Be Physically Active Each Day. How Can We Know?¹

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ABSTRACT For the first time in its five versions, Nutrition and Your Health: Dietary Guidelines for Americans contains an apparently nondietary guideline recommending physical activity. Although new as a separate guideline, physical activity has been included in the weight guideline of previous versions. The current version recognizes the importance of physical activity to health beyond its effect on weight maintenance. The purpose of this paper is to examine what data are available or required to evaluate the level of physical activity in the population, particularly in light of current recommendations. The physical activity sections of several national surveys that assess individual behavior or activity-related policies are described. Surveillance of physical activity as a risk factor for chronic disease is critical because physical inactivity is highly prevalent, strongly associated with increased morbidity and mortality, costly and preventable. Determinants of physical activity behavior are also considered. These determinants are potentially important factors for surveillance and are critical components for planning successful interventions. J. Nutr. 131: 451S-460S, 2001.

KEY WORDS: • guideline • surveillance • health surveys • exercise • physical activity

In 2000, for the first time in its five versions and 20-year history, Nutrition and Your Health: Dietary Guidelines for Americans (1) will contain guidance that, at a glance, is not related to dietary consumption. The second statement under the basic message, Aim for Fitness, is “Be physically active each day.” Although new as a separate guideline in 2000, physical activity held a prominent position in the body weight guideline of the 1995 edition of the Dietary Guidelines, “Balance the food you eat with physical activity–maintain or improve your weight” (2). Furthermore, physical activity or exercise has been part of dietary recommendations since the 1970s, when guidance evolved from amelioration of deficiencies to avoidance of chronic disease. Before this latest version, physical activity was most frequently presented in the Dietary Guidelines as a means to help control body weight. However, cardiovascular benefits and other health effects of increasing physical activity were noted two decades earlier in Healthy People: The Surgeon General's Report on Health Promotion and Disease Prevention (3) and in guidance publications from other organizations such as the American Heart Association, the President’s Council on Physical Fitness and Sports, and the American College of Sports Medicine (ACSM)³ (4).

The 2000 Dietary Guidelines Advisory Committee recommended separating most of the discussion of physical activity from the weight guideline and adding a separate guideline on physical activity (5). These changes were recommended because of increasing recognition of the multifaceted relationships between nutrition and physical activity that go beyond weight management, awareness of the extensive health benefits of physical activity contrasted with the lack of physical activity levels adequate to achieve health benefits in the United States, and the recognized need for people in every age group to increase their physical activity levels regardless of their weight status. The Committee's report noted the need for a separate physical activity guideline to "provide a clearer, more understandable, and more forceful message to consumers."

The new guideline notes that persons of all ages benefit from regular physical activity. The recommendation is that adults should aim to accumulate at least 30 min of moderate physical activity daily and children should aim for at least 60 min daily. Physical activity can be included in daily routine activities or as part of a structured exercise program. It can be done all at once, or over 2–3 shorter bouts of activity. Those

¹ Published as a supplement to The Journal of Nutrition. The publication of this supplement was sponsored by the National Cancer Institute, National Institutes of Health, Bethesda, MD. The guest editor for this publication was Susan M. Krebs-Smith, NCI, NIH, Bethesda, MD.
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³ Abbreviations used: ACSM, American College of Sports Medicine; ATS, American Travel Survey; AWHP, Association for Worksite Health Promotion; BRFSS, Behavioral Risk Factor Surveillance System; CDC, Centers for Disease Control and Prevention; DLW, doubly labeled water; DOT, Department of Transportation; NCCDPHP, National Center for Chronic Disease Prevention and Health Promotion; NCHS, National Center for Health Statistics; NHANES, National Health and Nutrition Examination Survey; NHIS, National Health Interview Survey; NPTS, Nationwide Personal Transportation Survey; PE, physical education; SHPPS, School Health Policies and Programs Study; SMARTRAQ, Strategies for Metropolitan Atlanta’s Regional Transportation and Air Quality; YRBS, Youth Risk Behavior Survey.

0222-3166/01 $3.00 © 2001 American Society for Nutritional Sciences.
who already achieve the recommended minimum level of activity are encouraged to gain further benefits by increasing the time or intensity of physical activity. The benefits of activities for strength and flexibility as well as those for aerobic fitness are promoted, with attention to the effects of strengthening activities on bone health and improved functional ability of older persons. These recommendations echo those in Physical Activity and Health: A Report of the Surgeon General (4) and the joint recommendation from the Centers for Disease Control and Prevention (CDC) and the ACSM (6).

This clearer, more forceful message in the Dietary Guidelines is presumably needed because the American public is generally sedentary, despite continuing alarm over perceived declines in physical activity and the plethora of information about the many benefits of physical activity. For example, in a 1989 presentation (published in 1993), Ralph Paffenbarger noted, “Never before have there been so many sedentary individuals as in our Western World today... The adverse effects of these developments on public health have become increasingly obvious and now are widely recognized” (7). This was not a new message. In Healthy People: The Surgeon General’s Report on Health Promotion and Disease Prevention (3), we find, “For more than a generation, American living has become increasingly sedentary... The relative lack of physical activity has led to a decline in physical fitness among youth and adults alike.” Interestingly, these two statements made a decade apart also sounded a hopeful note of a recent resurgence in positive attitudes and promotion of physical activity, exercise and fitness. However, in the preface to the more recent Physical Activity and Health: A Report of the Surgeon General (4), Acting Surgeon General Audrey Manley wrote, “We must get serious about improving the health of the nation by affirming our commitment to healthy physical activity on all levels: personal, family, community, organizational, and national... current levels of physical activity among Americans remain low, and we are losing ground in some areas.”

