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Part D: Background

Introduction

Over the past 35 years, various health associations and agencies in the United States have published guidelines or recommendations for health professionals and the public regarding the health benefits and risks of being physically active. The rationale for these publications was that on the one hand, many people were insufficiently active and needed guidance on why and how to become more physically active, but on the other hand, an increase in physical activity by inactive adults posed significant health risks so medical guidance was needed. To determine how well various segments of the population are meeting these guidelines, national public health surveillance systems have been implemented by agencies within the US Department of Health and Human Services (HHS). The data collected by these surveillance systems over the past decade have indicated that many youth, adults, and older adults fail to meet these recommendations and that the rate of compliance varies substantially by sex, age, educational achievement, socioeconomic status, and race/ethnicity. These results are a major reason for an increased emphasis on developing federal physical activity and public health guidelines and policy statements. In addition, a majority of the questions now being asked about physical activity and health relate more to the dose (type, amount, and intensity) of activity that conveys health benefits in specific populations than to whether or not there are benefits from being physically active. Thus, it is important for the review of the science and the development of physical activity guidelines to carefully consider issues of dose response. This Background addresses all of these issues by discussing several key issues related to dose response, presenting an overview of the recent trends in physical activity by Americans, and outlining the history of physical activity and health recommendations and guidelines in the United States.

Some Issues Regarding Dose Response

Developing physical activity recommendations for public health would be quite easy if simply stated answers could be given to such questions as, “How much activity do I need to be healthy?” or “How much more benefit do I get if I walk 30 minutes 6 times per week verses just 3 times per week?” Unfortunately that does not appear to be the case. To provide an appropriate answer to such questions, a number of issues need to be considered, including a person’s current physical activity status, fitness level, health status, age, sex, and major health and fitness goals. Genetic differences among individuals also influence their responsiveness to a specific dose of activity. All of these issues affect any improvements in health and fitness that may come from increases in various combinations of type, intensity, duration, and frequency (the main components of dose).

The Process of Adaptation

Some of the body's structures and functions favorably adapt to the increase in demands placed on them whenever physical activity of a greater amount or higher intensity is performed than what is usual for the individual. It is these adaptations that are the basis for much of the improved health and fitness associated with increases in physical activity. This increase in activity is called *overload* and if applied correctly, will improve the capacity and/or efficiency of various tissues and systems. For example, cardiac stroke volume and skeletal muscle capillary density are enhanced in response to an increase in aerobic or endurance activity. Many different combinations of the main components of dose can achieve this overload. However, too big an overload applied too quickly can cause fatigue and contribute to injury. Therefore, the overload needs to be applied progressively in relatively small increments to allow for the body to adapt before receiving an even greater overload. This concept is called *progression.* The nature of the adaptation, also called *specificity*, that occurs in response to a progressive overload is influenced by the type of activity being performed. If the overload is produced by aerobic activities like walking, jogging, cycling or swimming, adaptations occur more to the oxygen transport system and various metabolic processes than if the activity is a resistance activity, such as weight lifting, which produces greater changes in muscle strength and mass. Understanding these three principles of the biological responses to activity – overload, progression, and specificity – helps in addressing issues about dose response to activity.

The Baseline Level of Physical Activity

The baseline level of habitual physical activity as well as the exercise capacity (physical fitness) of a person needs to be accounted for when considering an increase in physical activity. In other words, it is important to create an overload but not an excessive amount of overload. Therefore, for a person who has been sedentary for some time for whatever reason, the initial dose of activity should be at a relatively low intensity, of limited duration, with the sessions (also called bouts) spread throughout the week. An example of this approach would be a walking program with sessions of 5 minutes of slow walking, 5 to 6 days per week, with the bouts performed at various times throughout the day (e.g., 3 times per day). As the person adapts to this amount of activity, the bout duration could be slowly increased to 10 minutes, and as exercise capacity begins to increase, the walking speed could be increased. Such an approach is based primarily on expert opinion and clinical experience, as the benefits and risks of various approaches to initiating and progressing an activity program for very sedentary or unfit persons have not been systematically evaluated.

Another issue regarding baseline levels of physical activity is the apparent gradual decline in the recent decade in "routine physical activity" for an increasing proportion of the US population. Unfortunately, in the United States and other developed or developing countries, accurate data are not available on time trends for the total amount of physical activity performed throughout the day (energy expenditure for activities of daily living). Recent reports from objective measures of physical activity using accelerometers for 7 days provide some cross-sectional data on the US population. The results show that a far higher proportion of the population is inactive than has been indicated from self-reported estimates of physical activity (1;2). Very similar data have been reported for adults in Sweden using similar technology (3). We still need to better understand how the results of physical activity assessment by new objective measurement methods that can be applied to large populations compare to data collected by commonly used questionnaires. If the time spent being *physically inactive* is continuing to increase among the US population, it may be that the starting dose of activity will need to be adjusted downward to accommodate more people with lower exercise capacities. At the same time, the amount of activity that will have to be added to this lower baseline to return people to being physically active by current day standards will have to be increased.

Physical Activity Intensity

Intensity is a key factor when considering the dose of physical activity required to achieve specific health and fitness outcomes. Not only does an increase in activity intensity play a major role in producing many favorable adaptations, but it also has a key role in the risk of injury during activity. In most of the studies reviewed for this report, the intensity of physical activity was expressed either in *absolute* or *relative* values. *Absolute* intensity refers to the energy or work required to perform the activity and does not take into account the physiologic capacity of the individual. For aerobic activity, *absolute* intensity may be expressed as the rate of energy expenditure (e.g., kilocalories per minutes, multiples of resting energy expenditure [METs]) or, for some activities, simply as the speed of the activity (e.g., walking at 3 miles per hour, jogging at 6 miles per hour). For resistance exercise, absolute intensity is expressed as weight lifted or force exerted (e.g., pounds, kilograms). Absolute intensity also can be classified into categories such as light, moderate, hard, and very hard (Table D.1).

Table D.1. Classification of Physical Activity Intensity

Endurance Type Activity — Relative Intensity

Intensity	Percent VO_2R* Percent HRR	Percent HR_{max} ¥	RPE†
Very Light	<20	<50	<10
Light	20-39	50-63	10-11
Moderate	40-59	64-76	12-13
Hard	60-84	77-93	14-16
Very Hard	≥85	≥94	17-19
Maximal	100	100	20

Table D.1. Classification of Physical Activity Intensity (continued)

Endurance Type Activity — Intensity (METs and %VO_{2max}) in Healthy Adults Differing in VO_{2max}

Intensity	VO_{2max} = 12 METs METs	VO_{2max} = 12 METs Percent VO_{2max}**	VO_{2max} = 10 METs METs	VO_{2max} = 10 METs Percent VO_{2max}	VO_{2max} = 8 METs METs	VO_{2max} = 8 METs Percent VO_{2max}	VO_{2max} = 5 METs METs	VO_{2max} = 5 METs VO_{2max}
Very Light	<3.2	<27	<2.8	<28	<2.4	<30	<1.8	<36
Light	3.2-5.3	27-44	2.8-4.5	28-45	2.4-3.7	30-47	1.8-2.5	36-51
Moderate	5.4-7.5	45-62	4.6-6.3	46-63	3.8-5.1	48-64	2.6-3.3	52-67
Hard	7.6-10.2	63-85	6.4-8.6	64-86	5.2-6.9	65-86	3.4-4.3	68-87
Very Hard	≥10.3	≥86	≥8.7	≥87	≥7.0	≥87	≥4.4	≥88
Maximal	12	100	10	100	8	100	5	100

Resistance-Type Exercise

Intensity	Relative Intensity Percent 1RM[§]
Very Light	<30
Light	30-49
Moderate	50-69
Hard	70-84
Very Hard	≥85
Maximal	100

*%VO_2R – percent of oxygen uptake reserve; %HRR – percent of heart rate reserve
[¥]%HR_{max} = 0.7305 (%VO_{2max}) + 29.95 (4); values based on 10-MET group
†Borg Rating of Perceived Exertion 6-20 scale (5)
**%VO_{2max} = [(100%-%VO_2R) MET_{max}^{-1}] + %VO_2R; personal communication (6)
[§]RM = repetitions maximum, the greatest weight that can be moved once in good form

From: Howley, E. Med Sci Sports Ex. S364-S369, 2001. (7)

Some previous physical activity and health recommendations (8), defined absolute moderate intensity as 3.0 to 6.0 METs and vigorous intensity as more than 6.0 METs. After carefully reviewing these classifications, the PAGAC recommends that moderate intensity be defined at 3.0 to 5.9 METs and vigorous intensity as 6.0 or greater METs. This redefinition means that a number of activities classified as 6.0 METs would now be considered vigorous intensity rather than moderate intensity. A list of activities classified as 6.0 METs in the Compendium of Physical Activity (9) is included in Table D.2.

