HHS Public Access

Author manuscript

J Phys Act Health. Author manuscript; available in PMC 2024 April 11.

Published in final edited form as:

J Phys Act Health. 2021 August 01; 18(Suppl 1): S6–S24. doi:10.1123/jpah.2021-0179.

Surveillance of Physical Activity and Sedentary Behavior Among Youth and Adults in the United States: History and Opportunities

John D. Omura, MD[1], **Geoffrey P. Whitfield, PhD**[1], **Tiffany J. Chen, MSPH**[1], **Eric T. Hyde, MPH**[1], **Emily N. Ussery, PhD**[1], **Kathleen B. Watson, PhD**, **Susan A. Carlson, PhD**[1,2]

[1]Division of Nutrition, Physical Activity, and Obesity, Centers for Disease Control and Prevention, Atlanta, Georgia.

[2]Division of Population Health, National Center for Chronic Disease Prevention and Health Promotion, Centers for Disease Control and Prevention, Atlanta, Georgia.

Abstract

Background: Surveillance is a core function of public health, and approaches to national surveillance of physical activity and sedentary behavior have evolved over the past two decades. The purpose of this paper is to provide an overview of surveillance of physical activity and sedentary behavior in the United States over the past two decades, along with related challenges and emerging opportunities.

Methods: We reviewed key national surveillance systems for the assessment of physical activity and sedentary behavior among youth and adults in the United States between 2000–2019.

Results: Over the past 20 years, eight surveillance systems have assessed physical activity and five of those have assessed sedentary behavior. Three of the eight originated in non-public health agencies. Most systems have assessed physical activity and sedentary behavior via surveys. However, survey questions varied over time within and also across systems, resulting in a wide array of available data.

Conclusions: The evolving nature of physical activity surveillance in the United States has resulted in both broad challenges (e.g., balancing content with survey space, providing data at the national, state, and local level, adapting traditional physical activity measures and survey designs, and addressing variation across surveillance systems) and related opportunities.

INTRODUCTION

Surveillance is a core function of public health and is the ongoing systematic collection, analysis, and interpretation of outcome-specific data, which can then be used for planning, implementation, and evaluation of public health practice.[1] Once there is sufficient evidence that a behavior, such as physical activity, benefits health[2, 3], it is important to include

Corresponding Author Information: John D. Omura, National Center for Chronic Disease Prevention and Health Promotion, Division of Nutrition, Physical Activity, and Obesity, Centers for Disease Control and Prevention, 4770 Buford Highway NE, MS S107-5, Atlanta, GA 30341, Fax: 770-488-5473, ydk8@cdc.gov.

Disclaimer

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

its measurement in public health surveillance systems. Surveillance of physical activity is integral for monitoring physical activity trends over time, setting national goals or objectives regarding physical activity, and understanding which populations are most at risk because of low physical activity levels and related health outcomes.[4] To this end, physical activity has been assessed in several surveillance systems in the U.S. and other countries over many years.

Evidence demonstrating the health benefits of physical activity has grown substantially over the years[5, 6], and public health policies addressing physical activity have evolved as a result (Table 1). For example, early aerobic physical activity recommendations for adults (Table 1) could only consider the existing evidence at the time, which was primarily comprised of clinical studies that examined exercise to increase aerobic power.[7] Over time, as epidemiological studies linked moderate-intensity aerobic activity to health, recommendations and guidelines focused more on unstructured moderate-intensity aerobic activity accumulated weekly.[8, 9] Likewise, more current research linking sedentary behavior to poor health outcomes led to a recommendation to sit less.[9] Similar changes have occurred in national public health goals, including the *Healthy People* initiative, which identifies public health priorities each decade to help individuals, organizations, and communities across the United States improve health and well-being.[10] For instance, in response to changes in recommendations from the 1995 Centers for Disease Control and Prevention (CDC) and the American College of Sports Medicine (ACSM) to the *2008 Physical Activity Guidelines for Americans* (Table 1)[8, 11], the Healthy People 2010 goals for adult physical activity no longer included a target of 30 minutes per day of aerobic physical activity (Table 2). Opportunities and needs for data often emerge from evolving recommendations and *Healthy People* objectives, which can serve as a catalyst for change in surveillance systems as it is important for them to correspondingly adapt. For example, in *Healthy People 2020*, a consistent data source for monitoring the proportion of children aged 6 years and older meeting the physical activity guidelines was not available and so a corresponding *Healthy People* objective was not included. However, in 2016 the National Survey of Children's Health modified its physical activity questions allowing for assessment of meeting the physical activity guidelines in this age group. Subsequently, a corresponding objective was added in *Healthy People 2030*.

Public health surveillance of physical activity behaviors has evolved to reflect updated evidence and guidelines, facilitating the monitoring of the proportion of the U.S. population who perform this important health behavior using methods most consistent with current knowledge. Troiano, et al. previously published a review of physical activity surveillance at the national and state levels through 2001, including assessment instruments used in population surveys.[12] Since then, surveillance of physical activity has continued to evolve. For example, in response to the removal of the 10-minute bout recommendation in the *Physical Activity Guidelines for Americans*, 2nd edition[9], the 2020 National Health Interview Survey (NHIS) no longer requires respondents to report only activities lasting at least 10 minutes.[13] Such changes help keep surveillance systems current with scientific knowledge, but can impact estimates and complicate efforts to document trends in physical activity participation over time. Tracking and reporting changes to physical activity

surveillance can assist in the interpretation of physical activity surveillance estimates and reports.

Advances in physical activity assessment and technology can also drive changes in physical activity surveillance. Accelerometers are frequently used to measure bodily movement, which can be an indicator of physical activity behavior.[14] As use of accelerometers increased in physical activity research, they were incorporated into four 2-year cycles of NHANES between 2003 and 2014.[15] Further, the proliferation of cellular telephones and the decline in land-line telephones has spurred changes in survey sampling methods to address decreasing response rates of traditional surveys used in several national surveillance systems.[16] While cellphone technology may negatively impact survey response rates, data derived from cellphones (e.g. fitness tracking app records, activity records collected through passive monitoring) may provide emerging opportunities for monitoring physical activity behaviors.[17] Understanding the impact of changes in technology is therefore an integral component of discussions regarding opportunities and challenges in physical activity surveillance.

This paper provides a 20-year update to the 2001 Troiano, et al. review of physical activity surveillance.[12] This more recent time period includes critical milestones such as the release of both the 2008 *Physical Activity Guidelines for Americans* and the *Physical Activity Guidelines for Americans*, 2nd edition.[8, 9] The primary purpose of this paper is to provide an updated historical overview of the surveillance of physical activity and sedentary behavior at the state and national levels in the United States over the past 20 years. A secondary purpose is to describe current challenges and emerging opportunities impacting physical activity surveillance moving into the future.

DATA SOURCES

This section provides a brief overview of national and state sources of physical activity and sedentary behavior surveillance data available in the United States (Table 3). Detailed historical and methodological information is publicly available elsewhere for many of these surveillance systems.[18–21]

American Community Survey (ACS)[22]

The ACS is a nationally representative survey conducted by the U.S. Census Bureau since 2005. Data collection is continuous and data are released annually. The Census Bureau selects a random sample of addresses, including group quarters like college dormitories (since 2006), to be included in the ACS. From 2005 through 2012, the ACS collected data on all persons residing at a sampled address using three sequential methods, or “modes”: paper questionnaires through the mail, phone interviews, and personal visits with a Census Bureau interviewer. Starting in 2013, the Census Bureau added a fourth mode—an Internet response option. Starting in late 2017, the Census Bureau discontinued using phone interviews to follow up with non-respondents.

American Time Use Survey (ATUS)[23]

The ATUS began in 2003 and provides annual, nationally representative estimates of how, where, and with whom Americans spend their time. The U.S. Bureau of Labor and Statistics selects participants for ATUS using a stratified, three-stage sample design including state, households, and an individual within a household. Through a guided telephone interview, ATUS participants give a detailed record of all their activities in the previous day.

Behavioral Risk Factor Surveillance System (BRFSS)[24]

The BRFSS began in 1984 and is an annual, state-based system of health surveys that collects information on health risk behaviors, preventive health practices, and health care access primarily related to chronic disease and injury. BRFSS is a random-digit-dialed telephone survey of the civilian, non-institutionalized U.S. adult population ≥18 years of age. It is conducted in all 50 states, the District of Columbia (DC), Guam, Puerto Rico, and the U.S. Virgin Islands. Each state works with the Centers for Disease Control and Prevention (CDC) to develop a sampling protocol to select households, and one adult is selected from each household to participate in the survey. In 2011, BRFSS added survey calls to cellphone numbers and modified their weighting method; due to these methodological changes, data from 2011 and beyond are not directly comparable to previous years of BRFSS data, as shifts in observed estimates are likely to reflect the new methods rather than true trends.[25, 26]

National Health and Nutrition Examination Survey (NHANES)[15]

The NHANES program began in 1959 and has been conducted as a series of surveys focusing on different population groups or health topics. In 1999, the survey became a continuous program. NHANES combines interviews and physical examinations and uses a stratified, multistage, probability cluster sample of the U.S. civilian, noninstitutionalized population. The NHANES sample is selected in four stages: 1) primary sampling units (PSUs, generally counties), 2) segments within PSUs (census blocks or combination of blocks), 3) dwelling units, or households, within segments, and 4) individuals within households.[27] Nationally representative data are released for each 2-year cycle on the NHANES home page.[15].

National Health Interview Survey (NHIS)[28]

The NHIS has been conducted since 1957 and collects information on a variety of health measures. NHIS is primarily a face-to-face household interview survey of a sample of U.S. households, with some interviews also performed via telephone; it is conducted continuously throughout the year and data are released annually. The survey utilizes a multistage stratified sampling design that starts by selecting PSUs from a list of geographically designed PSUs that cover the 50 states and DC. The next level of sampling involves selecting households. The sampling plan is redesigned after every decennial census. Basic health and demographic information are collected for all household members; additional information, such as physical activity, is collected on one randomly selected adult (≥18 years of age) in each household. Periodically, additional questions related to physical activity are collected

from a randomly selected adult and child. NHIS underwent a redesign in 2019, however physical activity assessment was not included in the 2019 cycle.[29]

National Household Travel Survey (NHTS)[30]

The NHTS is conducted by the Federal Highway Administration and provides comprehensive data on travel and transportation patterns in the United States. It has been conducted in 2001, 2009, and 2017. Prior to the NHTS, the Nationwide Personal Transportation Survey (NPTS) was conducted in 1969, 1977, 1983, 1990, and 1995. The survey includes demographic characteristics of households, people, vehicles, and detailed information on daily and longer-distance travel for all purposes by all modes. NHTS survey data are collected from all household members age 5 and older from a sample of U.S. households and provide national estimates of trips and miles by travel mode, trip purpose, and various household attributes.

