^{-1} (3 × 150 = 450 and 5 × 150 = 750). Individuals should start at the lower end of this range when beginning an activity program and progress towards the higher end as they become more fit. Listed in Table 2 are the MET values for a variety of physical activities that are of light, moderate or vigorous intensity. For a comprehensive listing of MET values see tabulation by Ainsworth and colleagues (1) or the following Web site: http://prevention.sph.sc.edu/tools/compendium.htm. It is recognized that actual MET values can vary from person to person depending on a variety of factors (e.g., how they perform the activity, skill level, body composition), but the values provided in the compendium are sufficiently accurate for generally healthy adults age 18–65 yr for the purposes of this recommendation.

TABLE 2. MET equivalents of common physical activities classified as light, moderate or vigorous intensity.

Light <3.0 METs	Moderate 3.0 – 6.0 METs	Vigorous >6.0 METs
Walking	Walking	Walking, jogging & running
Walking slowly around home, store or office = 2.0*	Walking 3.0 mph = 3.3*	Walking at very very brisk pace (4.5 mph) = 6.3*
	Walking at very brisk pace (4 mph) = 5.0*	Walking/hiking at moderate pace and grade with no or light pack (<10 lb) = 7.0
		Hiking at steep grades and pack 10–42 lb = 7.5–9.0
		Jogging at 5 mph = 8.0*
		Jogging at 6 mph = 10.0*
		Running at 7 mph = 11.5*
Household & occupation		
Sitting — using computer work at desk using light hand tools = 1.5	Cleaning — heavy: washing windows, car, clean garage = 3.0	Shoveling sand, coal, etc. = 7.0
Standing performing light work such as making bed, washing dishes, ironing, preparing food or store clerk = 2.0–2.5	Sweeping floors or carpet, vacuuming, mopping = 3.0–3.5	Carrying heavy loads such as bricks = 7.5
	Carpentry — general = 3.6	Heavy farming such as bailing hay = 8.0
	Carrying & stacking wood = 5.5	Shoveling, digging ditches = 8.5
	Mowing lawn — walk power mower = 5.5	
Leisure time & sports		
Arts & crafts, playing cards = 1.5	Badminton — recreational = 4.5	Basketball game = 8.0
Billiards = 2.5	Basketball — shooting around = 4.5	Bicycling — on flat: moderate effort (12–14 mph) = 8.0; fast (14–16 mph) = 10
Boating — power = 2.5	Bicycling — on flat: light effort (10–12 mph) = 6.0	Skiing cross country — slow (2.5 mph = 7.0; fast (5.0–7.9 mph) = 9.0
Croquet = 2.5	Dancing — ballroom slow = 3.0; ballroom fast = 4.5	Soccer — casual = 7.0; competitive = 10.0
Darts = 2.5	Fishing from river bank & walking = 4.0	Swimming — moderate/hard = 8–11†
Fishing — sitting = 2.5	Golf — walking pulling clubs = 4.3	Tennis singles = 8.0
Playing most musical instruments = 2.0–2.5	Sailing boat, wind surfing = 3.0	Volleyball — competitive at gym or beach = 8.0
	Swimming leisurely = 6.0†	
	Table tennis = 4.0	
	Tennis doubles = 5.0	
	Volleyball — noncompetitive = 3.0–4.0	

Ainsworth, et al. 2000 (1). * On flat, hard surface. † MET values can vary substantially from person to person during swimming as a result of different strokes and skill levels.

In summary, 30 min of moderate-intensity physical activity 5 d·wk^{-1} or 20 min of vigorous-intensity physical activity on 3 d·wk^{-1}, or a combination of moderate- and vigorous-intensity activity in the range of 450 to 750 MET·min·wk^{-1} is the minimal amount of activity recommended to achieve substantial health benefits over and above the routine light-intensity activities of daily living. This activity can be accumulated in ≥10-min bouts. Larger amounts of physical activity, including more activity at higher intensities, provide additional health benefits but the nature of the relationship (amount versus benefit) likely varies by health outcome. More generally, the shape of the dose-response curves, the possible points of maximal benefit, and the possible benefits from activity bouts shorter than 10 min remain unclear. Moreover, further investigation is required to determine how men and women might best combine bouts of moderate- and vigorous-intensity physical activity to obtain desired benefits and the relative importance of various components of physical activity (e.g., intensity, frequency, energy expenditure) in achieving specific outcomes.