Table D.2. Physical Activities Listed as 6.0 METs in the Compendium of Physical Activities

Compendium Code (2000)	METs	Heading (Activity Group)	Activity Description
2050	6	Conditioning exercise	Weight lifting (free weight, nautilus or universal-type), power lifting or body building, vigorous effort (Taylor Code 210)
2090	6	Conditioning exercise	Slimnastics, jazzercise
2110	6	Conditioning exercise	Teaching aerobic exercise class
4050	6	Fishing and hunting	Fishing in stream, in waders (Taylor Code 670)
4080	6	Fishing and hunting	Hunting, deer, elk, large game (Taylor Code 170)
4110	6	Fishing and hunting	Hunting, pheasants or grouse (Taylor Code 680)
5120	6	Home activities	Moving furniture, household items, carrying boxes
6050	6	Home repair	Carpentry, outside house, installing rain gutters, building a fence, (Taylor Code 640)
6180	6	Home repair	Roofing
8020	6	Lawn and garden	Chopping wood, splitting logs
8060	6	Lawn and garden	Gardening with heavy power tools, tilling a garden, chain saw
8110	6	Lawn and garden	Mowing lawn, walk, hand mower (Taylor Code 570)
8200	6	Lawn and garden	Shoveling snow, by hand (Taylor Code 610)
11030	6	Occupation	Building road (including hauling debris, driving heavy machinery)
11100	6	Occupation	Coal mining, general
11192	6	Occupation	Farming, taking care of animals (grooming, brushing, shearing sheep, assisting with birthing, medical care, branding)
11320	6	Occupation	Forestry, planting by hand
11380	6	Occupation	Horse grooming
11560	6	Occupation	Shoveling, light (less than 10 pounds/minute)
11780	6	Occupation	Using heavy power tools such as pneumatic tools (jackhammers, drills, etc.)
12010	6	Running	Jog/walk combination (jogging component of less than 10 minutes) (Taylor Code 180)
15050	6	Sports	Basketball, non-game, general (Taylor Code 480)
15110	6	Sports	Boxing, punching bag

Table D.2. Physical Activities Listed as 6.0 METs in the Compendium of Physical Activities (continued)

Compendium Code (2000)	METs	Heading (Activity Group)	Activity Description
15190	6	Sports	Drag racing, pushing or driving a car
15200	6	Sports	Fencing
15500	6	Sports	Paddleball, casual, general (Taylor Code 460)
15640	6	Sports	Softball, pitching
15680	6	Sports	Tennis, doubles (Taylor Code 430)
15730	6	Sports	Wrestling (one match = 5 minutes)
15733	6	Sports	Track and field (high jump, long jump, triple jump, javelin, pole vault)
16040	6	Transportation	Pushing plane in and out of hangar
17027	6	Walking	Carrying 16 to 24 lb load, upstairs
17080	6	Walking	Hiking, cross country (Taylor Code 040)
17210	6	Walking	Walking, 3.5 mph, uphill
18150	6	Water activities	Skiing, water (Taylor Code 220)
18300	6	Water activities	Swimming, lake, ocean, river (Taylor Codes 280, 295)
18310	6	Water activities	Swimming, leisurely, not lap swimming, general
19010	6	Winter activities	Moving ice house (set up/drill holes, etc.)
19160	6	Winter activities	Skiing, downhill, moderate effort, general

NOTE: This table is adapted from *The Compendium of Physical Activities* (9).

In contrast, *relative* intensity takes into account or adjusts for a person's exercise capacity. For aerobic exercise, *relative* intensity is expressed as a percent of a person's aerobic capacity (VO_{2max}) or VO_2 reserve, as a percent of a person's measured or estimated maximum heart rate or heart rate reserve, or as an index of how hard the person feels he or she is exercising (rating of perceived exertion) (10). A percent of maximum heart rate or heart rate reserve can be used because a near linear relation exists between the increase in heart rate and the increase in oxygen uptake during dynamic aerobic exercise. Table D.1 also provides the classification of physical activity intensity showing the relation between absolute and relative intensity for aerobic activity and relative intensity for resistance exercise.

In most experimental studies evaluating the effects of increased activity on various fitness and health outcomes, intensity is expressed relative to each person's capacity (e.g., 60% to 75% of VO_{2max}). However, in nearly all of the large prospective observational studies, physical activity intensity is expressed in absolute terms (no adjustment made for each person's exercise capacity). These differences in methodology limit to some degree direct comparison of dose-response data from these 2 major sources of evidence. For an activity of a given absolute intensity, such as walking at 3.0 miles per hour (3.3 METs), the relative intensity varies inversely to the aerobic capacity of the individual. As shown in Figure D.1, for highly fit people with an aerobic capacity of 14 METs, walking at 3.0 miles per hour has a relative intensity of 24 % (left y-axis) or light intensity (right y-axis), but for people of low fitness who have only a 4-MET capacity, the relative intensity is at 83% (left y-axis) or hard intensity (right y-axis). A similar situation is displayed for a walking speed of 4.0 miles per hour with a MET value of 5.0. Note that it is impossible for people with a 4-MET capacity to walk this fast for an extended period of time, as the energy requirement exceeds their aerobic capacity. Standardization of activity intensity classification is essential for accurately establishing the relation between intensity and health or fitness outcomes.

Figure D.1. The Relative Exercise Intensity for Walking at 3.0 mph (3.3 METs) and 4.0 mph (5.0 METs) Expressed as a Percent of VO_{2max} for Adults With an Exercise Capacity Ranging from 4 to 14 METs

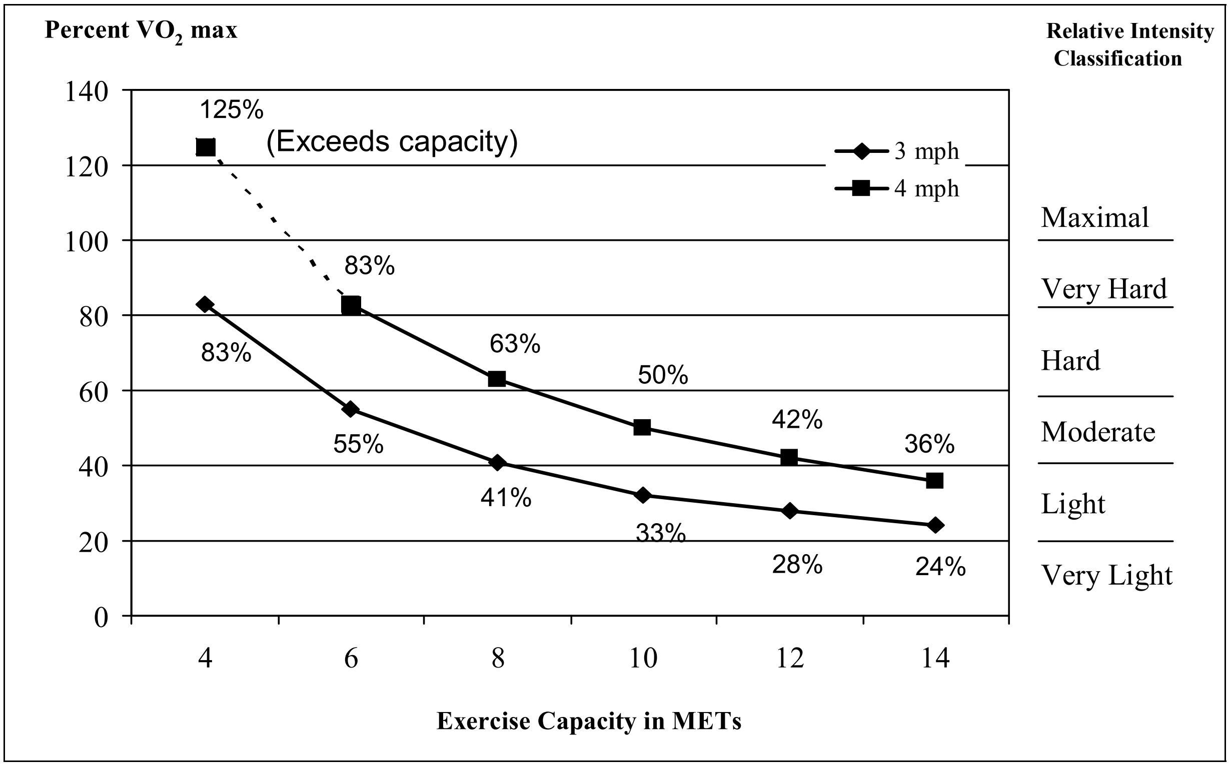


Figure D.1. Data Points

Exercise Capacity	METs 4	METs 6	METs 8	METs 10	METs 12	METs 14
3 mph	83	55	41	32	28	24
4 mph	–	83	63	50	42	36

Physical Activity Amount

The amount of physical activity performed by a person for a given period of time is the product of activity duration, absolute intensity, and frequency. Thus, the amount of activity is one expression of activity dose. For many of the prospective observational studies cited in this review, the primary activity exposure is the amount of leisure-time or total physical activity expressed in minutes or hours per day or week (of moderate, vigorous, or moderate plus vigorous activity), distance walked or jogged/run per day or week. Exposure also can be the estimated amount of energy expended expressed in kilocalories per day or week, kilocalories per kilogram of body weight per day or week, or MET-minutes or MET-hours per day or week.

In experimental studies, the amount of activity sometimes has been expressed in these same units but also has been given with the intensity in relative units along with the frequency and duration of the activity sessions with no overall amount or volume of activity provided (e.g., 30 minutes at 70% heart rate reserve [HRR], 5 times per week for 24 weeks). To pool or compare results across studies and develop generalized conclusions about the benefits provided with various amounts of physical activity, it was necessary to be able to compare one expression of the amount of activity with others. Table D.3 provides this type of information for walking, jogging, and running over a range in activity intensity from 3.0 to 16.0 METs.

Table D.3. Walk, Jog, and Run Speeds and METs, MET-Minutes, MET-Hours, and Distance (miles) for 2.5 Hours (150 min) and 5.0 Hours (300 min) per Week of Physical Activity. Also Listed Are the Estimated Kilocalories (kcal) Expended by a 75 kg (165 lb) Adult During 150 and 300 Minutes per Week at the Different Intensities of Activity.