In light of the increased focus on physical activity in the Dietary Guidelines, the goal of this paper is to examine how we evaluate the level of physical activity in the population. That is, how can we conduct surveillance of physical activity? Surveillance of physical activity as a risk factor for chronic disease is critical because inactivity is highly prevalent, strongly associated with increased morbidity and mortality, costly and preventable (8). Furthermore, population assessment is necessary for monitoring progress toward achieving the recommendations of the Dietary Guidelines (1) and the similar recommendations that are further detailed and quantified in Healthy People 2010, Health Objectives for the Nation (9). In addition to considering what measures are available and what measures are still needed, we will address determinants of physical activity. Determinants of behavior are potentially important factors for surveillance and are critical to planning successful interventions.

**How do we measure physical activity?**

Physical activity is defined as “any bodily movement produced by skeletal muscles that results in energy expenditure” (10). Yet the behavior described by this simple term is complicated to assess. Physical activity can occur in multiple contexts for different purposes, i.e., transportation, occupation (paid or unpaid), household maintenance or child care tasks, and recreation (for leisure time). There are different types of physical activity that lead to improvements in cardiorespiratory endurance, muscle strength, flexibility, coordination or combinations of these attributes. To quantify physical activity, it is necessary to measure the frequency and duration of episodic occurrences. If an estimate of energy expenditure or distinction based on degree of exertion is desired, assessment of intensity of performance is also required. Increasingly, there is interest in measures of inactivity, such as time spent watching television, using a computer or in other sedentary pursuits.

The assessment of physical activity has received much attention in workshops and published reviews [e.g., 11, 12]. Rather than repeat all that has been stated previously, this paper will concentrate on aspects of assessment that are particular to surveillance of physical activity at the state or national level. In particular, this discussion will concentrate on the assessment instruments that have been used or are being developed for use in surveys to describe the population of the United States.

**Objective measures**, such as energy expenditure assessed by the doubly labeled water (DLW) method or movement recorded by an accelerometer, seem straightforward choices for evaluating physical activity. However, measures or estimates of resting metabolic rate and the thermic effect of food are required to partition activity energy expenditure from total energy expenditure measured by DLW. Furthermore, information on behavioral aspects such as type of activity, frequency, duration and intensity are not obtained from DLW assessments without additional measures that compromise the desirable noninvasive aspect of the DLW method. Because of the cost of the stable oxygen isotope, DLW is not feasible for use in population studies. Accelerometers are able to capture frequency and duration of distinct bouts of activity and can be calibrated to provide a measure of intensity. However, accelerometers underestimate or miss certain types of activity because of placement (e.g., cycling with waist placement) or under incompatible conditions (e.g., swimming). Activity monitors have not yet been used in population studies, but their feasibility of their use in surveys may be increasing. In most large studies, physical activity is assessed by some form of questionnaire, either filled out by the respondent or collected by interview.

**Historical and current monitoring of physical activity**

A framework for examining efforts to monitor physical activity can be found in the series of objectives for the nation that grew out of the first Surgeon General’s Report on Health Promotion and Disease Prevention (3). The first objectives were published in Promoting Health/Preventing Disease: Objectives for the Nation (13), setting goals for 1990, and the most recent are found in Healthy People 2010 (9). In setting targets for 1990, there were 11 objectives for physical activity and fitness, including four quantifiable objectives targeting individual behavior (two for youth aged 10–17 y, one for adults aged 18–65 y, one for adults ≥65 y old) and four objectives for improved surveillance/evaluation systems. Two objectives targeted awareness and one targeted provision of employer-sponsored fitness programs. Three of the seven objectives with quantitative targets had no baseline data available. Data sources at the national level were the National Health Interview Survey (NHIS) and three one-time surveys conducted for private corporations. Data at the state or local level were available only for selected states from the Councils on Physical Fitness. There were two surveillance objectives and two evaluation system objectives in Promoting Health/Preventing Disease: Objectives for the Nation (13). The surveillance objectives sought to establish a methodology to address the physical fitness of children aged 10–17 y in a systematic manner and to provide data for regular monitoring of national trends and patterns of...
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Table 1
Physical activity and fitness objectives in Healthy People 2010

Goal: Improve health, fitness, and quality of life through daily physical activity

Physical activity in adults
22–11 Reduce the proportion of adults who engage in no leisure-time physical activity
22–2 Increase the proportion of adults who engage regularly, preferably daily, in moderate physical activity for at least 30 minutes per day
22–3 Increase the proportion of adults who engage in vigorous physical activity that promotes the development and maintenance of cardiorespiratory fitness 3 or more days per week for 20 or more minutes per occasion

Muscular strength/endurance and flexibility
22–4 Increase the proportion of adults who perform physical activities that enhance and maintain muscular strength and endurance
22–5 Increase the proportion of adults who perform physical activities that enhance and maintain flexibility.