Muscular Strength and Endurance

Evidence supporting the health benefits of activities that increase muscular strength and endurance in non-elderly populations has accumulated rapidly in recent years (10,52). For example, mechanical loading on skeletal tissue by resistance exercise can effectively stimulate an increase in bone formation in young adults and slow bone loss in middle age (75). Presumably, this can result in a lower risk of osteoporosis, osteopenia and bone fracture. In addition, recent observational studies have suggested an inverse association between risk of all-cause mortality and various components of muscular strength or endurance (18,32). Although the specific mechanisms for these associations are not known, one may be the ability of muscular strengthening activities to promote the development and maintenance of metabolically active lean muscle mass, which is particularly important for enhancing glucose metabolism (27). Resistance training at least twice per week provides a safe and effective method to improving muscular strength and endurance by 25% to 100% or more (52). It is recommended that 8–10 exercises be performed on two or more nonconsecutive days each week using the major muscles. A resistance (weight) should be used that results in substantial fatigue after 8–12 repetitions of each exercise. The emerging evidence on musculoskeletal health benefits (30,52) and the potential population-wide effects of promoting skeletal health support the need for a public health recommendation that includes resistance exercise.

Obesity, Gaining, and Losing Weight

Rapidly increasing rates of obesity reflect a lack of energy balance as large numbers of people are consistently expending fewer calories than they consume. Unfortunately, few reliable data are available on the relative contributions to this obesity epidemic by energy intake and energy expenditure, although both as well as individual variation are important. While more information is gathered on the varied causes of obesity, it seems vitally important for public health efforts to address both energy expenditure and energy intake.

It is reasonable to assume that persons with relatively high daily energy expenditures would be less likely to gain weight over time, compared with those who have low energy expenditures. So far, data to support this hypothesis are not particularly compelling (57), but some observational data indicate that men who report at least 45–60 min of activity on most days gain less weight than less active men (16). Furthermore, the specific types and amounts of activity required to prevent weight gain in the majority of people have not been well established using prospective study designs, and it is clear that they cannot be precisely set without considering individual factors such as energy intake and genetics. Thus, currently it is best to assume that the specific amount of physical activity that will help prevent unhealthy weight gain is a function that differs from individual to individual, but that in general more activity increases the probability of success (62).

The only discretionary component of daily energy expenditure is physical activity, and the replacement of typically sedentary routines by various kinds of activity is a common approach to increasing energy expenditure. For example, walking or bicycling instead of driving a car for short trips would expend additional calories while traveling the same distance. Still, despite the intuitive appeal of the idea that physical activity helps in losing weight, it appears to produce only modest increments of weight loss beyond those achieved by dietary measures and its effects no doubt vary among people (64). A review of studies where exercise or physical activity was the sole intervention or was added to caloric restriction found only modest weight loss resulting from exercise (57). However, these studies were relatively short term and the effect of physical activity on weight loss over the long term remains unclear.

Several observational studies have been conducted on the role of physical activity in preventing weight regain after an initial sizable weight loss (34,41,58,76,82). The designs and methods of these studies have varied, but all focused on people who had lost 30–50 lb (13.6–22.7 kg) and had not regained after several years. Studies using self-report of physical activity and energy expenditure assessed by doubly labeled water techniques (58,76) generally support the notion that 60–90 min of moderate-intensity physical activity/day may be necessary for weight maintenance after such large weight losses.