Speed (mph)	METs	For 2.5 hr/wk (150 min/wk) MET-min	For 2.5 hr/wk (150 min/wk) MET-hours	For 2.5 hr/wk (150 min/wk) Miles	For 2.5 hr/wk (150 min/wk) kcal	For 5.0 hr/wk (150 min/wk) MET-min	For 5.0 hr/wk (150 min/wk) MET-hours	For 5.0 hr/wk (150 min/wk) Miles	For 5.0 hr/wk (150 min/wk) kcal
Rest	1.0	150	2.5	0.0	190	300	5.0	0.0	380
2.5	3.0	450	7.5	6.25	565	900	15.0	12.5	1,130
3.0	3.3	495	8.25	7.5	620	990	16.5	15.0	1,240
4.0	5.0	750	12.5	10.0	940	1,500	25.0	20.0	1,880
4.3	6.0	900	15.0	10.75	1,125	1,800	30.0	21.5	2,250
5.0	8.0	1,200	20.0	12.5	1,500	2,400	40.0	25.0	3,000
6.0	10.0	1,500	25.0	15.0	1,875	3,000	50.0	30.0	3,750
7.0	11.5	1,725	28.25	17.5	2,155	3,450	56.5	35.0	4,310
8.0	13.5	2,025	33.75	20.0	2,530	4,050	67.5	40.0	5,060
10.0	16.0	2,400	40.0	25.0	3,000	4,800	80.0	50.0	6,000

2.5 - 4.3 mph = walk
5-10 mph = jog/run
† kilocalories for 75 kg adult when exercising at the given intensity for either 150 or 300 minutes.

Note: These are gross energy expenditure values during exercise; thus, they include the energy expenditure at rest and not just the additional energy expenditure due to the activity. Kilocalories calculated using 1 MET = 1 kilocalorie per kilogram per hour and rounded to nearest 5 kilocalories. MET values from Ainsworth and colleagues (9).

Based on data in this table, for 2.5 hours per week of activity at moderate absolute intensity (3.0 to less than 6.0 METs), a person would have a range for MET-minutes per week of 450 to less than 900, MET-hours per week of 7.5 to less than 15.0 and, if they weighed 165 pounds (75 kilograms), their kilocalories of energy expenditure would range from 565 to less than 1,125 kilocalories. If this were achieved by walking at various speeds, the distance would range from 6.25 to less than 10.75 miles per week. At 5 hours per week of moderate-intensity activity, the MET-minutes per week would range from 900 to less than 1,800 and MET-hours per week would range from 15.0 to less than 30.0. Kilocalories expended by a 165-pound (75 kilogram) adult would range from 1,130 to less than 2,250 and the distance walked would be 12.5 to less than 21.5 miles.

The energy expenditure values in Table D.3 are estimated gross values. They include both the energy expenditure required at rest (1 MET) as well as the added (net) energy expenditure required for performing the activity. The estimated energy expenditure for a 165-pound (75 kilogram) person at rest for 150 minutes during the week is about 190 kilocalories. If that person instead walked at a 3.0 mile per hour pace for the 150 minutes, his or her estimated energy expenditure during this time would be about 620 kilocalories, or an increase above rest of 430 kilocalories. However, if the person jogged at a 6 mile per hour pace for these 150 minutes, he or she would expend approximately 1,875 kilocalories, or an increase above rest of about 1,685 kilocalories. Thus, a 165-pound person jogging at 6 miles per hour for 150 minutes per week would expend approximately 1,255 more kilocalories than if he or she walked at 3 miles per hour for the same amount of time during the week. This example demonstrates the substantial increase in energy expenditure as the intensity of the activity increases. In this example, the *increase* in kilocalories while jogging is nearly 4 times greater than the increase while walking (430 versus 1,655).

Recent Trends in Physical Activity in the United States

Since the 1995 physical activity and public health recommendations published by the Centers for Disease Control and Prevention and the American College of Sports Medicine (8) and *Physical Activity and Health: A Report of the Surgeon General* published in 1996 (11), national health behavior surveillance systems have collected cross-sectional information on self-reported compliance with these recommendations by representative samples of Americans. The major national public health surveillance systems monitoring physical activity in the US population include the Behavioral Risk Factor Surveillance System (BRFSS; http://www.cdc.gov/brfss/), the Youth Risk Behavior Surveillance System (YRBSS; http://www.cdc.gov/HealthyYouth/yrbs/), National Health and Nutrition Examination Survey (NHANES; http://www.cdc.gov/nchs/nhanes.htm), and the National Health Interview Survey (NHIS; http://www.cdc.gov/nchs/nhis.htm). For details regarding the methodologies used by each of these surveys, readers are referred to their respective websites. These surveys provide snapshots of participation in selected types or categories of activities by adults and youth and participation in structured programs of activity, such as physical education and organized sports in youth. They include measures of inactivity as well as of activity and, in many cases, include information through 2005. No surveillance system exists that captures an overall determination of physical activity performed or the energy expended during activity throughout the day – during work, school, home and self care, commuting, and leisure time. However, one systematic review of physical activity trends over the past 50 years suggest that declines have occurred in work-related activity, self-transportation activity, and activity in the home, resulting in overall decrease in physical activity (12).

Adults and Older Adults

The BRFSS is a state-based random-digit dialed telephone survey of the non-institutionalized US civilian population aged 18 years and older. Beginning in 2001, BRFSS included biannual questions about leisure-time physical activity asking whether respondents participated in either moderate- or vigorous-intensity activity in bouts of at least 10-minute duration. If they did, respondents were asked to report the frequency and duration of these activities (13). Participants who reported at least 30 minutes of moderate-intensity activity 5 or more days per week or 20 minutes of vigorous-intensity activity 3 or more days per week, or both were considered to be engaged in regular physical activity and to meet current recommendations. In 2005, the prevalence of women reporting that they regularly engaged in physical activity was 46.7%, which was a relative increase of 8.6% from 2001 (43.0%), while men increased 3.5%, from 48.0% to 49.7%. For women, a significant increase between 2001and 2005 was reported in all racial/ethnic groups and all age and education level categories except for women aged 18 to 24 years (Figure D.2). Among men, significant increases were observed for the age range 45 to 64 years, non-Hispanic whites, non-Hispanic blacks, high school graduates and college graduates.

As can be seen in Figure D.2, the percentage of men who reported being physically active is greater than for women and steadily declines with age in both sexes. The prevalence at age 18 to 24 years is 60.5% for men and 50.8% for women, but significantly decreases by age 65 years and older to 43.1% in men and 32.2% in women. For both men and women, higher levels of education were associated with a higher prevalence of reporting being physically active, ranging from 35.5% and 34.2% for men and women who had not graduated from high school up to 52.6% and 49.1% for men and women who were college graduates. Non-Hispanic white men and women tend to have a higher reported prevalence of being active than other racial/ethnic groups with the largest differences in 2005 being between non-Hispanic white and black women and between non-Hispanic white men and Hispanic men.

The data presented in Figure D.2 are quite consistent with self-report data from other national surveys conducted over the past decade.

Figure D.2. Estimated Age Adjusted Percentage of Persons ≥18 Years Reported Meeting the Healthy People 2010 Objective for Regular Physical Activity in 2001 and 2005: Data from BRFSS