National Survey of Children's Health (NSCH)[31]

The NSCH provides representative health data on non-institutionalized children aged 0 to 17 years through adult proxy reporting in the U.S. and in each state. In 2003, 2007, and 2011/2012, the NSCH was a national telephone survey using a list-assisted random-digit-dial (RDD) sample of landline telephone numbers within non-overlapping areas, supplemented with an independent RDD sample of cellphone numbers in 2011/2012 only. It was conducted by the National Center for Health Statistics using the same sampling frame as CDC's National Immunization Survey (NIS). If more than one child lived in the household, only one child was randomly selected to be the subject of the detailed interview; a parent or guardian respondent in the household who knows about the health and health care of the selected child was interviewed as an adult proxy for the child.

Starting in 2016, the NSCH transitioned to a self-administered mail- and web-based survey conducted annually by the U.S. Census Bureau on a random address-based sample of households. After stratifying by state and a child-presence indicator, strata of addresses more likely to have children are oversampled. A screener survey is used to determine households with children (0–17 years) and create rosters of these children with corresponding demographic information. Children with special health care needs and children aged 0–5 years are oversampled. One child per household is then randomly selected, and a parent or guardian respondent in the household who knows about the health and health care of the selected child is given an age-specific topical survey regarding the child, to report as an adult proxy.

Youth Risk Behavior Survey (YRBS)[32]

The Youth Risk Behavior Surveillance System (YRBSS) includes ongoing national, state, territorial, tribal, and large urban school district surveys, of which the national Youth Risk Behavior Survey (YRBS) is one. The YRBS, as part of the YRBSS, has been conducted by the CDC every other year since its beginning in 1991. It is a self-administered school-based survey of a nationally representative sample of U.S. public and private school students in grades 9–12 in the 50 states and DC. The national survey is administered to 9th through 12th grade students drawn from probability samples of schools and students. It uses a

three-stage cluster sample design, with the first-stage sampling frame of counties as PSUs. PSUs are categorized into 16 strata by metropolitan statistical area (MSA) status and black and Hispanic student percentages. Next, the second-stage sampling frame of schools with grades 9–12 are sampled from those PSUs. Last, the third stage randomly samples one or two classrooms of a required subject or period in each grade.

REPORTED AEROBIC ACTIVITY

This section presents the various assessments of aerobic activity across systems, organized as surveys of children and adolescents, surveys of adults, and time use or trip diary data.

Surveys of children and adolescents

The surveillance systems that collect information about physical activity in children and adolescents via survey questions are the NHANES, NHIS, NHTS, NSCH, and YRBSS (Table 4).

Questions specific to youth on NHANES have differed across the years. From 1999–2008, parents of children aged 2 to 11 years were asked how many days their child participated in vigorous physical activity (e.g., that makes them sweat and breathe hard). From 2009–2020, NHANES assessed how many of the past 7 days youth engaged in ≥ 60 minutes of moderate-to-vigorous physical activity (e.g. that increases heart rate and makes breathing hard some of the time), although included age groups differed across the years. A proxy, most commonly a parent, reported for their children aged less than 12 years, and those aged 12 years and older self-reported. From 2013–2016, more extensive questions were included as part of the NHANES questionnaire that assessed physical activity outside of the school day (ages 3–15), vigorous activity (ages 5–15), and participation in sports or physical activity clubs (ages 5–15). Many NHANES questions assessing moderate- and vigorous-intensity activity for those aged 12 and older are the same as those asked of adults and are covered in the next section and in Table 4.

The NHIS has periodically included physical activity-related questions among children. For example, the complementary and alternative medicine supplement included child content on participation in yoga, tai chi, and qi chong.[33, 34] However, these questions have not been used as part of routine national surveillance of children's physical activity. The NHTS examined physical activity among children and adolescents aged 5 years and older with adult household members serving as proxies for those under 16 years of age. The included questions assessed episodes of (1) outdoor walking and (2) biking (for exercise only, 2001 and 2009; overall and for exercise, 2017). In 2017, NHTS also asked about days engaged in at least 30 minutes of (1) vigorous activity and (2) moderate activity for those aged 5 years or older. Finally, the NHTS included questions in 2009 and 2017 about active transportation to school assessed as the usual mode of transportation (e.g., biking or walking) to school.

In 2003, 2007, and 2011/12, the NSCH asked parents about the number of days children engaged in vigorous activity for ≥ 20 minutes. Starting in 2016, this question was removed and replaced with a question about the number of days in the past week children engaged in physical activity (e.g., exercise, play a sport, or participate in physical activity) for ≥ 60

minutes. Parents were also queried about whether children participated in sports teams or lessons.

From 1993–2009, the YRBS asked high school students to report how many days in the past 7 they engaged in ≥ 20 minutes of vigorous activity (e.g., that makes them sweat and breathe hard) and from 1999–2009 students also reported days engaged in ≥ 30 minutes of moderate activity (e.g., that does not make them sweat or breathe hard). From 2005–2019, the YRBS asked high school students to report how many days in the past 7 they engaged in ≥ 60 minutes of moderate-to-vigorous physical activity (e.g., that increases heart rate and makes breathing hard some of the time); however, due to changes in the sequence of the survey questions in 2011, questionnaire changes preclude comparison of this question for 2009 and earlier with 2011 and later. From 1991–2019, high school students were asked about how many days they go to physical education (PE) classes, along with additional questions about minutes of exercise during PE class included from 1991–2009. From 1991–2019, students were also asked whether they played on sports teams during the previous 12 months.

Surveys of adults

For adults, the main surveillance systems that collect self-reported information about physical activity include BRFSS, NHANES, and NHIS (Table 4). ACS and NHTS contain a more limited number of physical activity survey questions. Each of these systems has a long and varied history of collecting physical activity data.

BRFSS has tracked physical activity in 2 different ways. First, a single core question about past-month participation (yes/no) in any non-occupational physical activities or exercises such as running, calisthenics, golf, gardening, or walking has the longest history on the BRFSS.[35] In 1984, 35 states included this question on their BRFSS core. By 1996, all states had incorporated this question as part of the BRFSS core; this question is often referred to as the BRFSS Physical Activity Tracking Question. From 1984–1991, in even years from 1992–2000, and in odd years from 2011–2019, BRFSS physical activity questions assessed the 2 non-occupational physical activities each adult spent the most time doing during the past month, including frequency and duration. The relative intensity of each reported activity is estimated to determine if the activity is of moderate- or vigorous-intensity for each respondent. Relative intensity takes into account the respondent's maximal oxygen uptake, which is estimated based on their sex and age. In odd years from 2001–2009, BRFSS included different questions; respondents were asked to recall overall frequency and duration of time spent doing non-occupational physical activities of moderate intensity (e.g., small increases in breathing or heart rate) and of vigorous intensity (e.g., large increases in breathing or heart rate) in a usual week for at least 10 minutes at a time.

Prior to 1999, physical activity assessment in NHANES was of limited scope. Starting with the continuous NHANES that began in 1999, the physical activity section expanded. From 1999–2006, NHANES respondents were asked how many days in the past month and for how long each day they walked or biked for transportation. Frequency (e.g. how often) and duration (e.g. for how long each time they participated for at least 10 minutes) were also assessed separately for each the following types of activity: 1) moderate-intensity or greater household physical activity, 2) vigorous-intensity leisure-time physical activity

(e.g., running, lap swimming, aerobics class, fast bicycling), and 3) moderate-intensity leisure-time physical activity (e.g., brisk walking, bicycling for pleasure, golf, or dancing). Also, the type of vigorous- and moderate-intensity leisure-time activities performed over the past 30 days was assessed. From 2007-present, NHANES respondents have been asked how often in the past month and for how long each time they participated for at least 10 minutes continuously in: 1) vigorous-intensity work- or household-related physical activity, whether paid or unpaid (e.g., carrying or lifting heavy loads, digging or construction work); 2) moderate-intensity work- or household-related physical activity, whether paid or unpaid (e.g., brisk walking or carrying light loads); 3) transportation-related walking or biking (assumed moderate intensity); 4) vigorous-intensity sports, fitness, or recreational physical activity (e.g., running or basketball); and 5) moderate-intensity sports, fitness, or recreational physical activity (e.g., brisk walking, bicycling, swimming, or golf).

Prior to 1997, physical activity assessment in NHIS was inconsistent and has been previously described.[12] In 1997, as part of the NHIS questionnaire redesign, physical activity questions were included in the core questionnaire for the first time. From 1998–2018, a series of leisure-time physical activity questions assessed frequency and duration of physical activity that occurred for at least 10 minutes at: 1) light to moderate intensity and 2) vigorous intensity. A separate question was included on the frequency of muscle-strengthening activity. In 2005, 2010, and 2015, as part of the Cancer Control Supplement, the NHIS also included questions on leisure and transportation walking (frequency, duration) that took at least 10 minutes. In addition to the questions related to walking, other supplements have periodically included questions to assess physical activity behavior. For example, supplements have included questions related to physical activity associated with a person's job or main daily activity and for alternative health.[36] In 2019, the NHIS questionnaire underwent a major redesign. This included the physical activity questions, which were revised slightly from the 2018 version and will appear every two years starting in 2020, along with a series of questions on leisure and transportation walking. Revisions include the removal of light-intensity activity from the questions assessing moderate-intensity activity and removal of the 10-minute bout requirement for physical activity and walking questions.

Two surveys, the ACS and the NHTS, have more limited physical activity assessments. ACS and NHTS query employed adults about their mode of transportation to work. Since 2005, the national ACS has asked employed persons aged 16 years and older about their primary mode of transportation in the preceding week, and response options include walking and biking. Similar to ACS, the 2001, 2009, and 2017 NHTS also assessed the primary mode of transportation to work in the preceding week for all employed persons aged 16 years and older, and responses included walking and biking. As highlighted in the section for youth, the NHTS also included questions for those aged 5 years or older about episodes of (1) outdoor walking and (2) biking and about days engaged in at least 30 minutes of (1) vigorous activity and (2) moderate activity.