Physical activity in children and adolescents
22–6 Increase the proportion of adolescents who engage in moderate physical activity for at least 30 minutes on 5 or more of the previous 7 days
22–7 Increase the proportion of adolescents who engage in vigorous physical activity that promotes cardiorespiratory fitness 3 or more days per week for 20 or more minutes per occasion
22–8 Increase the proportion of the Nation’s public and private schools that require daily physical education for all students
22–9 Increase the proportion of adolescents who participate in daily school physical education
22–10 Increase the proportion of adolescents who spend at least 50 percent of school physical education class time being physically active
22–11 Increase the proportion of children and adolescents who view television 2 or fewer hours per school day

Access
22–12 (Developmental) Increase the proportion of the Nation’s public and private schools that provide access to their physical activity spaces and facilities for all persons outside of normal school hours (that is, before and after the school day, on weekends, and during summer and other vacations)
22–13 Increase the proportion of worksites offering employer-sponsored physical activity and fitness programs
22–14 Increase the proportion of trips made by walking
22–15 Increase the proportion of trips made by bicycling

1 Objective numbers in Healthy People 2010 (9).

participation in physical activity. This second objective singled out the need for data on participation in public recreation programs in community facilities. The evaluation objectives prescribed that, by 1990, data should be available to allow evaluation of the short- and long-term health effects of participation in programs of appropriate physical activity. Furthermore, data should be available to evaluate the effect of participation in physical fitness programs on job performance and health care costs.

Data availability has come a long way in two decades. In Healthy People 2010 (9), there are 15 objectives for physical activity and fitness (Table 1). Where possible, baseline data for adults are presented by up to 28 subpopulations defined by race and ethnicity, gender, age, education level, geographic location, disability status or presence of arthritis symptoms. For children and adolescents, data are presented by up to 34 categories, with categories defined by gender, race and ethnicity, grade in school, parents’ education level or family income level. New with Healthy People 2010 is a set of Leading Health Indicators, which is a small subset of objectives selected on the basis of their ability to motivate action, availability of data to monitor progress and relevance as broad public health issues. Physical activity is a Leading Health Indicator with two objectives, one for adults and one for adolescents (Objectives 22–2 and 22–7).

The physical activity and fitness objectives in Healthy People 2010 (Table 1) are grouped under four headings that have different data sources. The data source for objectives under physical activity in adults and muscular strength/endurance and flexibility is the NHIS. For physical activity in children and adolescents, the Youth Risk Behavior Survey (YRBS) provides data. Data for access come from several sources. Access to school facilities (a developmental objective) will potentially be tracked with the School Health Policies and Programs Study (SHPPS), conducted by the CDC’s National Center for Chronic Disease Prevention and Health Promotion (NCCDPHP). Data on employer-sponsored fitness programs come from the National Worksite Health Promotion Survey, conducted by the Association for Worksite Health Promotion (AWHP). Data on trips made by walking and bicycling come from the Nationwide Personal Transportation Survey (NPTS), conducted by the United States Department of Transportation (DOT).

The Behavioral Risk Factor Surveillance System (BRFSS) and the National Health and Nutrition Examination Surveys (NHANES) were not included in Healthy People 2010 physical activity and fitness objectives as data sources. However, these two data surveys will be considered along with those that provide data for Healthy People 2010. BRFSS provides data on physical activity at the state level and was used as the source for baseline data on light-to-moderate physical activity in Healthy People 2000. The NHANES has not been a major source of physical activity data in the past, but has potential for future applications.

Sources of data for Risk Reduction Objectives

National Health Interview Survey. The NHIS, a cross-sectional household interview survey, is a primary source of data on physical activity participation among adults ≥18 years old. Sampling and interviewing are continuous throughout each year, with data collected annually from ~43,000 households including ~106,000 persons. In 1985, 1990, 1991, 1995, and 1998, NHIS included a section in either the core interview or a supplement on “exercise” that collected information on all activities reported as exercise, sports or physically active hobbies performed during the 2-wk period before interview. Information on participation in ~20 listed activities was requested; reporting of other activities was also allowed. For each activity reported, the respondent was asked about frequency of participation over the 2-wk period, average duration of each occurrence and degree of increase (none, small, moderate, large) in heart rate or breathing as a measure of intensity. Over the years, changes to the physical activity assessment have occurred that complicate physical activity trend comparisons. In 1991, age exclusions on inquiries about certain activities were removed and several items were dropped, added or reworded. Before 1991, there were questions about hard physical work on the job, assessment of activity relative to age peers, and knowledge and attitudes about exercise. In 1991, respondents were asked about physician recommendations to begin or continue exercise or physical activity.

NHIS underwent a major redesign for the 1997 and subsequent surveys. In planning for the redesign, a comprehensive physical activity assessment was developed that included phys-
physical activity in the contexts of recreation (leisure time), transportation, household tasks and occupation. Within recreation, overall frequency and duration of vigorous and light or moderate activities would be ascertained as well as a listing of the activities done. Similar questions on strengthening and stretching activities were included with the addition of a question on what muscle groups were targeted for strengthening or stretching. Transportation activity would be assessed by asking about frequency and duration of walking or bicycling to and from work, school or errands. Household activity would be assessed by asking about frequency and duration of strenuous tasks in or around the home, as well as a listing of the tasks done. One question assessed job-related activities by asking the respondent to choose one of four statements that described moving around and lifting tasks.