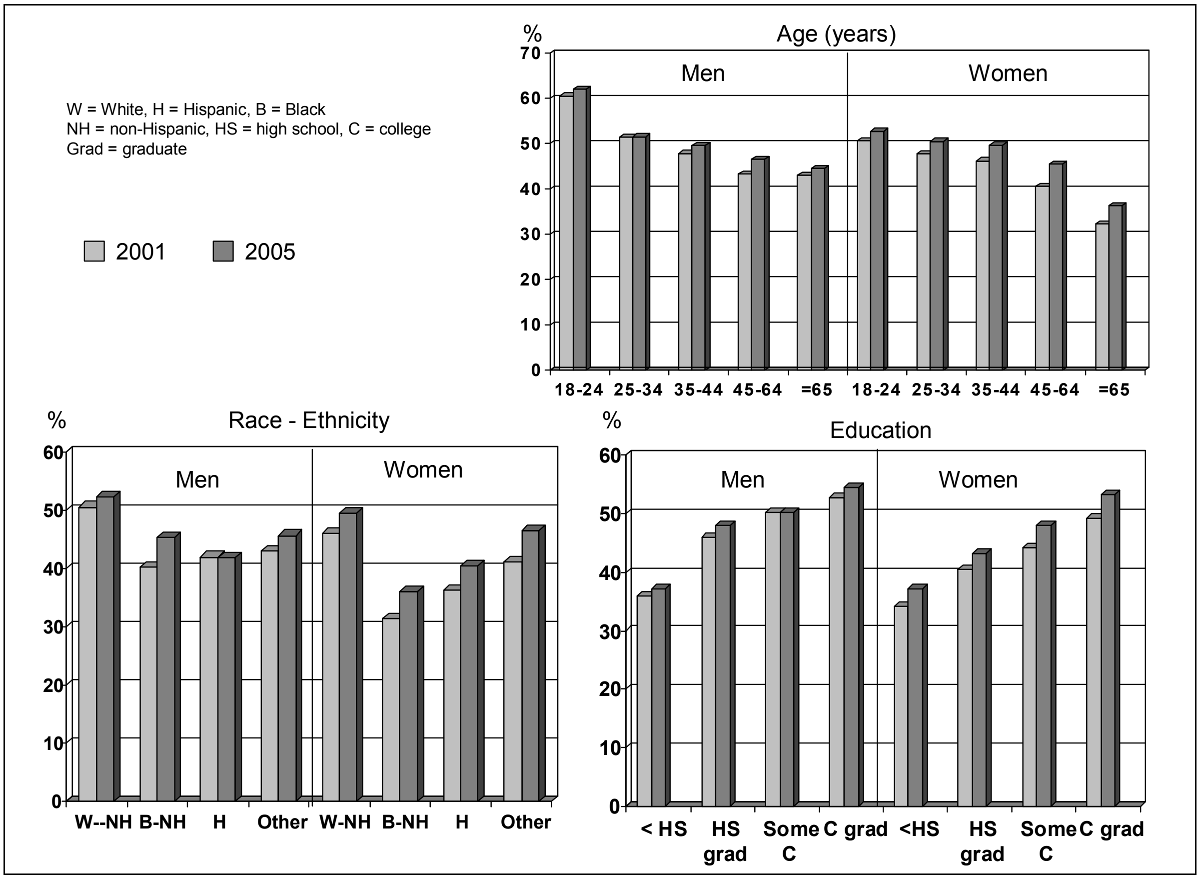


Figure D.2. Data Points Age

Year	Men 18-24	Men 25-34	Men 35-44	Men 45-64	Men *65	Women 18-24	Women 25-34	Women 35-44	Women 45-64	Women *65
2001	60.5	51.4	47.8	43.3	43.1	50.6	47.7	46.2	40.6	32.2
2005	62	51.5	49.6	46.5	44.5	52.7	50.5	49.7	45.5	36.3

Figure D.2. Data Points Race — Ethnicity

Year	Men W--NH	Men B-NH	Men H	Men Other	Women W-NH	Women B-NH	Women H	Women Other
2001	50.6	40.3	42	43.1	46	31.4	36.3	41.2
2005	52.3	45.3	41.9	45.7	49.6	36.1	40.5	46.6

Figure D.2. Data Points Education

Year	Men < HS	Men HS grad	Men Some C	Men C grad	Men <HS	Men HS grad	Men Some C	Men C grad
2001	35.8	46	50.3	52.6	34.2	40.3	44.3	49.1
2005	37.2	47.9	50.3	54.6	37.1	43.2	47.9	53.3

Figure D.3 displays data from the Healthy People 2010 Database (DATA2010) for men and women combined for selected measures of physical activity reported annually from 1997 to 2006 (14). Over this period, 30% to 35% of adults reported participation in moderate- or vigorous-intensity activity sufficient to meet existing recommendations, and those reporting no leisure time activity remained in the 35% to 40% range. Neither of these measures showed a consistent trend over time. From 1997 through 2000, approximately 16% of the adult population reported performing muscle strength and endurance exercises, with an increase to about 20% being reported from 2001 to 2006.

Figure D.3. Reported Physical Activity by Adults in the USA: 1997-2006 The Healthy People 2010 Database

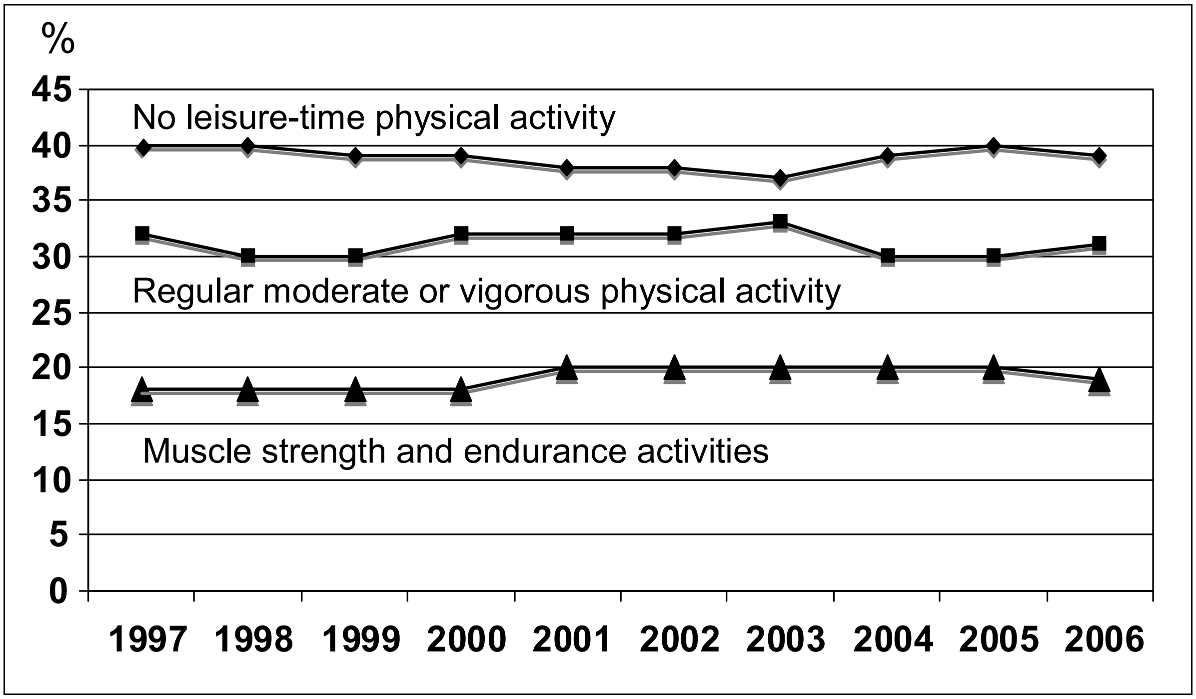
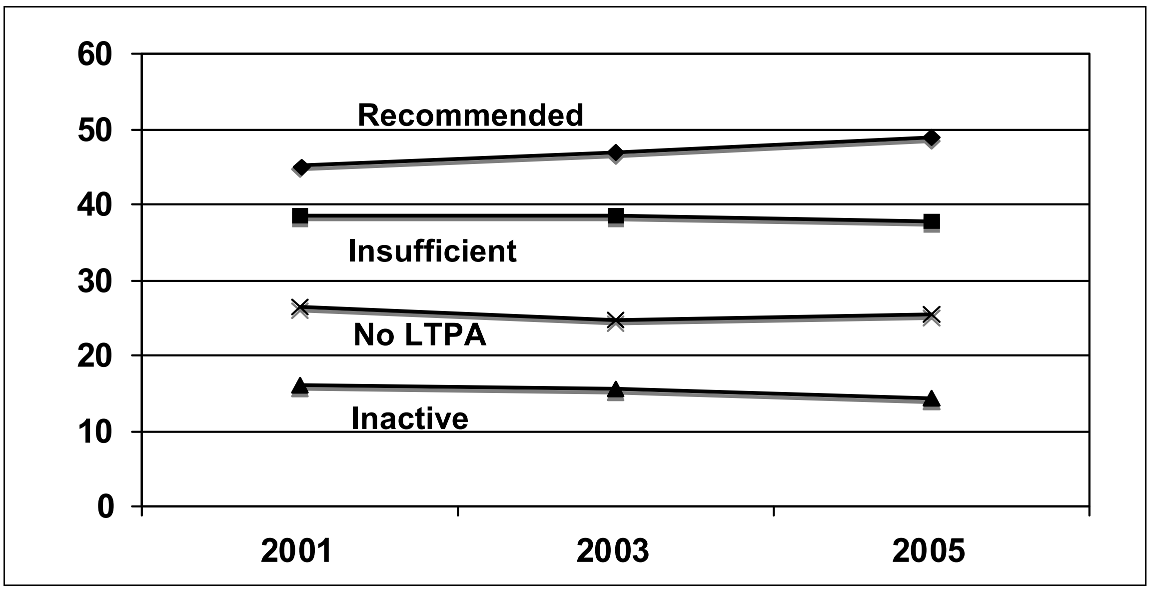


Figure D.3. Data Points

Activity	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
No leisure-time physical activity	40	40	39	39	38	38	37	39	40	39
Regular moderate or vigorous physical activity	32	30	30	32	32	32	33	30	30	31
Strength and endurance activities	18	18	18	18	20	20	20	20	20	19

Depending on how the questions are asked and the activity classification criteria used, responses to the various national physical activity surveillance systems indicate that 45% to 50% of adults in the US report meeting current public health recommendations for moderate-to-vigorous physical activity (defined as moderate-intensity activities [i.e., brisk walking, bicycling, vacuuming, gardening, or anything else that causes small increases in breathing or heart rate] for at least 30 minutes per day at least 5 days per week, or vigorous-intensity activities [i.e., running, aerobics, heavy yard work, or anything else that causes large increases in breathing or heart rate] for at least 20 minutes per day at least 3 days per week, or both). About 38% to 40% report being insufficiently active (defined as doing more than 10 minutes total per week of moderate- or vigorous-intensity lifestyle activities [i.e., household, transportation, or leisure-time activity] but less than the recommended level of activity). Around 25% report performing no moderate-to-vigorous physical activity during leisure time (defined as no physical activities or exercises such as running, calisthenics, golf, gardening, or walking in the previous month), and approximately 15% are considered inactive (defined as less than 10 minutes total per week of moderate- or vigorous-intensity lifestyle activities [i.e., household, transportation, or leisure-time activity]. Figure D.4 provides data from the BRFSS for 2001-2005 for all adults combined (13).