Time use or trip diary data

Two surveillance systems (ATUS and NHTS) collect diary information that permit assessment of different physical activity constructs. The ATUS interview records all activities for a respondent in the previous day and can be used to estimate time spent in various physical activities. The ATUS collects data in enough detail to link ATUS primary activity codes with metabolic equivalents (METs) cataloged in the Compendium of Physical Activities.[37, 38] Also, there are opportunities to use multiple data elements within ATUS to identify different types of physical activity. For example, activities coded as travel can be considered as active transportation if they were reported to occur during walking or bicycling.[39]

The NHTS collects data on trips taken in a 24-hour period for a randomly assigned day of the week. Trip log retrieval was conducted for all household members in 2001 and all members aged 5 and older (adult proxy for children aged 5–15 years) in 2009 and 2017. Information collected includes purpose of the trip (work, shopping, etc.), means of transportation used (car, bus, subway, walk, etc.), trip distance, and trip minutes. NHTS trip data can be used to examine trips that were made using active transportation (i.e., walking or bicycling as a means of transportation) and can also be used to examine the mode of transportation used to get to specific destinations, such as school for children and adolescents. Collection prompts and details have differed somewhat over the years, so differences in data collection techniques should be carefully examined when using data from the trip diary for examining trends. For example, the 2017 NHTS changed the definition of a trip to allow walk and bike trips to and from home (loop trips) that were not included in previous years.[40]

REPORTED MUSCLE-STRENGTHENING ACTIVITY

Frequency of muscle-strengthening activity is assessed via questionnaire among both adolescents and adults (Table 4). NHANES and YRBS have assessed muscle-strengthening activity in adolescents. Specifically, the NHANES questionnaire assessed muscle-strengthening activity for those aged 12 and older from 1999–2006 and for those aged 12–15 from 2013–2016. The YRBS asked high school students about the frequency of participation in muscle-strengthening activity from 1991–2003 and 2011–2019. For adults, an assessment of muscle-strengthening frequency is included in BRFSS for 2011–2019, NHIS for 1998–2018, and NHANES for 1999–2006.

REPORTED SEDENTARY BEHAVIOR

Surveys of children and adolescents

The survey-based surveillance systems that collect information about sedentary behavior in children and adolescents include NHANES, NSCH, and YRBSS (Table 5). These systems mainly focus on screen time (e.g., television [TV] viewing, computer usage), with the one exception being NHANES that assessed sitting time among all respondents aged 12 and older from 2009–2016.

Although exact questions differed over time, all three systems have a similar history of assessing screen time. Two systems started with one question assessing TV viewing only (NSCH 2003 and 2007, YRBS 1999 and 2001), and NHANES included a combined TV viewing and computer use question from 1999–2002 for those aged 16 years and older. Next, each system included separate TV and computer use questions (NHANES 1999–2018; NSCH 2011/12, 2016, and 2017; YRBS 2003–2019), although the examples included within the computer use questions have changed periodically, and the age groups assessed have changed for NHANES over time. Most recently, NHANES 2019–2020 and NSCH 2018–2020 switched to a single screen time question. NHANES 2019–2020 assessed average hours in a typical school day spent playing with a smartphone or computer, watching TV or movies, or playing video games. NSCH 2018–2020 assessed average hours in a typical school day spent in front of a TV, computer, cellphone, or other electronic device watching programs, playing games, accessing the internet or using social media, not including time spent doing schoolwork.

Surveys of adults

Some screen time questions in NHANES have periodically included adults as well as youth, including the combined TV viewing and computer use question in 1999–2002 and the separate TV viewing and computer use questions from 2003–2006 and 2011–2016 (Table 5).

For adults, NHANES has the longest history of collecting data on sitting time. NHANES 2007–2008 assessed time spent sitting or reclining on a typical day, then ‘reclining’ was removed for NHANES 2009–2020 (2009–2016, ages 12 years and older; 2017–2020, ages 18 years and older). Questions assessing time spent sitting during weekdays and weekend days among adults were also included in the 2000 and 2005 NHIS Cancer Control Supplement.

Time use data

Similar to using the ATUS for estimating physical activity participation, intensity (MET) coding of the ATUS data allows for the classification of activities and occupations as sedentary (1.0 to 1.5 METs).[38] Examples of activities classified as sedentary are eating and drinking and watching television.

DEVICE-COLLECTED HUMAN MOVEMENT

NHANES is the only national surveillance system that has periodically included measures of human movement assessed via a device (Table 6). In 2003–2006, all ambulatory examination participants aged 6 years and older were asked to wear the ActiGraph 7164 device on a waist belt during waking hours for 7 days, and to remove the device only for water-based activities.[15] In 2011–2014, all examination participants aged 6 years and older (ages 3–5 years were added in 2012) were asked to wear the water-resistant ActiGraph GT3X+ on a wrist band at all times for seven days and eight nights.[15] Most commonly, accelerometer output has been translated into categories of activity intensity based on predicted energy expenditure, which are then used to create national estimates of time spent in light-, moderate-, and vigorous-intensity physical activity and sedentary behaviors.[14, 41]

However, accepted standardized thresholds for classifying activity intensity using wrist-worn accelerometers do not currently exist; thus, activity intensity categories are not provided for the 2011–2014 NHANES accelerometer data.[42]

TEST-BASED FITNESS AND STRENGTH ASSESSMENTS

Though not direct measures of physical activity behaviors or movement, cardiovascular fitness and muscular strength are physiological parameters that are related to physical activity. NHANES has periodically included testing related to fitness and muscle strength (Table 6). Cardiovascular fitness testing via submaximal exercise testing was conducted as part of NHANES 1999–2004 for respondents aged 12–49 years and in 2012 among youth aged 6–15 years. Muscle strength has been tested periodically in NHANES via different procedures (Table 6). This testing was done for those aged 50 years and older in each cycle from 1999–2004 and for those 6 years and older in each cycle from 2011–2014, although the types of assessments differed slightly. In addition, the NHANES National Youth Fitness Survey was conducted in 2012 and included multiple additional tests of cardiovascular capacity, performance endurance, core strength, and upper and lower body strength for youth aged 3–15 years.

DISCUSSION

Over the past 20 years, national and state surveillance systems have used a variety of measures to monitor physical activity and sedentary behaviors among children, adolescents, and adults, resulting in a wide array of available data. This evolving nature of physical activity surveillance in the United States has resulted in data that can be used for a variety of public health purposes, as well as broad challenges and related opportunities.

Data Availability and Uses

Data from surveillance systems that measure and track changes in physical activity behavior can be used for many purposes. These include setting health goals or objectives, monitoring trends in physical activity over time, creating public awareness of physical activity as an important health behavior, identifying populations at high risk and related health disparities, developing and evaluating programs, supporting health-related policy or legislation, and examining relationships of interest (e.g., relationships between behavior and health outcomes or between policy changes and changes in behavior).[4] Making physical activity surveillance data and related estimates easily accessible for researchers and practitioners can facilitate data use. All data systems highlighted in this manuscript provide public-use datasets. Further, several of the surveillance systems offer summary reports (e.g., NHIS, YRBSS)[43–45] or have related web-enabled tools (e.g., ACS, BRFSS, NHTS, NSCH, YRBSS)[46–50] that provide estimates for various indicators, including those related to physical activity, by selected demographic and geographic characteristics. In addition, these surveillance systems and their resulting data can help inform global efforts. In particular, NHANES' physical activity questions are based on the International Physical Activity Questionnaire (IPAQ). This facilitates international comparisons as the IPAQ is the basis for physical activity estimates in many countries.[51]

Most available physical activity estimates focus on current physical activity guidelines (Table 1) or *Healthy People* objectives (Table 2). The *Healthy People 2020* data portal and the CDC Division of Nutrition, Physical Activity, and Obesity's (DNPAO) "Nutrition, Physical Activity, and Obesity: Data, Trends, and Maps" interactive database provide estimates across different physical activity surveillance systems, as well as estimates stratified by select demographic and geographic characteristics and year.[52, 53] In addition, many journal articles provide an in-depth examination of long-term trends in physical activity, correlates of physical activity, and associations between these physical activity variables and health.[35, 39, 54–68] For example, a number of articles have examined trends and correlates of walking for leisure and transportation using the NHIS walking questions.[63–68]

The limited assessment of sedentary behavior, device-collected human movement, and fitness testing across surveillance systems has led to less widely available estimates than those of aerobic and muscle-strengthening activity. For sedentary behavior, estimates of self-reported sitting time among adults can be found in published literature.[38, 54, 69–71] For example, Ussery et al found that self-reported sitting time among US adults increased from 5.5 hours per day in 2007/2008 to 5.9 hours per day in 2017/2018.[71] Screen time estimates as a proxy for sedentary behavior for children and adolescents are more readily available on several data portals, including the *Healthy People 2020* data portal and CDC's Youth Online portal.[52, 72] A number of studies have used device-collected human movement data, such as accelerometer-based measures from the 2003–2006 NHANES, to assess physical activity levels and sedentary time among youth and adults in the U.S., although more recent national estimates are lacking.[14, 73–75] In addition, estimates regarding fitness testing are similarly limited. For example, only a few publications have examined cardiorespiratory fitness levels among youth, muscular strength in children and youth, and cardiorespiratory fitness levels among U.S. adults 20–49 years of age.[76–82] A single previous study also combined aerobic activity, sedentary behavior, and fitness assessments by examining the associations of youth physical activity and screen time with fatness and fitness in children and adolescents.[83]

Challenges and Related Opportunities

The challenges and related opportunities for physical activity and sedentary behavior surveillance have been highlighted in previous publications, which include recommendations and suggestions for enhancing national physical activity surveillance.[12, 84] However, these papers do not fully capture the past two decades. Given that the current review provides an update to cover the past 20 years of physical activity surveillance in the United States, we highlight current challenges and related opportunities.

Identifying and Filling Assessment Gaps—Public health surveillance systems (e.g., NHIS, NHANES) generally include physical activity questions that allow analysts to categorize individuals into groups based on physical activity guidelines and *Healthy People* objectives. As outlined previously, the main components of the physical activity guidelines (i.e., frequency, duration, and intensity) are captured in multiple systems with a few notable exceptions where additional assessment is needed. For example, there is currently a lack of data on muscle-strengthening activity among children younger than high school age, muscle-strengthening duration and volume in general, bone-strengthening activity among

children and adolescents, vigorous-intensity activity among children and adolescents, and multi-component activity that includes balance training along with aerobic and muscle-strengthening activity among older adults.[9] Additionally, assessment of specific activity types, such as balance training, is rare in existing surveillance systems and activity across multiple domains, such as occupational physical activity, is limited. A better understanding of these components can provide useful information to examine the role of occupational physical activity on health and for designing and monitoring the impact of physical activity promotion programs such as group exercise and falls prevention programs for older adults that include aerobic exercise, strength training, and balance training.[85] For sedentary behavior, current assessment is mainly limited to a single question assessing total sitting time in adults and various questions assessing screen time, usually in youth. More detailed information about various domains in which sedentary behavior occurs (e.g. occupational, transportation-related) may inform strategies to reduce sedentary time. Filling these identified gaps would help public health professionals and researchers more completely describe physical activity participation and sedentary behavior in the U.S. and design related interventions.