In 2005 the US Departments of Health and Human Services and Agriculture published Dietary Guidelines for Americans 2005 (71) in which recommendations were

included regarding the profiles of activity that would contribute to 1) the protection against selected chronic diseases (≥30 min of moderate intensity exercise on most days), 2) prevention of unhealthy weight gain (approximately 60 min of moderate- to vigorous-intensity activity on most days), and 3) to sustain weight loss in adults who have lost substantial body weight (participate in at least 60–90 min of moderate-intensity activity daily). See Table 3 for a summary of these recommendations. These weight gain prevention guidelines come from the Institute of Medicine Report published in 2002 (26) and are similar to those published in the International Association for the Study of Obesity report in 2003 ("it seems likely that moderate intensity activity of approximately 45 to 60 minutes per day… is required to prevent the transition to overweight or obesity" and "prevention of weight regain in formally obese individuals requires 60–90 minutes of moderate intensity or lesser amounts of vigorous intensity activity" (57), page 101]). The DHHS guidelines are consistent with the prior CDC/ACSM guidelines (49) and this update in that a minimum of 30 $min \cdot d^{-1}$ of moderate-intensity on 5 $d \cdot wk^{-1}$ provides meaningful protection against various chronic diseases, that greater benefit is achieved by activity of greater duration and/or intensity, and that resistance exercise should be performed to enhance skeletal muscle strength and endurance.

Attempting to maintain a healthy weight is influenced by a complex set of cultural, psychosocial and biological factors making it is difficult to accurately identify what the primary cause of obesity is for any individual. One can argue that people become obese because they consume more calories than they expend, but this does not tell us why the imbalance exists or the best way to correct it. Meaningful physical activity guidelines for the prevention of unhealthy weight gain or obesity will need to be effectively integrated with calorie intake guidelines. For most adults in the US today, consumption of calories is unimpeded while expenditure of calories via physical activity is difficult; thus it is unlikely that without some self restriction of calorie intake or expanded opportunities and greater encouragement for physical activity many people will become or continue to be overweight or obese. Development of such integrated "calorie balance" guidelines and specific strategies on how to effectively implement them should be a high priority for physical activity and nutrition professionals. In the mean time, because of the documented obesity-independent benefits of regular physical activity (25,37,40), adults regardless of body size or shape should be encouraged to meet the moderate-intensity, minimum of 30 $min \cdot d^{-1}$ on 5 $d \cdot wk^{-1}$ guideline. For individuals who achieve this level of activity, but remain overweight, an increase in their physical activity is a reasonable component of any strategy to lose weight.

ADDITIONAL ISSUES

Risk of Physical Activity

Physically active adults tend to experience a higher incidence of leisure-time and sport related injuries than their less active counterparts (15). However, it appears that healthy adults who meet the present recommendations by performing moderate-intensity activities have an overall musculoskeletal injury rate that is not much different than inactive adults (11). More active men and women have a higher injury rate during sport and leisure-time activity while inactive adults report more injuries during nonsport and nonleisure time. A possible reason for this lower injury incidence during non-leisure time is the increased fitness levels (endurance, strength, balance) of the more active adults (23).

Risk of musculoskeletal injuries increases as the intensity and amount of the activity increases and can be as high as 55% among men and women involved in jogging programs (51) and U.S. Army basic training (29). Thus, while physical activity above the minimal recommendations results in additional health benefits, the associated musculoskeletal health risks are increased as well, possibly negating some of the added benefit. This dose-injury relation for specific activities is unknown and likely differs by activity and individual anatomic and behavioral characteristics (24).

As with musculoskeletal injuries, the risk of sudden cardiac arrest or myocardial infarction is very low in generally healthy adults during moderate-intensity activities (74,79). However, risk of cardiovascular complications increases transiently during vigorous physical exertion, especially for persons who have latent or documented coronary artery disease and are habitually sedentary (9). For example, Siscovick and associates (60) reported that the relative risk of cardiac arrest during vigorous exercise (jogging) compared with that at all other times of the day, was 56 times greater among men who exercise infrequently

TABLE 3. Physical activity recommendations included in the Dietary Guidelines for Americans 2005 (US Department of Health and Human Services, 2005).