Figure D.4. Reported Physical Activity by Adults in the USA: 2001-2005 Data from BRFSS



"Recommended," "Insufficient," and "Inactive" data comprise one measure, and responses should sum to ~100%. "No Leisure-Time Physical Activity" is a separate question, and should not be included with calculations for the recommended, insufficient, or inactive.

Figure D.4. Data Points

Physical Activity	2001	2003	2005
Recommended	45.3	46.9	48.8
Insufficient	38.6	38.5	37.7
No leisure-time physical activity	26.3	24.6	25.4
Inactive	16.0	15.6	14.2

Youth

Based on data from the YRBSS for 2005, 35.8% of high school students reported meeting current physical activity recommendations (defined as performing any kind of physical activity that increased their heart rate and made them breathe hard some of the time (i.e., moderate or vigorous intensity) for at least 60 minutes per day on 5 or more days of the 7 days preceding the survey) (5). The reported prevalence of meeting this level of physical activity was higher in boys (43.8%) than girls (27.8%) and higher in white (46.9%), black (38.2%), and Hispanic (39.0%) boys than for white (30.2%), black (21.3%), and Hispanic (26.5%) girls. Prevalence estimates of meeting current recommendations of at least 60 minutes per day 5 or more days per week of moderate- or higher-intensity activity ranged from 26.9 to 45.9% across state surveys (median 33.9) for students in grades 9-12.

The recommended level of physical activity used as a benchmark by the YRBSS before the 2005 survey was either 20 minutes of vigorous-intensity activity (activities that make a person sweat and breathe hard) at least 3 days per week or at least 30 minutes of moderate-intensity activity (activity that does not cause a person to sweat or breathe hard) on at least 5 days per week. The percentage of students meeting these recommendations in 2005 was substantially higher than for the updated 60 minutes per day recommendations: boys (75.8%) were higher than girls (61.5 %) and white (77.0%), black (71.7%), and Hispanic (76.0) boys had higher compliance rates than did white (63.3%), black (53.1%), and Hispanic (62.6%) girls. Students reporting not participating in any moderate or vigorous intensity activity during the past 7 days was 7.6% nationwide, with a higher prevalence among girls (11.3%) than among boys (7.9%) and higher among black (14.4%) than white (8.1%) and Hispanic students (10.6%).

In 2005, 54.2% of high school students reported attending a physical education (PE) class one or more days per week on an average week they were in school with a higher percentage of boys (60.0%) reporting yes than girls (48.3%) and higher percentages of white (58.1%), black (61.7%), and Hispanic (65.9%) boys reporting yes than white (46.1%), black (50.5%), and Hispanic (57.5%) girls. The prevalence of attending PE class at least one day per week varied by state from a low of 25.2% to a high of 94.2%. However, when the frequency criteria for attending PE class was increased from 1 day per week to 5 days in an average week, the prevalence decreased to 37.1% for boys and 29.0% for girls, with the variation among states ranging from 6.7% to 60.7%.

Based on data from the various physical activity questions contained in the YRBSS for 2005, high school boys tend to meet moderate-to-vigorous physical activity recommendations more frequently than do girls, with this sex difference being true for white, black, and Hispanic youth. Overall, it appears that white high school students report being somewhat more active than Hispanic and black students, but their attendance in PE classes does not appear to be any different.

Figure D.5 displays the trends for various indices of physical activity for high school students for the period 1999-2005 collected using the YRBSS (14). Included are the percentage of students who met the previous recommendations of either moderate- or vigorous-intensity activity, students reporting no moderate or vigorous physical activity, and the percentage of students reporting attending PE class 5 days per week on average or at least one day per week. The overall impression gained from the data displayed in this figure is that over this 7-year period, neither reported activity meeting moderate-to-vigorous physical activity recommendations or attendance in high school PE classes changed much. The prevalence of students not reporting any moderate-to-vigorous physical activity over the past week also has remained quite constant.

Figure D.5. Percent of High School Students in the United States with Various Physical Activity Profiles: 1999-2005 Data from YBRFSS

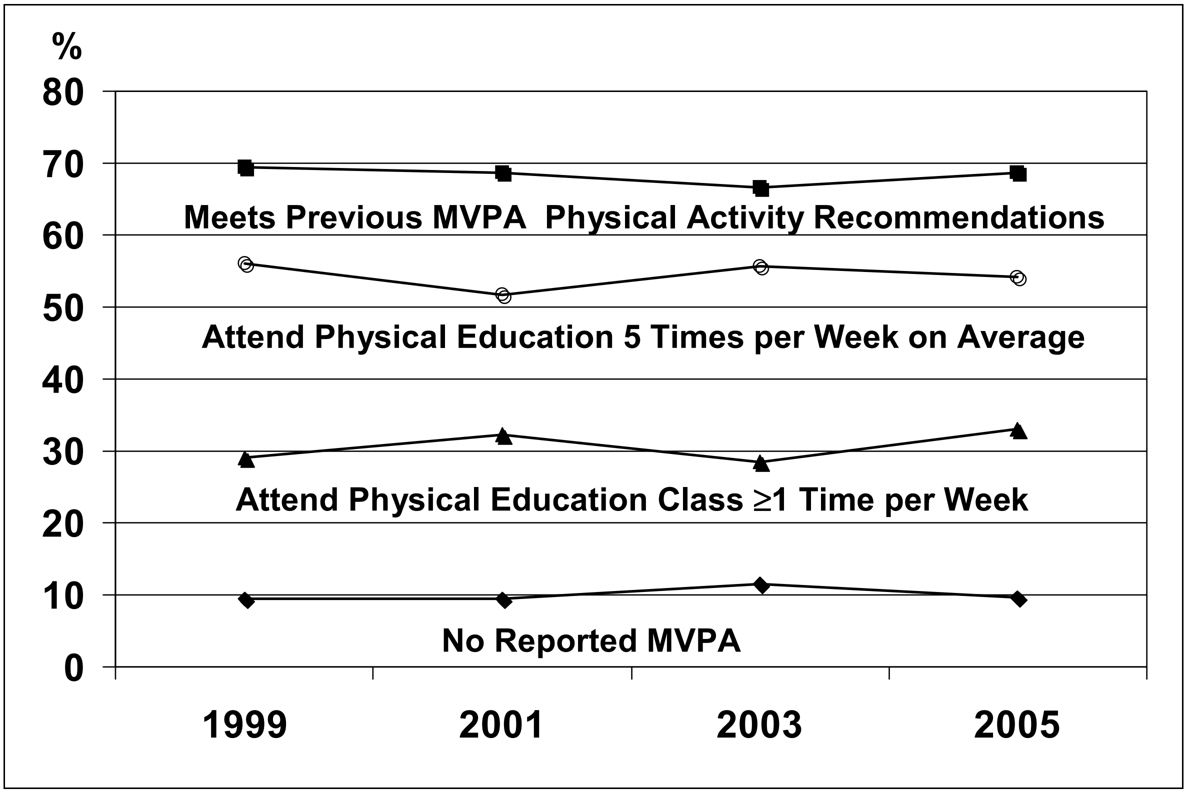


Figure D.5. Data Points

Activity	1999	2001	2003	2005
Meet moderate or vigorous physical activity	69.5	68.6	66.6	68.7
Physical education class 5 times per week	56.1	51.7	55.7	54.2
Physical education class ≥1 time per week	29.1	32.2	28.4	33
No moderate or vigorous physical activity	9.4	9.5	11.5	9.6

Comment on Measures of Physical Activity Trends in the United States

As mentioned previously, no national surveillance system in the United States attempts to document all activity performed throughout the day. Also, no national surveillance system exists to track physical activity of young children not yet in high school or to specifically target the rapidly increasing older population. The results of the national surveillance systems cited above generally indicate some small changes in the activity status of youth and adults in the past 5 to 10 years, primarily based on whether or not they meet current physical activity recommendations. Data from the BRFSS for 2001-2005 do demonstrate a 6% or so relative increase in adults meeting moderate-to-vigorous physical activity recommendations, and other BRFSS data for the period 1994-2004 indicate that the percentage of the population who reported no LTPA decreased from 29.8% in 1994 to 23.7% in 2004 (13). However data collected using the NHIS indicate that the percentage of adults who engaged in regular leisure-time physical activity did not change between 1997 and 2006.

Overall, the data provided by these national surveillance programs consistently demonstrate that a majority of adults do not meet current physical activity and public health recommendations. Although about two-thirds of high school students report meeting previous moderate-to-vigorous physical activity recommendations (at least 30 minutes of moderate intensity activity at least 5 days per week, or vigorous intensity activity at least 20 minutes at least 3 times per week), only 35.8% report meeting the current recommendations (at least 60 minutes per day of moderate or vigorous intensity activity on at least 5 days per week) (5). Also, any changes in the various indices of physical activity for high school students have been small and inconsistent over the past decade.