When designing and refining questions for surveillance systems that might address these gaps, it is necessary to balance the level of detail needed with questionnaire brevity. When preference is given to brevity, opportunities may exist to supplement data with periodic survey supplements. For example, the 2010 National Youth Physical Activity and Nutrition Study was a cross-sectional, school-based study conducted by the CDC that included a survey collecting information on behaviors and behavioral determinants related to nutrition and physical activity among high school students.[86] In addition, the NHANES National Youth Fitness Survey was conducted in 2012 to collect data on physical activity and fitness levels, providing an evaluation of the health and fitness of children in the U.S. aged 3 to 15 years.[87]

Providing Data at the National, State, and Local Level—Local level data can help local policy makers and public health professionals plan, monitor, and evaluate physical activity programs. Although many systems provide estimates at the state level (e.g., ACS, ATUS, BRFSS, NHTS, NSCH, YRBSS), these existing systems do not have sufficient sample sizes to produce direct estimates for most areas below the state level (e.g., county, city, place, or in the case of YRBSS, the school district) with the exception of the ACS. While local level data are important, sufficiently increasing sample sizes to produce local level estimates within systems may be challenging.

In the absence of producing direct estimates, small area estimation techniques, especially the statistical model-based approaches, have been applied to national or state health surveys to generate reliable small area estimates.[88–90] For example, the PLACES project is a collaboration between the CDC, the Robert Wood Johnson Foundation, and the CDC Foundation.[91] The purpose of the PLACES project is to provide model-based estimates at the county, place (incorporated and census designated places), census tract, and ZIP Code Tabulation Area level for 27 chronic disease risk factors, health outcomes, and clinical preventive service use for the entire United States.[91] The PLACES project includes small area estimates of the prevalence of adults who report no leisure-time physical activity.[91]

These estimates can help with public health planning, although they are not currently useful for evaluation or tracking changes at the local level over time.[88–90]

Traditional Physical Activity Measures—In general, the estimates reviewed in this report are based on surveys that collect physical activity data using self-report or proxy-report methods. However, such self-reported data have several limitations, including recall and social desirability biases.[92] These biases have been shown to result in overestimates of physical activity behavior and underestimates of sedentary behavior.[84, 92–96] Additional challenges are related to questions assessing screen time and sedentary behavior.[97–99] For example, screen time questions, often used as a proxy for sedentary behavior, do not account for sedentary behaviors that occur outside time spent using screens; may measure TV, new technologies, and interactive or social media use together or separately, and only outside the scope of schoolwork for youth; and may not measure media multitasking (e.g. screen time during physical activity or using multiple media simultaneously).[97–100] Single-item, self-reported measures of sitting time among adults have been shown to underestimate total sedentary time and aggregate measures may not reflect true population estimates.[101]

Device-based assessment methods can measure human movement, an important component of physical activity behavior, and help reduce the previously described challenges of reported active and sedentary behaviors. However, incorporating device-based measurement into a surveillance framework presents several challenges itself, including the cost along with the complexity of the devices and analyzing the data they provide.[84] In addition, the evolving technology makes it difficult to consistently measure and track changes over time. For example, although accelerometers were incorporated into NHANES twice, the different devices and protocols used (e.g., waist-worn versus wrist-worn) make it difficult to compare these data.[84, 102] An additional challenge of wearable devices for physical activity surveillance is the lack of standard metrics or cut points for defining participation in moderate- and vigorous-intensity activity.[84] Device-based measures alone are also unable to provide information on the context or purpose of activity recorded. Finally, current physical activity guidelines were based largely on the associations between reported physical activity and health, not human movement data and health.[3, 84] Guidelines based on human movement data have not been established, making standardized reporting device-based data assessing movement more challenging.[84] Despite these limitations, device-based assessment methods offer an important opportunity for physical activity surveillance. Expanded use can help clarify and resolve outstanding questions, along with efforts to establish physical activity guidelines based on human movement data.

Traditional Survey Designs—Surveillance relies on the ongoing systematic collection of data. Some national surveillance systems that measure physical activity have revised their methods and measures over time which limits the ability to make comparisons before and after the changes occurred. Traditional survey-based surveillance systems also take time to collect, process, and report data, which can limit their timeliness. Moreover, all of the surveillance systems described here depend upon their ability to reach and engage potential survey respondents.[16] Declining response rates present a challenge to the viability of such surveys. Response rates over the past 20 years have declined, including the NHIS sample

adult section (response rate: 72.6% in 1998 to 63.4% in 2018) and the BRFSS (median state-level response rate: 59.2% in 1998 and 49.9% in 2018).[103–106] The pervasiveness of cellphones and lack of landlines is especially problematic for surveys that rely on lists of telephone numbers for sampling, although many systems have updated their sampling methods to address these issues.[16, 25] For example, in 2011, BRFSS added new procedures to include cellular telephone households and modified their weighting method to adjust survey data for differences between the demographic characteristics of respondents and the target population.[25, 107] Other strategies to maximize response rates include incentives, address-based sampling, utilizing multiple modes, two phase sampling, responsive design, and retaining respondents in panel surveys.[16]

New assessment methods and technologies may provide alternative data sources that can complement traditional physical activity and sedentary behavior data sources.[84, 108] These types of emerging data are being explored across multiple sectors. For example, a 2020 study reviewed emerging data sources for pedestrian and bicycle monitoring and categorized them based on whether the mode used can be detected with no or little effort.[17] Examples identified in this review included those with mode-unspecified data (e.g., cell-tower mobile phone positioning, multi-app location-based service, Wi-Fi/Bluetooth) and mode-specified data (e.g., regional bicycle-tracking app, fitness-tracking app, bike-share program).[17] Moving forward, sectors can work together to better understand how these emerging data are captured, explore the validity of measures and the representativeness of data, develop solutions to data access and privacy concerns, and further explore the feasibility of using these sources for public health surveillance purposes.[84]

Crowd-sourced human movement data using wearable activity monitors, such as smartphone apps and wearable devices, is another possible source for national physical activity surveillance.[84, 108–111] Previous studies in this area have generally found that users of wearable activity monitors are not representative of the overall U.S. population, and are notably more active than the general population.[109–111] Ownership and sharing of data from commercial wearable activity monitors pose additional challenges. Future research examining methods to overcome such limitations may help improve the potential application of these data for national physical activity surveillance.

The healthcare sector also holds potential as an emerging source of physical activity surveillance data. An expert panel convened by the National Academies of Science recommended several sector-specific strategies, including those in the healthcare sector, to enhance public health surveillance of physical activity.[112] Strategies recommended included developing surveillance systems to monitor the prevalence of physical activity assessment in health care delivery through expanded integration of a standard physical activity vital sign (PAVS) and expanding the use of data from wearable devices for monitoring physical activity in at-risk patients.[112] The latter recommendation may be particularly useful, since users of wearable devices are most willing to share their data with their healthcare provider.[109–111, 113]

Communicating Variation Across Surveillance Systems—Given the number of surveillance systems that measure physical activity using various measures and survey

designs, it is not surprising that variation exists in physical activity estimates across surveillance systems.[60, 84, 114] However, this presents a challenge in interpreting and communicating these differing estimates.[84] Experts have previously recommended methods to improve communication, translation, and dissemination of information about estimates of physical activity from surveillance systems.[84] For example, future communication efforts can provide explanations for the differences in prevalence estimates across measures by incorporating this information into widely accessed materials, such as codebooks and manuals for national datasets.[60, 84]

CONCLUSION

Over the past 20 years, national and state surveillance systems have used a variety of measures to monitor physical activity and sedentary behaviors among children, adolescents, and adults, resulting in a wide array of available data. The evolving landscape of physical activity surveillance in the United States has resulted in both broad challenges and emerging opportunities, including balancing content and survey space; providing data at the national, state, and local level; adapting traditional physical activity measures and survey designs; and addressing variation across surveillance systems.

REFERENCES

1. Thacker SB, Berkelman RL. Public health surveillance in the United States. Epidemiol Rev. 1988;10:164–90. [PubMed: 3066626]
2. Physical Activity Guidelines Advisory Committee. Physical Activity Guidelines Advisory Committee Scientific Report, 2008. 2008.
3. Physical Activity Guidelines Advisory Committee. 2018 Physical Activity Guidelines Advisory Committee Scientific Report. 2018.
4. Ainsworth BEM, C. A. Physical Activity and Public Health Practice. Taylor & Francis; 2012.
5. Morris JN, Heady JA, Raffle PAB, Roberts CG, Parks JW. Coronary Heart-Disease and Physical Activity of Work. The Lancet. 1953/11/21/ 1953;262(6795):1053–1057. doi:10.1016/S0140-6736(53)90665-5
6. Paffenbarger RS, Wolf PA, Notkin J, Thorne MC. Chronic Disease in Former College Students: I. Early Precursors of Fatal Coronary Heart Disease. American Journal of Epidemiology. 1966;83(2):314–328. doi:10.1093/oxfordjournals.aje.a120587 %J American Journal of Epidemiology [PubMed: 5930778]
7. Physical Activity and Health: A Report of the Surgeon General. (U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion) (1996).
8. U.S. Department of Health and Human Services. 2008 Physical Activity Guidelines for Americans. 2008.
9. U.S. Department of Health and Human Services. Physical Activity Guidelines for Americans, 2nd edition. 2018.
10. U.S. Department of Health and Human Services. Healthy People 2030. Accessed October 26, 2020. https://health.gov/healthypeople
11. Pate RR, Pratt M, Blair SN, et al. Physical activity and public health: a recommendation from the Centers for Disease Control and Prevention and the American College of Sports Medicine. JAMA. 1995;273(5):402–407. doi:10.1001/jama.1995.03520290054029 [PubMed: 7823386]
12. Troiano RP, Macera CA, Ballard-Barbash R. Be physically active each day. How can we know? J Nutr. 2001;131(2):451S–460S. doi:10.1093/jn/131.2.451S [PubMed: 11160577]