Engage in regular physical activity and reduce sedentary activities to promote health, psychological well-being, and a healthy body weight.
To reduce the risk of chronic disease in adulthood: Engage in at least 30 min of moderate-intensity physical activity, above usual activity at work or home, on most days of the week.
For most people, greater health benefits can be obtained by engaging in physical activity of more vigorous intensity or longer duration.
To help manage body weight and prevent gradual, unhealthy body weight gain in adulthood: Engage in approximately 60 min of moderate- to vigorous-intensity activity on most days of the week while not exceeding caloric intake requirements.
To sustain weight loss in adulthood: Participate in at least 60–90 min of daily moderate-intensity physical activity while not exceeding caloric intake requirements. Some people may need to consult with a healthcare provider before participating in this level of activity.
Achieve physical fitness by including cardiovascular conditioning, stretching exercises for flexibility, and resistance exercises or calisthenics for muscle strength and endurance.

and only 5 times greater among men who exercise frequently. Despite the transient increases in the incidence of sudden death and acute myocardial infarction during vigorous intensity exercise, (20,43,60,81), it should be noted that, compared to their sedentary counterparts and those with low aerobic fitness, physically active or aerobically fit individuals have a 25% to 50% lower overall risk of developing cardiovascular disease (54,70,80).

Screening/Clearance

There is controversy regarding the utility of medical screening procedures such as exercise testing prior to initiating vigorous exercise programs. The ACSM recommends symptom-limited exercise testing before vigorous exercise (>60% $\dot{V}O_{2max}$) is undertaken by men ≥ 45 yr and women ≥ 55 yr, those with 2 or more major cardiac risk factors, persons with any signs or symptoms of coronary artery disease, or those with known cardiac, pulmonary, or metabolic disease (6). However, few systematically collected data are available to substantiate this recommendation. Guidelines developed by the AHA and the American College of Cardiology underscore this lack of data (19). Also, a report in 2003 from the AHA indicated that exercise testing is not necessary for all people beginning a moderate intensity physical activity program (68). Moreover, guidelines from the U.S. Preventive Services Task Force discount the use of exercise test screening for heart disease in low-risk, asymptomatic adults (73). These recommendations and the extremely low rate of cardiovascular complications in asymptomatic persons while performing moderate-intensity activity (74,79), the poor predictive value of exercise testing for acute cardiac events (42), the high costs of mass exercise testing, and the uncertainties associated with interpreting abnormal electrocardiographic or cardiac imaging results in persons with a low pretest risk of coronary artery disease (63), indicate that it is impractical to use exercise testing to prevent serious cardiovascular events in all asymptomatic persons who exercise, especially during activities of moderate intensity.

Asymptomatic men and women who plan to be physically active at the minimum levels of moderate-intensity activity set forth in the present recommendation do not need to consult with a physician or health care provider prior to beginning unless they have specific medical questions. Symptomatic persons or those with any cardiovascular disease, diabetes, other active chronic disease, or any medical concern, should consult a physician or health care provider prior to any substantive increase in physical activity, particularly vigorous-intensity activity (68).

Promoting Physical Activity

Individually adapted behavior change is critical to facilitate a physically active lifestyle (31), but the process involves a multitude of complex variables, including personal, programmatic, social, environmental and related factors. To achieve long-term changes in health-related behaviors, these and medical factors must be addressed collectively (56). All healthcare professionals should broaden their advice to patients beyond the traditional prescriptive program based on medical clearance and supervision by initially encouraging them to accumulate moderate-intensity physical activity as specified in the present recommendation. A wide range of activities should be identified that meet each person's interests, needs, schedule and environment, take into consideration family, work and social commitments, with options for inclement weather and travel. Excellent materials for the education and counseling of clients are available form the National Institutes of Health (72), ACSM (5), and AHA (8). As information has increased about the role that environmental influences play in promoting or inhibiting physical activity even among the most motivated persons (31,56), future efforts to promote physical activity must consider how people interact with their environment (22). For all health professionals, the challenge is to leverage their professional credibility to enroll increasing numbers of participants in physical activity programs that are designed to overcome barriers to long-term adherence, using effective behavioral management and environmental change strategies, so that many more individuals will realize the benefits provided by a physically active lifestyle.

TABLE 4. Physical activity recommendations for healthy adults aged 18–65 yr—2007.