Time constraints led to this redesigned physical activity assessment being split between the core interview and periodic supplements. Questions on frequency and duration of vigorous and light or moderate activities and the frequency of strengthening activities were included in the core interview. Further detail and the additional questions were reserved for periodic modules. Modules with these questions have not been included in NHIS to date. However, a 1998 supplement to monitor progress toward the Healthy People 2000 objectives repeated the physical activity assessment as it was administered in 1991.

NHIS primarily provides data for adults on participation in leisure time physical activity. A rough estimate of activity from occupation is available from the 1985 and 1990 surveys. Absence of reported leisure-time physical activity has been used to estimate prevalence of a sedentary lifestyle. Further information about NHIS, including recent questionnaires and information on obtaining data can be found on the National Center for Health Statistics (NCHS) web site at [http://www.cdc.gov/nchs/nhis.htm](http://www.cdc.gov/nchs/nhis.htm).

### Behavioral Risk Factor Surveillance System.

The BRFSS is another important source of information on physical activity participation among adults. BRFSS is a random-digit-dialed telephone survey now conducted in all 50 states and the District of Columbia. It is the only national data system that provides information at the state level. Since 1986, physical activity has been assessed in BRFSS with a series of questions about exercise, recreation or physical activities other than regular job duties performed over the past month. Follow-up questions on what activity was performed, frequency and duration (as well as distance for running, jogging, walking or swimming) are asked about up to two activities that provided the most exercise during the period of interest.

The BRFSS is also undergoing evolution, and a new set of physical activity questions is being pilot tested for use from 2001. One question on the core interview will ask the respondent to categorize their work activity as mostly sitting or standing, walking, or heavy labor or physically demanding work. Other questions will ask frequency (days per week) and duration (total time) of moderate and vigorous activities performed outside of work during a usual week. To provide data to enable continued comparison of inactivity with inactivity in earlier years, a question will ask whether respondents participated during the past month in any physical activities or exercises outside of work. Optional questions for inclusion assess walking for any reason during a usual week, including frequency and duration, and frequency of strengthening activities in a usual week. The new BRFSS questions will have the distinction of being the first physical activity questions for a national survey that will have undergone extensive reliability and validity testing, in addition to the cognitive testing commonly used to refine national survey questions.

BRFSS primarily provides data on participation in leisure time physical activity. No reported leisure time activity has been used to estimate sedentary lifestyle. After 2001, the new questions will allow some adjustment for level of occupational activity. Further information about BRFSS, including English and Spanish language questionnaires, can be found on the NCCDPHP web site at [http://www.cdc.gov/nccdphp/brfss/](http://www.cdc.gov/nccdphp/brfss/).

### National Health and Nutrition Examination Survey.

Before NHANES III (1988–1994), this survey was not useful for monitoring physical activity. The physical activity questions in NHANES I (1971–1974) and II (1976–1980) were categorical reports of exercise (little or no, moderate or much) in recreation and activity aside from recreation (inactive, moderately or very active). NHANES III improved the physical activity assessment to some extent by asking for the frequency over the past month of walking a mile or more and of performing eight specific activities from the NHIS list, with the option of adding up to four other activities. Unfortunately, as is often the case, time constraints required shortening the questionnaire. In NHANES III, the need to remove items led to elimination of duration and intensity assessment. NHANES III can provide estimates of inactivity but cannot be used to estimate quantity of physical activity or prevalence of meeting physical activity recommendations.

NHANES 1999 and beyond will be a valuable resource for physical activity surveillance. In this survey, participants aged 12–49 y, without disqualifying health conditions, perform a submaximal treadmill test, providing the first fitness data on a nationally representative sample. These fitness data will also provide the ability to validate the improved physical activity assessment in NHANES. Respondents ≥16 y old are asked about physical activity over the past 30 d in transportation, household tasks, usual daily activities, recreation (leisure time) and sedentary activities. Respondents aged 12–15 y are asked the same questions with the exception of those for household tasks and usual daily activities. Young people aged 2–15 y (or their proxy if <12 y old) are asked about time spent watching TV and videos and time using a computer or video games on the previous day.

Transportation assessment includes frequency and duration of walking or bicycling for travel to work, school or errands. Daily activities are assessed by questions about frequency and duration of household tasks requiring at least moderate physical effort and by a question that asks respondents to describe their usual daily activities by choosing one of four statements related to moving around and lifting. Recreational activity is assessed by asking about exercises, sports and physically active hobbies done in leisure time or at school over the past 30 d. Respondents are asked to report the vigorous and then the moderate activities they have done. After reporting each set of activities (up to 4 in each intensity category), frequency and duration of each activity are requested. Frequency of strengthening activities over the past 30 d is also assessed. Respondents ≥16 y old are asked about the number of hours spent sitting and watching TV or videos or using a computer outside of work. For comparison to NHANES III, younger respondents are asked about watching TV/videos and computer/video game use on the previous day.

NHANES 1999 and beyond will provide data on participation in leisure time physical activity, with information on specific activities similar to that collected in NHIS in 1998 and earlier. Additionally, NHANES will provide less detailed
data on activity achieved through transportation, household tasks and occupation. As with NHIS and BRFSS, the absence of reported activities can be used to estimate prevalence of a sedentary lifestyle. However, NHANES also includes questions specifically addressing sedentary activity. Further information about NHANES, including current questionnaires and how to obtain NHANES III data, can be found on the NCHS web site at http://www.cdc.gov/nchs/nhanes.htm.