13. Centers for Disease Control and Prevention. 2020 National Health Interview Survey (NHIS) Questionnaire. Centers for Disease Control and Prevention (CDC). Updated April 5, 2021. Accessed May 5, 2021. https://ftp.cdc.gov/pub/Health_Statistics/NCHS/Survey_Questionnaires/NHIS/2020/EnglishQuest.pdf
14. Troiano RP, Berrigan D, Dodd KW, Masse LC, Tilert T, McDowell M. Physical activity in the United States measured by accelerometer. Med Sci Sports Exerc. 2008;40(1):181–8. doi:10.1249/mss.0b013e31815a51b3 [PubMed: 18091006]
15. Centers for Disease Control and Prevention. National Health and Nutrition Examination Survey (NHANES). Centers for Disease Control and Prevention (CDC). Updated August 14, 2020. Accessed August 19, 2020. https://www.cdc.gov/nchs/nhanes/
16. Czajka JL, Beyler A. Declining Response Rates in Federal Surveys: Trends and Implications. Vol. 1. 2016. https://aspe.hhs.gov/system/files/pdf/255531/Decliningresponserates.pdf
17. Lee K, Sener IN. Emerging data for pedestrian and bicycle monitoring: sources and applications. Transportation Research Interdisciplinary Perspectives. 2020;4:100095.
18. Centers for Disease Control and Prevention. About the Behavioral Risk Factor Surveillance System (BRFSS). Accessed June 23, 2021. https://www.cdc.gov/brfss/about/about_brfss.htm
19. National Center for Health Statistics. National Health and Nutrition Examination Survey: History. Accessed June 23, 2021. https://www.cdc.gov/nchs/nhanes/history.htm
20. Centers for Disease Control and Prevention. About the National Health Interview Survey. Accessed June 23, 2021. https://www.cdc.gov/nchs/nhis/about_nhis.htm
21. U.S. Census Bureau. American Community Survey Information Guide. Accessed June 23, 2021. https://www.census.gov/content/dam/Census/programs-surveys/acs/about/ACS_Information_Guide.pdf
22. U.S. Census Bureau. Understanding and Using American Community Survey Data: What All Data Users Need to Know. 2018. https://www.census.gov/content/dam/Census/library/publications/2018/acs/acs_general_handbook_2018.pdf
23. U.S. Census Bureau. American Time Use Survey User's Guide: Understanding ATUS 2003 to 2019. 2020. https://www.bls.gov/tus/atususersguide.pdf
24. Centers for Disease Control and Prevention. Behavioral Risk Factor Surveillance System (BRFSS). Centers for Disease Control and Prevention (CDC). Updated November 5, 2019. Accessed August 19, 2020. https://www.cdc.gov/BRFSS/
25. Centers for Disease Control and Prevention. Methodologic changes in the Behavioral Risk Factor Surveillance System in 2011 and potential effects on prevalence estimates. MMWR Morb Mortal Wkly Rep. 2012;61(22):410–3. [PubMed: 22672976]
26. Centers for Disease Control and Prevention. BRFSS 2011 Survey Data and Documentation. Accessed March 15, 2021. https://www.cdc.gov/brfss/annual_data/annual_2011.htm
27. National Center for Health Statistics. National Health and Nutrition Examination Survey, 2015−2018: Sample Design and Estimation Procedures. Accessed March 15, 2021. https://www.cdc.gov/nchs/data/series/sr_02/sr02-184-508.pdf
28. Centers for Disease Control and Prevention. National Health Interview Survey (NHIS). Centers for Disease Control and Prevention (CDC). Updated August 18, 2020. Accessed August 19, 2020. https://www.cdc.gov/nchs/nhis/
29. Survey Description, National Health Interview Survey, 2019 (2020).
30. Oak Ridge National Laboratory. National Household Travel Survey (NHTS). U.S. Department of Transportation, Federal Highway Administration. Accessed August 19, 2020. https://nhts.ornl.gov/
31. The Child & Adolescent Health Measurement Initiative (CAHMI). The National Survey of Children's Health. Data Resource Center for Child & Adolescent Health (DRC). Accessed August 19, 2020. https://www.childhealthdata.org/learn-about-the-nsch/NSCH
32. Centers for Disease Control and Prevention. Youth Risk Behavior Surveillance System (YRBSS). Centers for Disease Control and Prevention (CDC). Updated August 20, 2020. Accessed August 20, 2020. https://www.cdc.gov/healthyyouth/data/yrbs/
33. Black LI, Clarke TC, Barnes PM, Stussman BJ, Nahin RL. Use of complementary health approaches among children aged 4–17 years in the United States: National Health Interview Survey, 2007–2012. Natl Health Stat Report. Feb 10 2015;(78):1–19.

34. Black LI, Barnes PM, Clarke TC, Stussman BJ, Nahin RL. Use of Yoga, Meditation, and Chiropractors Among U.S. Children Aged 4–17 Years. NCHS Data Brief. Nov 2018;(324):1–8.
35. Moore LV, Harris CD, Carlson SA, Kruger J, Fulton JE. Trends in no leisure-time physical activity—United States, 1988–2010. Res Q Exerc Sport. 2012;83(4):587–591. doi:10.1080/02701367.2012.10599884 [PubMed: 23367822]
36. National Center for Health Statistics. Adult Physical Activity Information. Updated January 3, 2017. Accessed May 7, 2021. https://www.cdc.gov/nchs/nhis/physical_activity.htm
37. Tudor-Locke C, Washington TL, Ainsworth BE, Troiano RP. Linking the American Time Use Survey (ATUS) and the Compendium of Physical Activities: methods and rationale. J Phs Act Health. 2009;6(3):347–353. doi:10.1123/jpah.6.3.347
38. Tudor-Locke C, Leonardi C, Johnson WD, Katzmarzyk PT. Time spent in physical activity and sedentary behaviors on the working day: the American Time Use Survey. J Occup Environ Med. 2011;53(12):1382–1387. doi:10.1097/JOM.0b013e31823c1402 [PubMed: 22104979]
39. Whitfield GP, Paul P, Wendel AM. Active transportation surveillance—United States, 1999–2012. MMWR Surveill Summ. 2015;64(7):1–17.
40. McGuckin N, Fucci A. Summary of Travel Trends: 2017 National Household Travel Survey. 2018. https://nhts.ornl.gov/assets/2017_nhts_summary_travel_trends.pdf
41. Watson KB, Carlson SA, Carroll DD, Fulton JE. Comparison of accelerometer cut points to estimate physical activity in U.S. adults. J Sports Sci. 2013;32(7):660–9. doi:10.1080/02640414.2013.847278 [PubMed: 24188163]
42. Montoye AHK, Clevenger KA, Pfeiffer KA, et al. Development of cut-points for determining activity intensity from a wrist-worn ActiGraph accelerometer in free-living adults. J Sports Sci. Nov 2020;38(22):2569–2578. doi:10.1080/02640414.2020.1794244 [PubMed: 32677510]
43. National Center for Health Statistics. Selected Estimates Based on Data from the National Health Interview Survey. Updated February 11, 2021. Accessed May 7, 2021. https://www.cdc.gov/nchs/nhis/erkeyindicators.htm
44. Centers for Disease Control and Prevention. NHIS Early Release Program. Accessed November 2, 2020. https://www.cdc.gov/nchs/nhis/releases.htm
45. Centers for Disease Control and Prevention. YRBSS Reports, Fact Sheets, and Publications. Accessed November 4, 2020. https://www.cdc.gov/healthyyouth/data/yrbs/reports_factsheet_publications.htm
46. United States Census Bureau. Explore Census Data. Accessed November 2, 2020. www.data.census.gov
47. United States Department of Transportation. Explore NHTS Data. Accessed November 2, 2020. www.nhts.ornl.gov
48. Centers for Disease Control and Prevention. BRFSS Prevalence Data & Data Analysis Tools. Accessed November 4, 2020. https://www.cdc.gov/brfss/data_tools.htm
49. Data Resource Center for Child & Adolescent Health. National Survey of Children's Health Interactive Data Query (2016 – Present). Accessed November 4, 2020. https://www.childhealthdata.org/browse/survey
50. Centers for Disease Control and Prevention. 1991–2017 High School Youth Risk Behavior Survey Data. Accessed November 4, 2020. http://nccd.cdc.gov/youthonline/
51. The Global Observatory for Physical Activity. 1st Physical Activity Almanac: The Global Observatory for Physcial Activity - GoPA! Accessed June 23, 2021. https://indd.adobe.com/view/f8d2c921-4daf-4c96-9eaf-b8fb2c4de615
52. U.S. Department of Health and Human Services. Healthy People 2020. 2010. www.healthypeople.gov/2020
53. Centers for Disease Control and Prevention. Nutrition, Physical Activity, and Obesity: Data, Trends and Maps. Centers for Disease Control and Prevention (CDC). Updated July 8, 2020. Accessed August 19, 2020. https://www.cdc.gov/nccdphp/dnpao/data-trends-maps/index.html
54. Du Y, Liu B, Sun Y, Snetselaar LG, Wallace RB, Bao W. Trends in Adherence to the Physical Activity Guidelines for Americans for Aerobic Activity and Time Spent on Sedentary Behavior Among US Adults, 2007 to 2016. JAMA Netw Open. Jul 3 2019;2(7):e197597. doi:10.1001/jamanetworkopen.2019.7597 [PubMed: 31348504]