1. To promote and maintain good health, adults aged 18–65 yr should maintain a physically active lifestyle. I (A)
2. They should perform moderate-intensity aerobic (endurance) physical activity for a minimum of 30 min on five days each week or vigorous-intensity aerobic activity for a minimum of 20 min on three days each week. I (A)
3. Combinations of moderate- and vigorous-intensity activity can be performed to meet this recommendation. For example, a person can meet the recommendation by walking briskly for 30 min twice during the week and then jogging for 20 min on two other days. IIa (B)
4. These moderate- or vigorous intensity activities are in addition to the light intensity activities frequently performed during daily life (e.g., self care, washing dishes, using light tools at a desk) or activities of very short duration (e.g., taking out trash, walking to parking lot at store or office).
5. Moderate-intensity aerobic activity, which is generally equivalent to a brisk walk and noticeably accelerates the heart rate, can be accumulated toward the 30-min minimum by performing bouts each lasting 10 or more minutes. I (B)
6. Vigorous-intensity activity is exemplified by jogging, and causes rapid breathing and a substantial increase in heart rate.
7. In addition, at least twice each week adults will benefit by performing activities using the major muscles of the body that maintain or increase muscular strength and endurance. IIa (A)
8. Because of the dose-response relation between physical activity and health, persons who wish to further improve their personal fitness, reduce their risk for chronic diseases and disabilities, or prevent unhealthy weight gain will likely benefit by exceeding the minimum recommended amount of physical activity. I (A)

CONCLUSION

Frequent physical activity is an important behavior for individual and population health. See Table 4. To promote and maintain health, all healthy adults need to engage in moderate-intensity aerobic physical activity for a minimum of 30 $min \cdot d^{-1}$ on 5 $d \cdot wk^{-1}$ or vigorous-intensity aerobic activity for a minimum of 20 $min \cdot d^{-1}$ on 3 $d \cdot wk^{-1}$. [I (A)] Combinations of moderate- and vigorous-intensity activity can be performed to meet these guidelines. [IIa (B)] For example, a person can meet the recommendation by walking briskly for 30 min twice during the week and then jogging for 20 min on two other days. Moderate-intensity aerobic physical activity, which is generally equivalent to a brisk walk and noticeably accelerates the heart rate, can be accumulated toward the 30-min minimum from bouts lasting 10 or more minutes. [I (B)] Vigorous-intensity activity is exemplified by jogging, and causes rapid breathing and a substantial increase in heart rate. This recommended amount of aerobic activity is in addition to routine activities of daily living that tend to be of light intensity or last less than 10 min in duration. In addition, every adult should perform activities that maintain or increase muscular strength and endurance a minimum of two days each week. [IIA (A)] It is recommended that 8–10 exercises be performed on two or more nonconsecutive days each week using the major muscles of the body. Such activities include lifting weights, weight bearing calisthenics or similar resistance exercises that use the major muscle groups of the body. Because of the dose-response relation between physical activity and health, persons who wish to further improve their personal fitness, reduce their risk for chronic diseases and disabilities or prevent unhealthy weight gain may benefit by exceeding the minimum recommended amounts of physical activity. [I (A)].

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Disclosures

Writing Group Disclosures

Writing Group Member	Employment	Research Grant	Other Research Support	Speakers' Bureau/Honoraria	Ownership Interest	Consultant/Advisory Board	Other
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Gregory W. Heath	University of Tennessee	None	None	None	None	None	None
Paul D. Thompson	Hartford Hospital	None	None	None	None	None	None
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This table represents the relationships of writing group members that may be perceived as actual or reasonably perceived conflicts of interest as reported on the Disclosure Questionnaire, which all members of the writing group members are required to complete and submit. A relationship is considered to be "significant" if (a) the person receives $10 000 or more during any 12-month period, or 5% or more of the person's gross income; or (b) the person owns 5% or more of the voting stock or share of the entity, or owns $10 000 or more of the fair market value of the entity. A relationship is considered to be "modest" if it is less than "significant" under the preceding definition.

*Modest.

†Significant.

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