The use of self-report instruments to monitor physical activity over time is known to have a variety of limitations given the diversity of activities that are performed daily by people with different jobs, home care responsibilities, commuting patterns, and leisure-time pursuits. Attempting to obtain adequate detail so that accurate classifications of activity status can be made based on type, intensity, and amount of activity is difficult and can lead to inaccurate information and increased non-response. Until recently, no real option existed for collecting physical activity surveillance data other than by self-report. However, over the past decade, the technology of objective physical activity monitors, especially accelerometers, that can be used in large and diverse populations has developed substantially. Initially, these monitors were used in small-scale studies, but accelerometer data describing the physical activity patterns in relatively large (n=1,100 to 6,800) samples (1-3) has recently been published. These initial reports demonstrate the substantial potential for the use of such devices in national physical activity surveillance programs but also present a challenge for analyzing the large amounts of data they produce and interpreting results. For example, accelerometers were used to collect NHANES data minute by minute during waking hours over 7 days in approximately 6,800 children, adolescents, and adults (1). Based on these data, 42% of children aged 6 to 11 years met the current 60 minutes per day recommendation but only 8%

of adolescents met this goal and fewer than 5% of adults met the 30 minutes or more per day recommendation. These estimates of physical activity participation are substantially lower than those obtained in nationally representative surveys by self-report described above. The reasons for the differences are not clear. One reason may be participant over-estimation of physical activity in self-report surveys. Alternatively, accelerometers may not be accurately capturing all reported physical activity for a variety of reasons. Most likely, some combination of reasons explain the disparity. A much better understanding of how objective physical activity measurements obtained with currently available and new instrumentation relate to a variety of health outcomes is needed before such measurements can be used to inform future physical activity recommendations and policy statements.

Development of Physical Activity Guidelines in the United States[1]

By the late 1960s, a number of individuals and organizations in the United States had recognized the increasingly sedentary nature of the population and the negative health and fitness consequences of this decline in activity, and were promoting their own interpretation of a good or best exercise program. Data from a growing number of observational and experimental studies supported the value of being physically active, but no consensus existed on what programs were most effective and safe. Also, during the early 1960s, death rates from coronary heart disease were still on the rise and few effective treatments for preventing sudden cardiac death were available. It was well established that the increased work of the heart during vigorous exercise could trigger cardiac arrest or myocardial infarction in persons with coronary atherosclerosis. However, investigators and clinicians lacked an understanding of the etiology of the atherothrombotic disease process, how to detect it in at-risk populations, and what types and intensities of exercise were safe. Many people, including physicians, were very concerned about adults older than age 45 years increasing their physical activity, especially starting a vigorous exercise program or participating in athletic competition. It was this combination of concern about the need to promote exercise, but at the same time, fear that promoting exercise, if not carefully controlled, would cause many people to experience sudden cardiac death that precipitated the development of the first physical activity guidelines and recommendations. The evolution of the guideline process over a 35-year period has been characterized by attempts to reduce risk while maximizing benefit by providing clinically-oriented recommendations for patient or "at-risk" populations and by public health-oriented recommendations for the general public.

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[1] This overview of the development of physical activity guidelines in the United States was adapted from a chapter prepared by W. Haskell for *Epidemiologic Methods in Physical Activity* (15). Its use in this report was approved by the publisher.

Early Development of Physical Activity Recommendations and Guidelines

By the early 1970s, data from several epidemiologic and experimental studies demonstrated that physically active persons, including patients with coronary heart disease (CHD), had better health outcomes than did their less active counterparts. These data were useful in preparing early guidelines because the major concern was how to minimize risk while achieving health benefits. The earliest such guidelines were published by the American Heart Association (AHA) in 1972 and 1975. The first publication was *Exercise Testing and Training of Apparently Healthy Individuals: A Handbook for Physicians* (16). These guidelines were directed more at reducing the cardiovascular risk imposed by performing moderate- to vigorous-intensity exercise, including exercise testing for the "coronary prone," than at providing information on how to help patients become more physically active. The authors indicated that available data supported exercise in the rehabilitation of patients with CHD, but data were still inadequate to support widespread promotion of exercise for the prevention of CHD. The authors also advised that the exercise recommendations for the healthy but sedentary person, particularly for the middle-aged male, "not be arbitrarily formulated" and that "exercise intensity must be adjusted to individual capacity at the beginning of the program and regulated periodically during the succeeding stages."

The AHA's second publication, *Exercise Testing and Training of Individuals with Heart Disease or at High Risk for its Development: A Handbook for Physicians*, also focused more on assessment of exercise capacity and issues of risk than on details of program implementation, and more on rehabilitation than on secondary prevention (17). The following quote from the publication is an indication of the clinical approach taken to exercise guidelines in the 1970s: "Exercise is a therapeutic agent designed to promote a beneficial clinical effect and, as such, has specific indications and contraindications and possible toxic or adverse reactions" (page 24).

During this same time period, several professional organizations and government agencies began to issue recommendations, guidelines, and position stands on the importance of being physically active, how much of what types of activity should be performed, and how best to implement a safe activity plan to increase health and fitness. In 1973, *Exercise and Sport Sciences Reviews* published "The Quantification of Exercise Training Programs," a review of research on endurance exercise training and cardiorespiratory fitness by Michael Pollock (18). Much of the information developed during this review was used by Pollock and colleagues as the scientific basis for the first American College of Sports Medicine (ACSM) Position Statement on "The Recommended Quantity and Quality of Exercise for Developing and Maintaining Fitness in Healthy Adults," which was published in 1978 (19). This Position Statement focused on "developing and maintaining cardiorespiratory fitness and body composition in healthy adults," and its key recommendations were that individuals perform an endurance-type activity for 15 to 60 minutes, 3 to 5 days per week, at 60% to 90% of heart rate reserve or 50% to 85% of maximal oxygen uptake. Although reasonably brief (2.5 pages of text and 90 references), the recommendations in this document became the mainstay for most exercise professionals and much of the public wanting to know, "How much exercise is enough?" It is worthwhile noting that all the references cited in this document were from the field of exercise physiology, with none from physical activity or behavioral epidemiology.

The ACSM reissued this Position Stand in 1990 and changed the title to "The Recommended Quantity and Quality of Exercise for Developing and Maintaining Cardiorespiratory and Muscular Fitness in Healthy Adults" (20). The dose of exercise recommended was quite similar to the 1978 recommendation, with frequency and exercise mode remaining the same, session duration changing from "15 to 60" minutes to "20 to 60" minutes, and intensity changing from "60% to 90% of heart rate reserve or 50% to 85% of maximal oxygen uptake" to "60% to 90% of maximum heart rate or 50% to 85% of maximal oxygen uptake or heart rate reserve." A specific recommendation for enhancing muscle strength was added: one set of 8 to 12 repetitions of 8 exercises, 2 days per week. The statement also indicated that less intensive exercise might also provide health benefits: "ACSM recognizes the potential health benefits of regular exercise performed more frequently and for a longer duration, but at lower intensities than presented in this position statement." (p. 266).

In 1998, the ACSM published the third edition of its Position Stand, entitled, "Quantity and Quality of Exercise for Developing and Maintaining Cardiorespiratory and Muscular Fitness, and Flexibility in Healthy Adults" (21). The primary recommendations for exercise to enhance cardiorespiratory and body composition remained similar to the 1978 and 1990 recommendations except for a small reduction at the low end of the intensity range: 55% to 90% of maximum heart rate instead of 60% to 90% or 40% to 85% of maximal oxygen uptake reserve or heart rate reserve instead of 50% to 85%. This 1998 document also included recommendations for flexibility and adopted the concept of accumulation from public health recommendations published by the Centers for Disease Control and Prevention (CDC) and ACSM in 1995 (8). (See the following section for more details on the 1995 CDC/ACSM recommendations.) In discussing "duration of training, the ACSM Position Stand recommended "20 to 60 minutes of continuous or intermittent (minimum of 10-minute bouts accumulated throughout the day) of aerobic activity."

In addition to these Position Stands, the ACSM as well as other organizations developed publications that provided detailed guidelines for specialists such as physicians, exercise scientists, physical educators, physical therapists, coaches, and nurses. These guidelines were intended for use in providing exercise and fitness evaluations, developing physical activity prescriptions or plans for individuals or groups, and providing exercise instruction or leadership for patients and healthy persons. Included in these documents were the 7 editions of *Guidelines for Exercise Testing and Exercise Prescription* published by the ACSM between 1975 and 2005 (10;22-27) and *Exercise Standards: A Statement for Healthcare Professionals from the American Heart Association* (28).

A Paradigm Shift to Public Health Physical Activity Guidelines

Starting in the mid-1980s, various medical and public health organizations held discussions and published manuscripts on public health rather than clinical approaches to physical activity for achieving improved health outcomes (29). For example, CDC's Behavioral Epidemiology and Evaluation Branch organized a "Workshop on the Epidemiological and Public Health Aspects of Physical Activity and Exercise" in 1984, in which experts reviewed the current knowledge base relating physical activity to health status and identified actions to be taken to increase the activity status of Americans (30). Ten manuscripts were prepared as the basis for discussion during the conference, and they were published along with a conference overview (31). This meeting played a significant role in setting the stage for the evolution of a public health paradigm for physical activity over the next decade.

The goal of this effort was to augment or supplement, but not necessarily replace, the existing exercise-for–fitness paradigm promoted by the ACSM and other organizations by focusing primarily on enhancing physical fitness or working capacity, either in healthy persons or in the rehabilitation of various patient populations (32). During this 10-year period, substantial new data were published, especially from physical activity epidemiology, which related inactivity to increased risk of several chronic diseases and the potential protective effects of moderate-intensity, as well as vigorous-intensity activity. In addition, researchers reconsidered some of the prior epidemiologic data with respect to the most likely kinds and patterns of physical activity that were carried out by active people, who comprised some of the lower-risk groups. The tentative conclusion was that much of this risk-reducing activity was of moderate intensity (usually considered 3.0 to 6.0 METs) and that it was frequently performed in repeated short bouts. Thus, a disconnect appeared to exist between the accepted exercise-fitness paradigm, which emphasized vigorous activity performed in bouts of at least 20 minutes duration, and the intensity and bout duration that appeared to provide some protection against selected chronic diseases and all-cause mortality.