55. Brawner CA, Churilla JR, Keteyian SJ. Prevalence of physical activity is lower among individuals with chronic disease. Article. Medicine and Science in Sports and Exercise. 2016;48(6):1062–1067. doi:10.1249/MSS.0000000000000861 [PubMed: 26741117]
56. Steeves JA, Murphy RA, Crainiceanu CM, Zipunnikov V, Van Domelen DR, Harris TB. Daily Patterns of Physical Activity by Type 2 Diabetes Definition: Comparing Diabetes, Prediabetes, and Participants with Normal Glucose Levels in NHANES 2003–2006. Prev Med Rep. 2015;2:152–157. doi:10.1016/j.pmedr.2015.02.007 [PubMed: 25909051]
57. Murphy LB, Hootman JM, Boring MA, et al. Leisure Time Physical Activity Among U.S. Adults With Arthritis, 2008–2015. Am J Prev Med. Sep 2017;53(3):345–354. doi:10.1016/j.amepre.2017.03.017 [PubMed: 28601405]
58. Zhao G, Ford ES, Li C, Mokdad AH. Compliance with physical activity recommendations in US adults with diabetes. Diabet Med. Feb 2008;25(2):221–7. doi:10.1111/j.1464-5491.2007.02332.x [PubMed: 18201213]
59. Omura JD, Brown DR, McGuire LC, Taylor CA, Fulton JE, Carlson SA. Cross-sectional association between physical activity level and subjective cognitive decline among US adults aged >/=45 years, 2015. Prev Med. Oct 6 2020;141:106279. doi:10.1016/j.ypmed.2020.106279 [PubMed: 33035548]
60. Carlson SA, Densmore D, Fulton JE, Yore MM, Kohl HW, III. Differences in physical activity prevalence and trends from 3 US surveillance systems: NHIS, NHANES, and BRFSS. J Phys Act Health. 2009;6(s1):S18–S27. doi:10.1123/jpah.6.s1.s18 [PubMed: 19998846]
61. Whitfield GP, Carlson SA, Ussery EN, Fulton JE, Galuska DA, Petersen R. Trends in Meeting Physical Activity Guidelines Among Urban and Rural Dwelling Adults - United States, 2008–2017. MMWR Morb Mortal Wkly Rep. Jun 14 2019;68(23):513–518. doi:10.15585/mmwr.mm6823a1 [PubMed: 31194722]
62. Omura JD, Ussery EN, Loustalot F, Fulton JE, Carlson SA. Walking as an Opportunity for Cardiovascular Disease Prevention. Prev Chronic Dis. May 30 2019;16:E66. doi:10.5888/pcd16.180690 [PubMed: 31146804]
63. Ussery EN, Carlson SA, Whitfield GP, Watson KB, Berrigan D, Fulton JE. Walking for Transportation or Leisure Among U.S. Women and Men - National Health Interview Survey, 2005–2015. MMWR Morb Mortal Wkly Rep. Jun 30 2017;66(25):657–662. doi:10.15585/mmwr.mm6625a1 [PubMed: 28662018]
64. Ussery EN, Carlson SA, Whitfield GP, Watson KB, Berrigan D, Fulton JE. Transportation and Leisure Walking Among U.S. Adults: Trends in Reported Prevalence and Volume, National Health Interview Survey 2005–2015. Am J Prev Med. Oct 2018;55(4):533–540. doi:10.1016/j.amepre.2018.05.027 [PubMed: 30139708]
65. Whitfield GP, Carlson SA, Ussery EN, Watson KB, Berrigan D, Fulton JE. National-level environmental perceptions and walking among urban and rural residents: Informing surveillance of walkability. Prev Med. Jun 2019;123:101–108. doi:10.1016/j.ypmed.2019.03.019 [PubMed: 30878571]
66. Whitfield GP, Carlson SA, Ussery EN, et al. Racial and ethnic differences in perceived safety barriers to walking, United States National Health Interview Survey - 2015. Prev Med. Sep 2018;114:57–63. doi:10.1016/j.ypmed.2018.06.003 [PubMed: 29894716]
67. Carlson SA, Whitfield GP, Peterson EL, et al. Geographic and Urban-Rural Differences in Walking for Leisure and Transportation. Am J Prev Med. Dec 2018;55(6):887–895. doi:10.1016/j.amepre.2018.07.008 [PubMed: 30344032]
68. Watson KB, Whitfield GP, Thomas JV, Berrigan D, Fulton JE, Carlson SA. Associations between the National Walkability Index and walking among US Adults - National Health Interview Survey, 2015. Prev Med. Aug 2020;137:106122. doi:10.1016/j.ypmed.2020.106122 [PubMed: 32389677]
69. Ussery EN, Fulton JE, Galuska DA, Katzmarzyk PT, Carlson SA. Joint Prevalence of Sitting Time and Leisure-Time Physical Activity Among US Adults, 2015–2016. JAMA. Nov 20 2018;320(19):2036–2038. doi:10.1001/jama.2018.17797 [PubMed: 30458482]
70. Yang L, Cao C, Kantor ED, et al. Trends in Sedentary Behavior Among the US Population, 2001–2016. JAMA. 2019;321(16):1587–1597. doi:10.1001/jama.2019.3636 %J JAMA [PubMed: 31012934]

71. Ussery EN. PLACE HOLDER: Trends in self-reported sitting time and physical activity among US adults, NHANES 2007–2018. 2021;
72. Centers for Disease Control and Prevention. Youth Online. Accessed October 28, 2020. https://nccd.cdc.gov/youthonline/App/Default.aspx
73. Matthews CE, Chen KY, Freedson PS, et al. Amount of time spent in sedentary behaviors in the United States, 2003–2004. Am J Epidemiol. Apr 1 2008;167(7):875–81. doi:10.1093/aje/kwm390 [PubMed: 18303006]
74. Matthews CE, Keadle SK, Troiano RP, et al. Accelerometer-measured dose-response for physical activity, sedentary time, and mortality in US adults. Am J Clin Nutr. Nov 2016;104(5):1424–1432. doi:10.3945/ajcn.116.135129 [PubMed: 27707702]
75. Tudor-Locke C, Camhi SM, Troiano RP. A catalog of rules, variables, and definitions applied to accelerometer data in the National Health and Nutrition Examination Survey, 2003–2006. Prev Chronic Dis. 2012;9:E113. doi:10.5888/pcd9.110332 [PubMed: 22698174]
76. Gahche J, Fakhouri T, Carroll DD, Burt VL, Wang CY, Fulton JE. Cardiorespiratory Fitness Levels Among U.S. Youth Aged 12–15 Years: United States, 1999–2004 and 2012. 2014. NCHS data brief. https://www.cdc.gov/nchs/products/databriefs/db153.htm
77. Ervin RB, Wang CY, Fryar CD, Miller IM, Ogden CL. Measures of Muscular Strength in U.S. Children and Adolescents, 2012. 2013. NCHS data brief. https://www.cdc.gov/nchs/data/databriefs/db139.pdf
78. Wang CY, Haskell WL, Farrell SW, et al. Cardiorespiratory fitness levels among US adults 20–49 years of age: findings from the 1999–2004 National Health and Nutrition Examination Survey. Am J Epidemiol. 2010;171(4):426–35. doi:10.1093/aje/kwp412 [PubMed: 20080809]
79. Ross JG, Pate RR, Delpy LA, Cold RS, Svilar M. New Health-Related Fitness Norms. Journal of Physical Education, Recreation & Dance. 1987;58(9)
80. Pate RR. A New Definition of Youth Fitness. The Physician and Sportsmedicine. 1983;11(4)
81. Pate RR, Ross JG. Factors Associated with Health-Related Fitness. Journal of Physical Education, Recreation & Dance. 1987;58(9)
82. Pate RR, Ross JG, Baumgartner TA, Sparks RE. The Modified Pull-up Test. Journal of Physical Education, Recreation & Dance. 1987;58(9)
83. Bai Y, Chen S, Laurson KR, Kim Y, Saint-Maurice PF, Welk GJ. The associations of youth physical activity and screen time with fatness and fitness: the 2012 NHANES National Youth Fitness Survey. PLoS One. 2016;11(1):e0148038. doi:10.1371/journal.pone.0148038
84. Fulton JE, Carlson SA, Ainsworth BE, et al. Strategic Priorities for Physical Activity Surveillance in the United States. Med Sci Sports Exerc. Oct 2016;48(10):2057–69. doi:10.1249/MSS.0000000000000989 [PubMed: 27187094]
85. Project Enhance. Enhance®Fitness. Accessed February 19, 2021. https://projectenhance.org/enhancefitness/
86. Centers for Disease Control and Prevention. National Youth Physical Activity and Nutrition Study. Accessed November 4, 2020. https://www.cdc.gov/healthyyouth/data/yrbs/nypans.htm
87. Centers for Disease Control and Prevention. National Health and Nutrition Examination Survey: National Youth Fitness Survey. Accessed November 4, 2020. https://www.cdc.gov/nchs/nnyfs/index.htm
88. Zhang X, Holt JB, Yun S, Lu H, Greenlund KJ, Croft JB. Validation of multilevel regression and poststratification methodology for small area estimation of health indicators from the Behavioral Risk Factor Surveillance System. Am J Epidemiol. 2015;182(2):127–137. doi:10.1093/aje/kwv002 [PubMed: 25957312]
89. Datta GS. Model-based approach to small area estimation. In: Pfeffermann D, Rao CR, eds. Handbook of Statistics: Sample Surveys: Inference and Analysis. 2009:251–288.
90. Rao JNKM, I. Small Area Estimation. John Wiley & Sons Inc 2015.
91. Centers for Disease Control and Prevention. PLACES. Centers for Disease Control and Prevention (CDC). Accessed February 19, 2021. https://www.cdc.gov/places/index.html
92. Sallis JF, Saelens BE. Assessment of physical activity by self-report: status, limitations, and future directions. Res Q Exerc Sport. Jun 2000;71(2 Suppl):S1–14. [PubMed: 10925819]

93. Bowles HR. Measurement of active and sedentary behaviors: closing the gaps in self-report methods. J Phys Act Health. Jan 2012;9 Suppl 1:S1–4. doi:10.1123/jpah.9.s1.s1 [PubMed: 22287442]
94. Masse LC, de Niet JE. Sources of validity evidence needed with self-report measures of physical activity. J Phys Act Health. Jan 2012;9 Suppl 1:S44–55. doi:10.1123/jpah.9.s1.s44 [PubMed: 22287447]
95. Troiano RP, Pettee Gabriel KK, Welk GJ, Owen N, Sternfeld B. Reported physical activity and sedentary behavior: why do you ask? J Phys Act Health. Jan 2012;9 Suppl 1:S68–75. doi:10.1123/jpah.9.s1.s68 [PubMed: 22287450]
96. Ainsworth BE, Caspersen CJ, Matthews CE, Masse LC, Baranowski T, Zhu W. Recommendations to improve the accuracy of estimates of physical activity derived from self report. J Phys Act Health. Jan 2012;9 Suppl 1:S76–84. doi:10.1123/jpah.9.s1.s76 [PubMed: 22287451]
97. AAP Council on Communications and Media, Strasburger VC. Children, adolescents, obesity, and the media. Pediatrics. Jul 2011;128(1):201–8. doi:10.1542/peds.2011-1066 [PubMed: 21708800]
98. Verloigne M, Van Lippevelde W, Maes L, et al. Self-reported TV and computer time do not represent accelerometer-derived total sedentary time in 10 to 12-year-olds. Eur J Public Health. Feb 2013;23(1):30–2. doi:10.1093/eurpub/cks047
99. Rideout V, Robb MB. The Common Sense census: Media use by tweens and teens, 2019. 2019. https://www.commonsensemedia.org/sites/default/files/uploads/research/2019-census-8-to-18-key-findings-updated.pdf
100. Herrick KA, Fakhouri TH, Carlson SA, Fulton JE. TV watching and computer use in U.S. youth aged 12–15, 2012. NCHS Data Brief. Jul 2014;(157):1–8.
101. Prince SA, Cardilli L, Reed JL, et al. A comparison of self-reported and device measured sedentary behaviour in adults: a systematic review and meta-analysis. Int J Behav Nutr Phys Act. Mar 4 2020;17(1):31. doi:10.1186/s12966-020-00938-3 [PubMed: 32131845]
102. Troiano RP, McClain JJ, Brychta RJ, Chen KY. Evolution of accelerometer methods for physical activity research. Br J Sports Med. Jul 2014;48(13):1019–23. doi:10.1136/bjsports-2014-093546 [PubMed: 24782483]
103. Centers for Disease Control and Prevention. 1998 National Health Interview Survey (NHIS) Public Use Data Release. 2000. ftp://ftp.cdc.gov/pub/Health_Statistics/NCHS/Dataset_Documentation/NHIS/1998/srvydesc.pdf
104. Centers for Disease Control and Prevention. 2018 National Health Interview Survey (NHIS) Public Use Data Release. 2019. ftp://ftp.cdc.gov/pub/Health_Statistics/NCHS/Dataset_Documentation/NHIS/2018/srvydesc.pdf
105. Centers for Disease Control and Prevention. 1998 BRFSS Summary Quality Control Report. https://www.cdc.gov/brfss/annual_data/1998/pdf/1998SummaryDataQualityReport.pdf
106. Centers for Disease Control and Prevention. Behavioral Risk Factor Surveillance System 2018 Summary Quality Control Report. 2019. https://www.cdc.gov/brfss/annual_data/2018/pdf/2018-sdqr-508.pdf
107. Rolle-Lake L, Robbins E. Behavioral Risk Factor Surveillance System (BRFSS). StatPearls [Internet]. StatPearls Publishing LLC; 2020. https://www.ncbi.nlm.nih.gov/books/NBK553031/
108. National Academies of Sciences, Engineering, and Medicine,. Innovations in Federal Statistics: Combining Data Sources While Protecting Privacy. 2017.
109. Omura JD, Carlson SA, Paul P, Watson KB, Fulton JE. National physical activity surveillance: Users of wearable activity monitors as a potential data source. Prev Med Rep. Mar 2017;5:124–126. doi:10.1016/j.pmedr.2016.10.014 [PubMed: 28101443]
110. Strain T, Wijndaele K, Brage S. Physical Activity Surveillance Through Smartphone Apps and Wearable Trackers: Examining the UK Potential for Nationally Representative Sampling. JMIR Mhealth Uhealth. Jan 29 2019;7(1):e11898. doi:10.2196/11898 [PubMed: 30694198]
111. Ernsting C, Dombrowski SU, Oedekoven M, et al. Using Smartphones and Health Apps to Change and Manage Health Behaviors: A Population-Based Survey. J Med Internet Res. Apr 5 2017;19(4):e101. doi:10.2196/jmir.6838 [PubMed: 28381394]
112. National Academies of Sciences, Engineering, and Medicine,. Implementing strategies to enhance public health surveillance of physical activity in the United States. 2019.