**Youth Risk Behavior Survey.** NHANES III and later NHANES provide information about sedentary activities for youth, and also include a question asking how many times per week a child (aged 2–11 y) exercises or plays hard enough to make him/her sweat and breathe hard. However, the main source for physical activity data on youth is the YRBS. This school-based (grades 9–12) self-administered survey of risk factors is administered nationally every other year. YRBS questions were also included with the 1992 NHIS for respondents aged 12–21 y. The 1999 survey included eight questions about physical activity. Students were asked about the number of days in the past 7 d that they exercised or participated in vigorous physical activity for at least 20 min. They were asked similar questions about moderate activities of at least 30 min and about strengthening activities. Other questions asked about number of hours of TV watched on an average school day, number of days per week that include physical education (PE) classes, and the time spent actually exercising or playing sports in a PE class. Students were asked on how many sports teams they played over the past 12 mo and how many times during that period they sustained injuries requiring treatment while playing sports or being physically active. Before 1999, an additional question asked about stretching exercises. National data from 1990 through 1997 and documentation are available from the NCCDPHP Adolescent and School Health website at: http://www.cdc.gov/ncdpdp/dash/yrbss/datalareaq.htm.

**Nationwide Personal Transportation Survey.** The NPTS is a nationally representative household-based survey conducted every 5 y by the DOT. In 2000, the NPTS is being integrated with the American Travel Survey (ATS), another periodic DOT survey. The emphasis of the NPTS is on daily, local trips, whereas the emphasis of the ATS is on long-distance travel in the United States. Although the survey does not have a physical activity focus, it provides data used in Healthy People 2010 to monitor the proportion of trips made by walking and the proportion of trips made by cycling. Further information about the NPTS and the ATS, including questionnaires and related research can be found on the NPTS/ATS 2000 web site at http://www.nptsats2000.bts.gov/.

**Data sources for Program and Policy Objectives**

**School Health Policies and Programs Study.** The SHPPS is a national survey conducted periodically to assess school health policies and programs in elementary, middle/junior and senior high schools at the state, district, school and classroom levels. SHPPS was conducted in 1994 and repeated in 2000. The survey includes questions about physical education objectives, requirements and course characteristics, including class time and size, use of curricula or guidelines, and activities taught. Physical education teacher training and certification are assessed, as well as student testing and competency evaluation. Information on extracurricular (intramural and interscholastic) sports programs and coach training is also obtained. Further information about SHPPS results and questions can be found on the NCCDPHP Adolescent and School Health web site at http://www.cdc.gov/ncdpdp/dash/shpps/index.htm.

**National Worksite Health Promotion Survey.** This survey, conducted in 1999, was a collaborative effort of the not-for-profit Association for Worksite Health Promotion (AWHP), William M. Mercer, and the Office of Disease Prevention and Health Promotion of the U.S. Department of Health and Human Services. More than 1500 worksites were randomly selected to provide information on current and planned worksite health promotion programs and policies, including physical activity and fitness programs. The survey also collected information on corporate characteristics, including perspectives on health, values, support and barriers; use of health plans for health promotion delivery; and disease- and demand-management programs and trends. Although not currently scheduled, a follow-up to the 1999 survey is expected because of the wide interest in the 1999 survey results and the need for data to monitor Healthy People 2010 worksite objectives. Information on the AWHP can be found at http://www.awhp.org.

**Issues for monitoring physical activity.**

It is apparent from the discussion of available data sources above and from the summary in Table 2 that all aspects of physical activity are not covered equally or completely in national surveys. Information on youth younger than high school age is practically nonexistent. Data on behavior of older individuals are widely available for leisure time activity, although with varying degrees of detail and completeness. Transportation, occupational and household physical activity are only crudely assessed, if at all. Data on strengthening or flexibility-related activities are similarly limited. Furthermore, recent guidance such as that in the current Dietary Guidelines targets accumulating physical activity from all contexts (1,6). There are essentially no data sufficient for monitoring progress toward this accumulation type of recommendation.

To monitor progress toward achieving the goals of recent physical activity guidance, physical activity from transportation, occupation and household tasks must be assessed in addition to that from recreation. Although they receive less attention than aerobic activities, strengthening and flexibility should not be overlooked. To evaluate compliance with recommendations to accumulate a given quantity of activity at particular intensities (whether in minutes or energy units), activity must be fully quantified, which includes frequency, duration and intensity. Quantification should include sedentary pursuits as well, rather than using lack of reported activity as a surrogate for sedentary behavior.

Most guidance targets individuals, but as noted below, physical activity can be affected by many factors at the environmental level. SHPPS covers school-based activities and facilities. However, data are lacking on community barriers and supports for physical activity. Important factors that could be monitored include community crime statistics, availability of sidewalks, bike/hike trails and mass transit options. Expanding use of computerized database systems that integrate community infrastructure and personal environment information may facilitate consideration of these data in surveillance systems. An example of such a system is described in the section on determinants of physical activity and strategies for improvement.