For example, the results of some studies indicated that regular walking or other moderate-intensity activity, or moderate levels of cardiorespiratory fitness, were associated with reduced rates of cardiovascular disease (CVD) and all-cause mortality (4;33;34). Also, an increasing number of experimental studies showed disease risk factors or health-related fitness measures to be significantly improved in sedentary adults as a result of adherence to a program of regular walking or other moderate-intensity activity (35-37). During this time, a team of Canadian exercise scientists organized two major international conferences on Exercise, Fitness and Health (38) and Physical Activity, Fitness and Health (39). For both conferences, the goal was to understand the relationship of physical activity and fitness to major health outcomes, develop a conceptual model for these relationships, and formulate a consensus statement. These conferences and publications provided an excellent resource for the developing consensus that a physically inactive lifestyle is a major contributor to poor health outcomes throughout the lifespan.

In 1992, in light of the mounting evidence that a sedentary lifestyle significantly increased the risk of CHD morbidity and mortality, the AHA made sedentary lifestyle its fourth major CHD risk factor, joining cigarette smoking, hypertension, and hypercholesterolemia (40). This statement was the first formal recognition by the AHA that physical inactivity was a major independent risk factor for atherosclerotic heart disease and that physical activity could play a role in both primary and secondary prevention of CHD. This document went beyond recognizing just the benefits of exercise for heart disease to stating that people of all ages could benefit from a regular exercise program. It noted that activities such as walking, hiking, swimming, cycling, tennis, and basketball were especially beneficial if performed at 50% or more of a person's work capacity and that even low-intensity activities performed daily could have some long-term health benefits. This statement has been updated over the years by the AHA but without major changes in the key statements made in 1992; the most recent update was published in 2003 (41).

Given the influential nature of official position statements or recommendations by the AHA on heart disease prevention and treatment practices by the medical community in the United States, the elevation of inactivity to a major CHD risk factor brought substantial attention to the importance of a physically active lifestyle. Although this statement indicated the general nature of the activity that should be performed to help maintain good health, it lacked specific details regarding program design and implementation. However, it did indicate that intensities lower than that generally promoted in the past could provide health benefits.

In 1993, the year following the AHA statement recognizing inactivity as a major CHD risk factor, the CDC in collaboration with the ACSM, began developing a document that would provide specific recommendations about the profile of physical activity that should be performed to promote good health. To develop this statement, an expert panel was appointed that consisted of epidemiologists, exercise physiologists, public health professionals, and health psychologists. The panel was charged with developing a statement grounded in solid science that would clearly communicate its key messages to the public and provide a program that could be performed by a large segment of the general public with a minimal increase in risk. It took 2 years of work by the panel before *Physical Activity and Public Health: A Recommendation from the Centers for Disease Control and Prevention and the American College of Sports Medicine* was released to the public in 1995 (8). These first public health guidelines on physical activity and health were the culmination of a decade of work that began in 1984 with the CDC Workshop on the Epidemiological and Public Health Aspects of Physical Activity and Exercise.

The approach to physical activity for health taken by these "public health" guidelines was quite different than prior guidelines primarily based on the "exercise training" or "clinical" paradigm. The primary recommendation was that "Every American adult should accumulate 30 minutes or more of moderate-intensity physical activity on most, preferably all, days of the week." Because many of the prior recommendations had primarily advocated vigorous-intensity activity, having moderate-intensity activity as the key recommendation (even though prior guidelines based on vigorous-intensity exercise were recognized as still effective) raised many questions by exercise scientists and practitioners. The idea that substantial health benefits could be derived from brisk walking was not appreciated by many fitness advocates, but this recommendation was based on data from a variety of epidemiologic and experimental studies. Even more controversial was the idea that the activity each day did not need to be performed continuously for at least 30 minutes, but could be *accumulated* throughout the day in bouts of 8 to 10 minutes. For many years, the idea that the activity needed to be continuous to be effective had been promoted in programs such as "Aerobics" (42) but without any scientific evaluation. In retrospect, the recommendation for accumulated bouts appears to have been correct. However, in 1995, the published scientific data supporting this concept was quite limited, and remains so today. Only several experimental studies had directly compared the effects of continuous exercise bouts versus exercise accumulated through bouts of 8 to 10 minutes duration (43-45), and the nature of data collection in epidemiologic studies made the evaluation of the accumulation concept difficult, at best, to evaluate.

Following close on the heels of the CDC/ACSM report, the National Institutes of Health (NIH) convened a consensus conference on "Physical Activity and Cardiovascular Health" (46). The charge to this nonfederal, non-advocate 13-member panel representing cardiology, psychology, exercise physiology, nutrition, pediatrics, public health and epidemiology was "to provide physicians and the general public with a responsible assessment of the relationship between physical activity and cardiovascular health." During the 3-day conference, the panel listened to reports from 27 scientists on the relationship between physical activity and cardiovascular health, had open discussions with the presenting scientists and others in attendance, and held closed deliberations to formulate their recommendations. The draft recommendations were shared with conference participants and conflicting views were resolved and a final document produced.

The panel concluded that: (1) most Americans have little or no physical activity in their daily lives; (2) accumulating evidence indicates that physical inactivity is a major risk factor for cardiovascular disease; (3) moderate levels of physical activity confer significant health benefits; (4) all Americans should engage in regular physical activity at a level appropriate to their capacity, needs and interests; and (5) children and adults should set a goal of accumulating at least 30 minutes of moderate intensity physical activity on most, and preferably all, days of the week.

The panel also recognized that a greater amount and/or intensity of activity than the recommended minimum would provide greater health benefits for most people (i.e., dose response) and that cardiac patients should integrate increased physical activity into a comprehensive program of risk reduction. Thus, the panel made recommendations highly consistent with the CDC/ACSM working group in that it emphasized performing moderate-intensity physical activity (using brisk walking as a benchmark) on most or all days for at least 30 minutes per day, and noted the activity could be accumulated in bouts of at least 8 to 10 minutes duration. It also recognized that its recommendation was a minimum, and greater health benefits were achievable by performing greater amounts of activity or through "vigorous exercise." In other words, the prior recommendations of vigorous exercise performed for 20 to 30 minutes 3 days per week still applied.

At the same time the NIH was producing its consensus panel report, the World Health Organization also issued a report on the health benefits of regular activity (47). The major recommendations in this document were very consistent with recommendations made by the CDC/ACSM working group and the NIH consensus panel, namely that a target for all adults should be 30 minutes or more of moderate-intensity physical activity on most days. The WHO report also stated that daily physical activity should be the cornerstone for a healthy lifestyle throughout the lifespan; that more vigorous exercise, such as slow jogging, cycling, field and court games, and swimming, could provide additional health benefits; and that people with disabilities or chronic disease had a great deal to benefit from an individualized activity program. While recognizing that the responsibility for personal health decisions ultimately lies with the individual and family, policy recommendations for increasing physical activity were included in the report as well for major government organizations.

The CDC/ACSM, NIH, and WHO reports on physical activity and health, all published in 1995 and 1996, set the stage for the publication of *Physical Activity and Health: A Report of the Surgeon General* in 1996 (11). This report was commissioned by the Secretary of Health and Human Services in 1994 and authorized the CDC to be the lead agency for its development with collaboration from a number of federal organizations, especially the President's Council on Physical Fitness and Sports and the NIH. Non-government collaborating organizations included the ACSM, AHA, and the American Association of Health, Physical Education, Recreation and Dance. This was an extensive undertaking, and approximately 195 people contributed to writing, editing, reviewing, and publishing the report.

The stated goal of the Surgeon General's report was to summarize the existing literature on the role of physical activity in preventing disease and on the status of interventions to increase physical activity. It provided an historical background on the relation of physical activity to health, including the evolution of physical activity guidelines, looked at patterns and trends of physical activity in different populations in the United States, and described various projects to promote increased physical activity in youth and adults. It also summarized information on acute and chronic physiological responses to exercise and provided a systematic review of the effects of physical activity on major health outcomes. The report grew out of an emerging consensus among investigators and providers working in exercise science, epidemiology, public health, clinical medicine, health psychology, and education that the high prevalence of sedentary behavior among the American population was having a significant negative health impact, that a moderate amount and intensity of physical activity in this sedentary population could provide important health benefits, and that innovative, long-term programs were needed to reverse the continuing downward trend in physical activity.

The key recommendation from the Surgeon General's report was that people of all ages could improve the quality of their lives through a lifelong practice of moderate-intensity physical activity: "A regular, preferably daily, regimen of at least 30 to 45 minutes of brisk walking, bicycling, or even working around the house or yard will reduce the risk of coronary heart disease, hypertension, colon cancer and diabetes." A second key message was that "more is better." People already performing a moderate level of activity would benefit even more by increasing the intensity and/or duration of their activity. Both the CDC/ACSM report and the report by the Surgeon General have been cited frequently in the professional literature on physical activity and health, and the key recommendations, usually with no or only minor modifications, have been adopted by national agencies in a number of other countries.

To help assess the information available on the dose of physical activity needed for specific health outcomes, an international "consensus symposium" was held at Hockley Valley, Ontario, Canada in 2000 (48). The goal of this evidence-based symposium was to provide a comprehensive review of the existing science relating physical activity dose to health and to make specific recommendations regarding physical activity dose. The major conclusion regarding the dose-response relation for specific outcomes was that the available data were still inadequate to define any precise relation. However, the consensus panel did endorse the recommendations made in the CDC/ACSM report (8) and the Surgeon General's report (11).