113. Hyde ET, Omura JD, Fulton JE, Weldy A, Carlson SA. Physical Activity Surveillance Using Wearable Activity Monitors: Are US Adults Willing to Share Their Data? Am J Health Promot. Jul 2020;34(6):672–676. doi:10.1177/0890117119900587 [PubMed: 31957481]

114. Keadle SK, McKinnon R, Graubard BI, Troiano RP. Prevalence and trends in physical activity among older adults in the United States: A comparison across three national surveys. Prev Med. Aug 2016;89:37–43. doi:10.1016/j.ypmed.2016.05.009 [PubMed: 27196146]

115. American College of Sports Medicine position statement on the recommended quantity and quality of exercise for developing and maintaining fitness in healthy adults. Med Sci Sports. Fall 1978;10(3):vii–x. [PubMed: 723501]

116. Haskell WL, Lee IM, Pate RR, et al. Physical activity and public health: updated recommendation for adults from the American College of Sports Medicine and the American Heart Association. Med Sci Sports Exerc. Aug 2007;39(8):1423–34. doi:10.1249/mss.0b013e3180616b27 [PubMed: 17762377]

117. Nelson ME, Rejeski WJ, Blair SN, et al. Physical activity and public health in older adults: recommendation from the American College of Sports Medicine and the American Heart Association. Med Sci Sports Exerc. Aug 2007;39(8):1435–45. doi:10.1249/mss.0b013e3180616aa2 [PubMed: 17762378]

Table 1:

Selected U.S. Recommendations and Guidelines for Adult Aerobic Physical Activity, 1978–Present[a]

Year	**1978**	**1995**	**2008**	**2018**
Title	American College of Sports Medicine Position Statement on The Recommended Quantity and Quality of Exercise for Developing and Maintaining Fitness in Healthy Adults[115]	Physical Activity and Health: A Recommendation from the Centers for Disease Control and Prevention and the American College of Sports Medicine[11]	*2008 Physical Activity Guidelines for Americans*[8]	*Physical Activity Guidelines for Americans*, second edition[9]
Frequency	3 – 5 days per week	Most, preferably all, days of the week	Preferably spread throughout the week	Preferably spread throughout the week
Daily Duration	15 – 60 minutes	30 minutes	None	None
Minimum Bout Length	none	None[b]	At least 10 minutes	None
Intensity	60% – 90% of Heart Rate Reserve -or- 50% – 85% of Maximum Oxygen Uptake (VO_{2max})	Moderate intensity (equivalent to 3 to 6 METs)	Moderate intensity (equivalent to 3.0 to 5.9 METs) -or- Vigorous intensity (equivalent to ≥6.0 METs)	Moderate intensity (equivalent to 3.0 to 5.9 METs) -or- Vigorous intensity (equivalent to ≥6.0 METs)
Weekly Volume[c]	None	None	All adults should avoid inactivity. Some physical activity is better than none, and adults who participate in any amount of physical activity gain some health benefits. Substantial health benefits: at least 150 minutes per week of moderate-intensity, or 75 minutes per week of vigorous-intensity aerobic activity, or an equivalent combination of moderate- and vigorous-intensity aerobic activity. For additional health benefits: 300 minutes per week of moderate-intensity, or 150 minutes per week of vigorous-intensity aerobic physical activity, or an equivalent combination of moderate- and vigorous-intensity activity.	Some physical activity is better than none. Substantial health benefits: at least 150 minutes to 300 minutes per week of moderate-intensity, or 75 minutes to 150 minutes per week of vigorous-intensity aerobic physical activity, or an equivalent combination of moderate- and vigorous-intensity aerobic activity. For additional health benefits: >300 minutes per week of moderate-intensity equivalent physical activity.
Type	Any activity that uses large muscle groups, that can be maintained continuously, and is rhythmical and aerobic in nature	Examples of moderate-intensity physical activities were provided	Aerobic activity	Aerobic activity
Sedentary Behavior[d] Component	None	None	None	Adults should move more and sit less throughout the day. Adults who sit less and do any amount of moderate-to-vigorous physical activity gain some health benefits

[a] For a comprehensive catalog of historic physical activity recommendations before 1996, see "*Physical Activity and Health: A Report of the Surgeon General*"[7]

[b] Although not part of the recommendation statement itself, the publication does mention that physical activity can be accumulated through intermittent bouts as short as 8 to 10 minutes.[11] This topic was further clarified in subsequent publications.[116, 117]

[c] Although it is possible to estimate weekly volume with frequency, intensity, and duration, recommendations marked as 'none' did not specify a total weekly volume in the text.

[d] Sedentary behavior refers to any waking behavior characterized by a low level of energy expenditure (less than or equal to 1.5 METs) while sitting, reclining, or lying.[9]

Table 2.

Summary of Healthy People Physical Activity and Fitness Objectives, 1990–2030[a]

	1990	2000	2010	2020	2030
Youth Physical Activity Behavior	Increase proportion of youth aged 10–17 years participating: **1** Regularly in appropriate PA, particularly cardiorespiratory fitness programs which can be carried into adulthood **2** In daily PE programs	Increase proportion of youth aged 6–17 years who: **1** Engage regularly, preferably daily, in light to moderate PA for ≥30 min/day **2** Engage in vigorous PA ≥3 days/week for ≥20 min/occasion **3** Regularly perform PA that enhance and maintain muscular strength and endurance and flexibility Increase the proportion of youth in 1st-12th grade who participate in daily PE Reduce proportion of people aged ≥6 years[†] who engage in no leisure-time PA	Increase proportion of students grades 9–12 who: **1** Engage in moderate PA **2** Engage in vigorous PA Increase proportion of trips for youth aged 5–15 years made to school by: **1** Walking (≤1 mile) **2** Bicycling (≤2 miles) Increase proportion of students grades 9–12 who: **1** Participate in daily PE **2** Spend ≥50% of school PE class time being active	Increase proportion of adolescents* who meet current federal PA guidelines for: **1** Aerobic PA **2** Muscle-strengthening activity **3** Aerobic and muscle-strengthening guidelines Increase proportion of trips for youth aged 5–15 years made to school by: **1** Walking (≤1 mile) **2** Bicycling (≤2 miles) Increase proportion of adolescents* who participate in daily PE	Increase proportion of adolescents* who meet the current: **1** Aerobic PA guideline **2** Muscle-strengthening activity guideline **3** Aerobic and muscle-strengthening guidelines Increase proportion of children aged 6–13 years who meet the current aerobic PA guideline Increase proportion of youth aged 12–17 years who walk or use a bicycle to get to and from places Increase proportion of children and adolescents who play sports
Youth Sedentary Behavior			Increase proportion of students grades 9–12 who view TV ≤2 hours/school day	Increase proportion of children aged 0–2 years who view no TV/videos on an average weekday Increase proportion of youth[§] who: **1** View TV/videos or play video games for ≤2 hours/day **2** Use a computer or play computer games for non-school work for ≤2 hours/day	Increase proportion of children aged 2–5 years with total screen time of ≤1 hour/day