A major difficulty for physical activity assessment, especially in population surveys, is that it usually occurs as part of a multipurpose health survey rather than in a dedicated fitness/activity setting. Limits on the respondent burden and the resulting competition for interview time in multipurpose surveys often preclude collection of physical activity data with
The BRFSS revision process highlights several other important aspects for improving physical activity surveillance. Psychometric evaluation was used to develop items that measured the desired constructs. Cognitive testing was used to refine the questions and questionnaire to optimize respondent comprehension and reporting accuracy. The cognitive testing was repeated after modifications to confirm the effect of improvements. Perhaps most importantly, after a nearly final instrument was developed, it was tested for validity by comparison with activity monitor results and activity logs, and for reliability by repeat administration. Validity, reliability and field test results led to further modifications, which were followed by another round of cognitive testing. This process took sufficient breadth and depth to provide data required to monitor total physical activity. Compounding this difficulty is the use of national survey questionnaires as models for state- or local-level surveys to allow comparison of state and local data with data from larger regions. This leads to a lowest common denominator approach in which it is rare to obtain much data beyond aggregate estimates of leisure time activity.

A further challenge for those who are interested in surveillance of physical activity is the lack of consistent measures across time to assess trends. Assessment of physical activity is still developing, which leads to a difficult choice for survey designers and planners. Should surveys include improved questions as new knowledge or understanding emerges, or should inferior questions be retained to provide consistent measures over time and among surveys? Depending upon the aspect of physical activity and survey considered, both approaches are apparent. Cross-survey comparisons are potentially compromised because survey planners improve questions by slight wording changes or other modifications. Such seemingly minor changes can have surprisingly large effects on the data obtained (14). Macera and Pratt (8) describe the process applied in recent modifications to BRFSS that accommodated new recommendations, but retained a previous question to track trends.

The BRFSS revision process highlights several other important aspects for improving physical activity surveillance. Psychological evaluation was used to develop items that measured the desired constructs. Cognitive testing was used to refine the questions and questionnaire to optimize respondent comprehension and reporting accuracy. The cognitive testing was repeated after modifications to confirm the effect of improvements. Perhaps most importantly, after a nearly final instrument was developed, it was tested for validity by comparison with activity monitor results and activity logs, and for reliability by repeat administration. Validity, reliability and field test results led to further modifications, which were followed by another round of cognitive testing. This process took >2 y, but will result in a valid, reliable and practical set of questions on physical activity.

**Surveillance data and trends**

The questionnaire data collected in NHIS, BRFSS or other surveys to assess physical activity are used to categorize respondents’ physical activity patterns on the bases of frequency, intensity, duration, and occasionally, type of activity. The categorization schemes are driven by current health objectives and the data available. Categorizations for monitoring the Healthy People 2000 objectives included inactivity, regular sustained physical activity and regular vigorous physical activity (4). Corresponding to changes in the physical activity recommendations and health objectives, a recent categorization scheme uses inactivity, insufficient activity and sufficiently active (meeting recommendations). Those persons meeting the recommendation can be further classified by which type of activity, i.e., moderate intensity activities, vigorous intensity activities or both, accounts for the recommended activity levels (8).

**Adults.** No matter which categorization scheme is used, survey data show that lack of physical activity is a public health problem and that the scope of the problem is virtually unchanged over approximately the past 10 y (Fig. 1) (4,8). Depending upon the survey, 23–40% of adults in the United States report no leisure time physical activity (4,8,9,15). Using the newer categories and 1998 BRFSS data, 44% of adults report some activity, but still fall short of recommended levels and only 27% achieve the recommended levels of activity (8).

Although the prevalence estimates differ, the population surveys that assess physical activity generally find that men, young adults and non-Hispanic whites are more active than women, older adults and people of minority race and ethnicity. Surveys that adjust intensity ratings on the basis of age or other factors have found different relationships by gender or age, but these may be artifactual (4). Physical activity levels...
and vigorous activity for youth. The data do not capture trends in physical activity (or its lack) from occupation, transportation or routine activities of daily living. These aspects of activity may represent an important source of change in physical activity over time. Increasing demands on everyone’s time lead to a desire to maximize efficiency. The availability of convenient (and physical activity–free) options and the desire to save time may lead to many lost opportunities throughout the day to be physically active. Such subtle changes may be too small to ever be picked up by a surveillance system, but in aggregate could affect energy balance (19).

**Determinants of physical activity and strategies for improvement**

Determinants of physical activity vary considerably among both adults and children due to a complex mix of personal characteristics, sociodemographic conditions and numerous environmental influences. As with other health behaviors, knowledge of the health benefits of physical activity is not sufficient to bring about individual changes. Despite attention to recent research suggesting that even moderate intensity physical activity is associated with significant health benefits (4), measurable levels of leisure time activity have not changed appreciably (8). It is clear that effective strategies to increase physical activity levels in the population should involve multiple components rather than rely solely on personal motivation and individual behavior. However, the identification of the various personal, environmental and social factors that influence physical activity and their interactions is incomplete. Furthermore, methods to increase and maintain physical activity using a combination of approaches have not been thoroughly studied, especially among subgroups of the population. Multifaceted interventions must be developed, evaluated and implemented. Until then, physical activity levels are not likely to increase because of technological changes that conserve human energy, environmental and social constraints that promote isolated lifestyles, and safety concerns that might inhibit outdoor activity.

**Individual level behavior**

Some maintain that physiologically achievable fitness levels are predetermined by genetics, and the ability to be physically active is controlled by these predetermined fitness levels. One study found that when both parents were active, their children were 5.8 times more likely to be active than children with two inactive parents (20). However, this finding may be due to a shared environment and common values rather than an inherited trait. In fact, nongenetic factors have been shown to account for >70% of habitual physical activity and 88% of exercise participation, suggesting that in spite of a genetic propensity, there is much room for change (21).