The Institute of Medicine Report

In 2002, the Institute of Medicine (IOM) published a report primarily focusing on macronutrient intake and energy intake and expenditure. The report developed estimates of daily intake that are compatible with good nutrition throughout the life span and that may decrease the risk for chronic disease (49). The preparation of this report by the IOM, a private nonprofit organization and component of the National Academy of Sciences, was funded by HHS, the US Department of Agriculture (USDA), the US Department of Defense, and Health Canada. The panel considered the level of macronutrient, and thus caloric intake, consistent with good health and the caloric expenditure needed to keep people in a healthy weight range, defined as a body mass index (BMI) of 18.5 to 25.0 kg/m^2. For people to achieve these goals, the panel concluded the following regarding physical activity:

"Physical activity promotes health and vigor. Cross-sectional data from a doubly labeled water database were used to define a recommended level of physical activity, based on the physical activity level (PAL) associated with a normal body mass index (BMI) range of 18.5 to 25 kg/m^2. In addition to the activities identified with a sedentary lifestyle, an average of 60 minutes of daily moderate intensity physical activity (e.g., walking/jogging at 3 to 4 miles/hour) or shorter periods of more vigorous exertion (e.g., jogging for 30 minutes at 5.5 miles/hour) was associated with a normal BMI and therefore is recommended for normal-weight individuals. This amount of physical activity leads to an 'active' lifestyle, corresponding to a PAL greater than 1.6 (see Chapter 5). Because the Dietary Reference

Intakes are provided for the general healthy population, recommended levels of physical activity for weight loss of obese individuals are not provided." (p.880).

Upon the release of this report, many in the press, general public, and health professions considered that the report had articulated a significant change in physical activity recommendations for health, with the target now being 60 minutes of moderate-intensity activity daily rather the 30 minutes or more that had been promoted since 1995. However, it is very important to understand that the prior recommendations by CDC, ACSM, NIH, and HHS were based primarily on the amount of physical activity shown to be consistent with lower morbidity and mortality rates from selected chronic diseases and all-cause mortality, and not on the amount for achieving an optimal BMI of 18.5-25.0 kg/m^2, which was the major goal of the IOM report. Also, in the IOM report, the 60-minute recommendation was made in order to achieve *all* the identified health benefits fully, while in the other reports, the 30 or more-minute recommendation was considered a minimum. The other reports acknowledged that more exercise would bring additional benefits. As with the prior reports, the IOM document indicated that activity could be accumulated throughout the day and did not need to be performed only in a single session.

A key difference in the data considered during the formulation of the IOM recommendation versus other previous physical activity recommendations was the IOM panel's emphasis on doubly-labeled water studies. Combining data from available doubly-labeled water studies, the panel estimated the total daily energy expenditure of men and women who had a BMI of 18.5 to 25.0 kg/m^2. They determined that these subjects had an average PAL of about 1.75. The panel then took the PAL of people considered to be sedentary (1.25) and that of people considered to be of normal weight (1.75) then calculated the difference in PAL between people who were sedentary and those who were normal weight and converted this to minutes per day of moderate-intensity activity. Not taken into this consideration was the fact that the PAL for the subjects in the doubly-labeled water studies who were overweight or obese was not 1.25 but in the 1.59 to 1.85 range (50). These cross-sectional data do not deal with the question of how much added exercise will produce a meaningful change in body weight.

The IOM selection of a target activity level of 60 minutes per day or a PAL of 1.6 or greater to maintain optimal body weight is somewhat less than the target PAL of 1.75 in the 1998 report by the World Health Organization, *Obesity: Preventing and Managing the Global Epidemic* (51). In this extensive report, the authors stated that analyses of more than 40 national physical activity studies worldwide show a significant relationship between the average BMI of adult men and their PAL, with the likelihood of becoming overweight being substantially reduced at PALs of 1.8 or above. For women, the PAL associated with a healthy weight was approximately 1.6. Therefore, the WHO report suggested "that people should remain physically active throughout life and sustain a PAL of 1.75 or more in order to avoid excessive weight gain" (p.124).

In 2002, an international group of scientists with expertise in physical activity, nutrition, energy balance and obesity held a consensus meeting convened by the International Association for the Study of Obesity to assess "how much physical activity is enough to prevent unhealthy weight gain" (52). Part of their conclusion was that, "The current physical activity guideline for adults of 30 minutes of moderate intensity activity daily, preferably all days of the week, is of importance for limiting health risks for a number of chronic diseases, including coronary heart disease and diabetes. However, for the prevention of weight gain or regain this guideline is likely to be insufficient for many individuals in the current environment. There is compelling evidence that prevention of weight regain in formally obese individuals requires 60 to 90 minutes of moderate intensity activity or lesser amounts of vigorous activity. Although definitive data are lacking, it seems likely that moderate intensity activity of approximately 45 to 60 minutes per day or 1.7 PAL is required to prevent the transition to overweight or obesity" (page 101). This consensus statement recognized that the amount of physical activity associated with lower chronic disease mortality rates is very likely less than that needed in the current environment to prevent unhealthy weight gain or regain in many adults.

Dietary Guidelines for Americans, 2005

Every 5 years, the USDA and HHS are required by the US Congress to prepare *Dietary Guidelines for Americans*. The Guidelines published in 1995 and 2000 recognized that a physically active lifestyle should be maintained for optimal health, but no specific guideline focused on prevention of weight gain or weight loss. For example, in 2000 the recommendations were highly consistent with the 1995 CDC/ACSM report directed to improving general health status: "Aim to accumulate at least 30 minutes (adults) or 60 minutes (children) of moderate intensity activity on most days of the week, preferably daily. If you already get 30 minutes of physical activity daily, you can gain even more health benefits by increasing the amount of time you are physically active or by taking part in more vigorous activities. No matter what activity you choose, you can do it all at once, or spread it out over two or three times per day" (53), p.10.

The 2005 *Dietary Guidelines for Americans* structured the physical activity recommendations to separate advice about chronic disease prevention from advice about the amount of physical activity required for the prevention of unhealthy weight gain or regain or achieving weight loss in adults (54). They took the generally accepted position that a variety of health benefits are derived from at least 30 minutes of moderate-intensity exercise on most days, and separated this recommendation from the less well documented and understood recommendations regarding the amount of physical activity required to prevent unhealthy weight gain or regain and weight loss. The physical activity recommendations needed to help manage body weight were adopted in large part from the 2002 IOM report (49), which had primarily considered cross-sectional data from doubly-labeled water studies of energy expenditure (55). To help adults manage body weight and prevent gradual unhealthy weight gain, the *Guidelines* recommended approximately 60 minutes of moderate/vigorous activity on most days of the week (while not exceeding calorie requirements). To help adults lose weight and to sustain weight loss, the *Guidelines* recommended at least 60 to 90 minutes of daily moderate-intensity physical activity daily (while not exceeding calorie requirements). These two recommendations regarding weight gain prevention and weight loss received the most attention and contributed to some confusion among the public.

2007 American College of Sports Medicine and American Heart Association Physical Activity Recommendations

In 2002, the ACSM and CDC organized an expert panel to consider whether the 1995 CDC/ACSM physical activity and public health recommendations needed to be updated (8). Key reasons for this consideration included new scientific evidence since 1995 relating physical activity to health, physical activity recommendations by various organizations in the interim that appeared to be in conflict with the 1995 recommendations, and communications issues related to certain terminology used in the 1995 report. The panel decided that an update would be of value to health professionals and the public, and two writing groups were formed, one to prepare recommendations for adults (18 to 65 years) and another for older adults (older than 65 years). The purpose of these reports was to update and clarify the 1995 recommendations on the types and amounts of physical activity needed by healthy adults and older adults to improve and maintain health. These groups 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.

The writing groups prepared the two manuscripts, intending that the recommendations would represent an update from CDC and ACSM. However, after extensive review at CDC and HHS, it was decided that because physical activity recommendations for adults had been published as part of the 2005 *Dietary Guidelines for Americans* that CDC should not issue additional physical activity recommendations. ACSM representatives then asked the AHA to participate in issuing the updated recommendations, and the two sets of recommendations were published in 2007 (56;57). No major changes were made in the recommendations either for adults or older adults but a number of features about the type and amount of activity most likely to provide various benefits were clarified. Also, issues regarding the role of physical activity in body weight management were addressed and resistance exercise was made part of the core recommendation for all adults.

Primary recommendations for adults included the following:

- To promote and maintain health, all healthy adults aged 18 to 65 years need moderate-intensity aerobic (endurance) physical activity for a minimum of 30 minutes on 5 days each week or vigorous-intensity aerobic physical activity for a minimum of 20 minutes on 3 days each week. 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 minutes twice during the week and then jogging for 20 minutes on 2 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-minute minimum by performing bouts each lasting 10 or more minutes. 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 2 days each week. 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.

The recommendations for older adults are very similar to the updated ACSM/AHA recommendations for adults, but have several important differences. For example, the recommended intensity of aerobic activity takes into account the older adult's aerobic fitness, activities that maintain or increase flexibility are recommended, and balance exercises are recommended for older adults at risk of falls. In addition, older adults are encouraged to have an activity plan for achieving recommended physical activity that integrates preventive and therapeutic recommendations. The promotion of physical activity in older adults places more emphasis on moderate-intensity aerobic activity, muscle-strengthening activity, reducing sedentary behavior, and risk management.

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