Physical activity is an individual behavior, yet it is influenced by many factors outside an individual’s control. Even at the personal level, the motivational factors conducive to changing physical activity behavior vary considerably among adults and are influenced additionally by gender, education and socioeconomic factors. For example, some adults are able to increase physical activity once they understand its important linkage with health and longevity, particularly among those who are well educated and who have a family history of cardiovascular disease. However, for most adults, especially younger adults, the major reason for beginning and maintaining a physical activity program is for short-term benefit (i.e., to look attractive). For older adults, the motivations may be quite different. There may be less emphasis on looking attractive

**FIGURE 1** Participation by adults aged 18+ y in recommended levels of physical activity in the past month according to data from the Behavioral Risk Factor Surveillance System 1986–1998.
and more emphasis on maintaining mobility and independence or socializing with others.

Receiving advice from a physician regarding the benefit of being physically active may encourage many, especially those in high risk populations, to begin or continue an activity program (22,23). Unfortunately, this type of counseling is not routinely provided (24). In addition to time constraints and reimbursement issues, many physicians are not trained in assessing patients’ activity levels and recommending appropriate changes. Projects such as the Physician-based Assessment and Counseling for Exercise program and the Activity Counseling Trial have shown promise in providing a standardized way to educate physicians in appropriate counseling strategies (25,26). These studies have also shown that assessing physical activity and appropriate counseling by physicians or other professionals can be completed in a short amount of time (3–4 min) (26). Furthermore, there is evidence that this type of counseling can be effective in increasing activity levels among sedentary adults (23). Other policy changes within managed care organizations, such as support of fitness programs, have the potential to motivate members as well as health care staff by emphasizing the importance of physical activity to overall health.

System level changes

In spite of the potential success of interventions designed to change individual behavior, another promising approach is a combination of targeted individual interventions and environments that are conducive to physical activity. Several ways exist in which environments can be modified to support and encourage physical activity. Some of the obvious ways include neighborhood layout as well as access to trails, facilities and safe places to be active. Many neighborhoods are difficult to traverse by foot or bicycle. Access to neighborhood stores by walking is not convenient because of the barriers to pedestrian travel inherent in the development. Obtaining easements, building bicycle and walking paths, or adding sidewalks to existing streets are among the most expensive physical changes that would be required to gain access within a neighborhood. A more cost-effective strategy is to include these features as neighborhoods are designed and built, which may require policy changes.

As important as this physical framework appears to be, there are limited data to assess whether infrastructure changes are effective in promoting physical activity among neighborhood residents. A recent study that evaluated walking path use in a rural Missouri area found that the most frequent users of the trail were women, regular walkers and those with high education and income, which is consistent with what is known about those who walk. However, this study also found that persons with a high school education or less were more than twice as likely as others to have increased the amount of walking since they began using the trails, suggesting that this strategy may be effective in reaching high risk populations (27).

More subtle changes can also be used to promote an increase in daily activity expenditure. Examples of these changes include providing an opportunity to use stairs in public buildings by making stairwells obvious, attractive and well lit, providing reminders that encourage the use of stairs as an alternative to elevators and promoting climbing while riding escalators (28).

Walking or cycling for short trips can be another important way to increase overall physical activity. In addition to walking and biking paths, public transportation can provide increased opportunities for walking and cycling. Buses and trains can provide an alternative to a personal car for longer trips and still allow some walking or cycling within a total distance that is too far for walking or cycling alone. Employer-provided subsidies for public transportation may increase physical activity in addition to reducing automobile congestion and parking space needs. Other policy changes that facilitate increased use of public transportation include provision of bicycle storage at bus and train stations, bike racks on buses and policies that allow bicycles on subway or commuter trains.

New initiatives are underway to integrate information on travel patterns, land use patterns, political realities and individual behaviors to understand how these diverse factors may interact to affect the prevalence of physical activity in a community. In Atlanta, Strategies for Metropolitan Atlanta’s Regional Transportation and Air Quality (SMARTRAQ) is a collaborative effort between transportation bureaus, environmental agencies, public health departments, and land and economic development organizations. Data collected by the various partners will be collated and supplemented with a survey of the residents to capture behavioral details of the target population. Studies such as these with multiple and nontraditional partners can provide a great deal of information on personal and environmental interactions that has not been available previously. For more information see http://www.news-info.gatech.edu/news_releases/frank.html.

In general, many of the proposed environmental or policy interventions that may have promise for promoting physical activity have not been evaluated, particularly among subgroups of the population (28). As more data are collected and studies such as SMARTRAQ are completed, information on how these environmental changes are likely to affect physical activity levels will be available to guide interventions.

Social environment

An integral part of system level and policy changes is the involvement of the community members. If individuals in the community advocate for change, the changes are more likely to lead to continued development of activity friendly neighborhoods. This process also involves social support in a number of ways. Active communities foster programs that encourage age children to walk to school, organize local walk/run programs and promote neighborhood safety, all of which can provide social support to individuals within the community. Communities can also increase physical activity levels of their residents by providing access to facilities, organizing neighborhood watch programs or walking groups to promote safety. Other innovative ideas that have been suggested to increase physical activity on a community level include increasing access to exercise videos at public libraries, promoting development of neighborhood gardens, funding and maintaining bike paths, walking paths or sidewalks, and encouraging the use of school halls or tracks for walking (29).

Among the potential determinants of physical activity that have been studied, lack of social support from family or friends has been found to be important for college students, adults, women and older adults. However, lack of social support has a stronger association with physical inactivity than activity, suggesting that once active, social support may not be as important (30–32). Therefore, social support and community support in the form of programs may be more important for getting people initially involved in physical activity, and other factors may be more important in keeping people active. Because the majority of health-related benefits are obtained by
getting sedentary people to become active, this initial step may have valuable benefits (4).

Neighborhood safety is an area that has been identified recently as a potential deterrent for older adults (33,34). The prevalence of inactivity was shown to increase dramatically among residents ≥65 y old who perceived their neighborhood to be unsafe. This effect was not seen among younger adults, suggesting that older adults may be more dependent on local resources for being active. This observation is consistent with other studies that find adults and college students prefer home-based programs rather than programs that require travel to a facility (32,35). These findings emphasize the importance of the local community as an agent in physical activity promotion.

Physical activity among children is an area of concern because of the recent increase in overweight among youth, yet school requirements for classes in physical activity have been declining systematically (36,37). Children spend most of their time during the week in school and may not have opportunities to be active after school; thus, increasing the time a child is active during the school day should be a priority. Finding time for activity and educating children about the importance of being active should be included in the educational curriculum for all children. Additionally, the use of school facilities after hours may encourage children and their parents to become more active and provide alternatives to otherwise sedentary activities, such as watching television.

Another way to increase activity for both children and adults is to participate in programs such as "Kids Walk to School" (see: http://www.cdc.gov/nccdphp/dnlp/kidswalk.htm). In this program, groups of children walk with one or two parents to ensure that they are safely escorted to and from school. This program is designed to alleviate some of the safety issues that discourage walking to school, even if the school is a short distance away.

Adults who work outside the home have additional time constraints for physical activity. Their limited nonworking time may involve household tasks and, particularly for working parents, childcare. Policy changes within corporate environments could serve to make physical activity an accepted part of the workday. Work sites that provide on-site facilities (including lockers and showers) and flexible schedules that encourage employees to be active during working hours are strategies that have been suggested to improve employee health (28,29). Opportunities to be active at the workplace may be particularly important for women. Access to well-lit stairways, supporting lunchtime walks or aerobic classes can also be effective in work place settings. One study has estimated that providing employees with opportunities to be active at the work site may result in increased productivity, fewer absences and less employee turnover compared with employees in similar work sites without these policies in place (38).

Effective strategies to increase health-related physical activity will undoubtedly involve a mix of individual motivation, conducive environments and social involvement. It is critical to plan an integrated approach so that sedentary individuals will be encouraged to increase activity, active adults will remain active and children will grow up understanding the importance of physical activity and knowledgeable about ways to lead an active lifestyle.

Summary and conclusions

The inclusion of a separate guideline on physical activity in Nutrition and Your Health: Dietary Guidelines for Americans acknowledges the contribution of physical activity to health beyond its effect on weight maintenance. The Dietary Guidelines Advisory Committee also noted the low prevalence of physical activity levels sufficient to achieve health benefits. The recommendations in the guideline conform with those in other federally supported publications (4,6). These recent recommendations for physical activity have shifted from an emphasis on extended bouts of vigorous activity to an accumulation of moderate intensity activity from shorter episodes. Earlier guidance focused on structured exercise programs; although this approach is still acknowledged, the importance of physical activity achieved through routine daily activities is now highlighted.

Data for surveillance of physical activity are critical because inactivity is highly prevalent, associated with morbidity and mortality, costly and preventable. The data required to monitor these new recommendations are quite different from those required to assess participation in sustained vigorous activity. Measures of vigorous activity, which have evolved over several decades, are fairly reliable, but overestimation of activity is commonly found in validation studies (12). Furthermore, most national survey data evaluate physical activity only in the context of recreation or leisure time. To monitor progress on the new recommendations, surveys will have to incorporate assessments of activity from occupation, transportation, household tasks and other activities of the daily routine. Moderate intensity activities will have to be captured in addition to those of vigorous intensity. Assessment of accumulated short episodes of moderate intensity activity from a variety of contexts poses challenges to survey designers and to survey respondents. The variety of contexts for activity can be assessed separately, but this requires a greater number of questions than is often acceptable in multipurpose health surveys. Moderate intensity activities and routine activities may be difficult for respondents to recall and report because they are less salient than vigorous activities (39). Research is required to develop measures for sedentary lifestyle that will improve upon the proxy evaluations currently used, which are based on reports of no leisure time activity. Refinement of national surveillance systems should incorporate psychometric evaluation, cognitive testing, and reliability and validity evaluation (8).

Beyond capturing new aspects of physical activity, surveillance systems may have to incorporate measures of environmental determinants of physical activity. Environmental factors such as community infrastructure, worksite and public transportation policies, and social support are increasingly being recognized as important determinants of physical activity. Development on this front will require behavioral research to determine what factors are relevant as well as evaluations of research to design effective measures.

A surveillance system must be flexible to adapt to changes such as those required to track the recent physical activity guidelines. However, the monitoring of trends is also important and is jeopardized by changes in the surveillance system. Balancing these potentially conflicting needs will require careful consideration. The process may be aided by maintaining certain items to provide transitional data, as was achieved with the redesign of the BRFSS (8).

LITERATURE CITED