	1990	2000	2010	2020	2030
Adult Physical Activity Behavior *(aged ≥ 18 years unless otherwise noted)*	Increase proportion of adults aged 18–64 years participating regularly in vigorous physical exercise Increase the percent of adults aged ≥65 years engaging in appropriate PA, e.g., regular walking, swimming or other aerobic activity	Reduce proportion of people aged ≥6 years† who engage in no leisure-time PA Increase proportion of adults who: **1** Engage regularly, preferably daily, in light to moderate PA for ≥30 min/day¶ **2** Engage in vigorous PA ≥3 days/week for ≥20 min/ occasion** **3** Regularly perform physical activities that enhance and maintain muscular strength and endurance and flexibility.	Reduce proportion of adults who engage in no leisure-time PA Increase proportion of adults who: **1** Engage in regular moderate or vigorous PA **2** Engage in regular vigorous PA **3** Perform regular muscle-strengthening activity **4** Perform flexibility training Increase the proportion of trips for adults made by: **1** Walking (≤1 mile) **2** Bicycling (≤5 miles)	Reduce proportion of adults who engage in no leisure-time PA Increase proportion of adults who meet current federal PA guidelines for: **1** Aerobic PA of at least moderate intensity for ≥150 min/week, ≥75 min/week of vigorous intensity, or an equivalent combination **2** Aerobic PA of least moderate intensity for >300 min/week, >150 min/week of vigorous intensity, or an equivalent combination **3** Muscle-strengthening activities on ≥2 days/ week **4** Meet the objectives for aerobic PA and muscle-strengthening activity Increase proportion of trips for adults made by: **1** Walking (≤1 mile) **2** Bicycling (≤5 miles) Increase proportion of employed adults who have access to and participate in employer-based exercise facilities/programs	Reduce proportion of adults who engage in no leisure-time PA Increase proportion of adults who meet the current: **1** Minimum aerobic PA guideline needed for substantial health benefits **2** Highly active aerobic PA guideline needed for more extensive health benefits **3** Muscle-strengthening activity guideline **4** Minimum guidelines for aerobic PA and muscle-strengthening activity Increase proportion of older adults with reduced physical or cognitive function who engage in light, moderate, or vigorous leisure-time PA**** Increase proportion of adults who walk or use a bicycle to get to and from places
Other	Increase proportion of: **1** Adults who can accurately identify the variety and duration of exercise thought to promote most effectively cardiovascular fitness **2** PCPs who include an exercise history	Increase proportion of school PE class time that students spend being active, preferably engaged in lifetime physical activities Increase proportion of worksites†† offering employer-sponsored PA and fitness programs Increase community	Increase proportion of public/ private schools that: **1** Require daily PE¶¶ **2** Provide access to their PA spaces and facilities for all persons during non-school time†††	Increase proportion of public/private schools that: **1** Require daily PE*** **2** Provide access to their PA spaces and facilities for all persons outside normal school hours†††	Increase proportion of adolescents who participate in daily PE**** Increase proportion of worksites that offer a PA program as part of an employee health promotion program**** Increase proportion of adults with provider-diagnosed arthritis who receive health care provider counseling for PA or exercise****

	1990	2000	2010	2020	2030
	as part of their new patient exam **3** Employees of companies and institutions with >500 employees offering employer-sponsored fitness programs Establish a methodology for and participation in systematically assessing the physical fitness of youth aged 10–17 years Make data available to: **1** Evaluate short- and long-term health effects of participation in appropriate PA programs **2** Evaluate effects of participation in programs of physical fitness on job performance and health care costs **3** Regularly monitor national trends and patterns of PA participation, including participation in public recreation programs in community facilities	availability and accessibility of PA and fitness facilities[§§] Increase proportion of PCPs who routinely assess and counsel patients regarding PA frequency, duration, type, and intensity	Increase proportion of worksites offering employer-sponsored PA and fitness programs	Increase (1) number of states and (2) proportion of school districts that require regular scheduled elementary school recess Increase proportion of school districts that require or recommend an appropriate period of time for elementary school recess Increase number of states with childcare licensing regulations that require: **1** Activity programs providing large muscle or gross motor activity/ development/ equipment **2** Children to engage in vigorous or moderate PA **3** Number of min/day of PA (or by time in care) Increase proportion of office or physician visits that include exercise counseling or education[§§§] Increase policies for the built environment that enhance access to and availability of PA opportunities[¶¶¶]	Increase proportion of physician office visits made by adult patients with obesity that include counseling or education related to weight reduction, nutrition, or PA[****] Increase the proportion of child care centers where at least 60 minutes of physical activity a day is provided to children (aged 3 to 5 years) Increase the proportion of parents of children (aged 6 to 17 years) who follow the American Academy of Pediatrics (AAP) recommendations to place consistent limits on the time their child spends using media

Abbreviations: PA, physical activity; PE, physical education; TV, television; PCP, primary care provider

[a]Objectives are paraphrased to fit within the table.

[*]Students in grades 9–12

[†]Sub-objectives for people aged ≥65 years, people with disabilities, lower-income people (annual family income <$20,000) aged ≥18 years, blacks aged ≥18 years, Hispanics aged ≥18 years, and American Indians/Alaska Natives aged ≥18 years

[§]Sub-objectives for children aged 2–5 years, children and adolescents aged 6–14 years, and adolescents grades 9–12

[¶] Sub-objective to increase the proportion of Hispanics aged ≥18 years who engage in light to moderate PA for ≥30 min/day ≥5 times/week

[**] Sub-objectives for lower-income people (annual family income <$20,000) aged ≥18 years, blacks aged ≥18 years, and Hispanics aged ≥18 years

[††] Sub-objectives specifying worksites with 50–99, 100–249, 250–749, ≥750 employees

[§§] Sub-objectives specifying hiking, biking, and fitness trail miles; public swimming pools; and acres of park and recreation open space

[¶¶] Sub-objectives specifying middle and junior high schools, and senior high schools

[***] Sub-objectives specifying elementary schools, middle and junior high schools, and senior high schools

[†††] That is, before and after the school day, on weekends, and during summer and other vacations

[§§§] Sub-objectives for patients with a diagnosis of cardiovascular disease, diabetes, or hyperlipidemia; and all child and adult patients

[¶¶¶] Sub-objectives specifying community-scale policies, street-scale policies, and transportation and travel policies

[****] Objectives are managed by a different topic area in 2030

Sources:

1990: https://eric.ed.gov/?id=ED296989, Healthy People 1990 Midcourse Report

2000:https://www.cdc.gov/nchs/data/hp2000/hp2k01.pdf, Physical Activity and Fitness

2010: https://www.cdc.gov/nchs/data/hpdata2010/hp2010_final_review_focus_area_22.pdf, Comprehensive Summary of Objectives: Physical Activity and Fitness

2020: https://www.cdc.gov/nchs/data/hpdata2020/HP2020MCR-C33-PA.pdf, Table 33–1. Physical Activity Objectives

2030: https://health.gov/healthypeople/about/workgroups/physical-activity-workgroup

Table 3.

Select Characteristics of National Surveillance Systems that Monitor Physical Activity or Sedentary Behavior in the United States through 2019

Category	American Community Survey (ACS)	American Time Use Survey (ATUS)	Behavioral Risk Factor Surveillance System (BRFSS)	National Health and Nutrition Examination Survey (NHANES)[a]	National Health Interview Survey (NHIS)	National Household Travel Survey (NHTS)	National Survey of Children's Health (NSCH)	National Youth Risk Behavior Survey (YRBS)
Years	2005 – 2019	2003 – 2019	1984 – 2019	1999 – 2019	1957 – 2019[b]	2001, 2009, and 2017[c]	2003, 2007, 2011/2012, 2016 – 2019 (yearly)	1991 – 2019 (odd years)
Age Range	All ages	≥ 15 yrs	≥ 18 yrs	All ages	≥ 18 yrs[b]	≥ 5 yrs	0–17 yrs	High school students
Mode/ Method	Survey questions (mail, telephone (stopped in 2017), in-person interview, online (added in 2013)	One-day activity log (telephone)	Survey questions (telephone)	Survey questions and examination (in-person) Proxy (most commonly a parent) for those aged < 12 years	Survey questions (in-person)	One-day travel diary and survey questions (online, paper, telephone) Parent proxy for those aged ≤ 15 years-	Survey questions (telephone; starting in 2016 mail and web-based) Parent proxy for all ages	Survey questions (self-administered in classroom)
Sampling Frame	Addresses	Addresses	Telephone list	Addresses	Addresses	Addresses	Addresses	Schools
Response Rate (latest year)	86.0% (2019)	42.0% (2019)	49.4% (2019)[d]	51.9% (interviewed, 2017 – 2018)	53.1% (2018)	15.6% (2017)	42.4% (2019)	60.3% (2019)
Number of responders (latest year)	2.2 million (2019)	~9,400 (2019)	418,268 (2019)	9,254 (interviewed, 2017 – 2018)	25,417 sample adults (2018)	26,099 (2017)	29,433 (2019)	13,677 (2019)

[a] NHANES I (1971–1974), II (1976–1980), and III (1988 –1994) preceded the continuous NHANES.

[b] Periodically, the complementary and alternative medicine supplement included child content on participation in yoga, tai chi, and qi chong, however, this was not routinely captured as part of physical activity surveillance. In the 2019 questionnaire redesign, NHIS also included a sample child (17 years and younger) from households with children. However, physical activity was not assessed in the sample adult or child in 2019 and instead has been moved to the rotating core.

[c] Nationwide Personal Transportation Survey (NPTS) was conducted in 1969, 1977, 1983, 1990, 1995.

[d] BRFSS response rate represents the median rate for all states and territories.

Table 4:

Summary of Physical Activity Surveillance Measures and Data Availability by National Surveillance System, United States 2000–2019

System	Physical Activity Measure	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19
ACS	Active transportation to work						**2005–19** (ages 16+, employed)														
ATUS	24-hour activity log				**2003–19** (ages 15+) (duration)																
BRFSS *(ages 18+)*	Any non-occupational physical activity in past month	**2000–19** (change in sampling prevents comparison across the year 2010)																			
	Moderate-intensity non-occupational activity		**Odd years, 2001–09** (frequency, duration)																		
	Vigorous-intensity non-occupational activity		**Odd years, 2001–09** (frequency, duration)																		
	Top 2 non-occupational activities in past month	**X**											**Odd years, 2011–19** (frequency, duration, type; added additional activities to the list used in 1984–2000)								
	Muscle-strengthening activity												**Odd years, 2011–19** (frequency)								
NHANES	Days of any vigorous activity	**1999–08** (ages 2–11)																			
	Walk/bicycle for transportation	**1999–06** (ages 12+) (frequency, duration)																			
	Household physical activity	**1999–06** (ages 16+) (frequency, duration)																			
	Vigorous LTPA	**1999–06** (ages 12+) (frequency, duration, type)																			
	Moderate LTPA	**1999–06** (ages 12+) (frequency, duration, type)																			
	Vigorous-intensity occupational/household activity								**2007–16** (ages 12+) 2017–2018 (18+ years) (frequency, duration)												
	Moderate-intensity occupational/household activity								**2007–16** (ages 12+) 2017–2018 (18+ years) (frequency, duration)												
	Walk/bicycle for transportation								**2007–16** (ages 12+) 2017–2018 (18+ years) (frequency, duration)												
	Vigorous-intensity LTPA								**2007–16** (ages 12+) 2017–2018 (18+ years) (frequency, duration)												
	Moderate-intensity LTPA								**2007–16** (ages 12+) 2017–2018 (18+ years) (frequency, duration)												
	Days of physical activity ≥60 min										**2009–20** (2009–12, ages 2–11; 2013–16, ages 2–15; 2017–20, ages 2–17)											
	Days of vigorous activity ≥20 min														**2013–16** (ages 5–15)						
	Participation in (asked separately):														**2013–16** (ages 3–15) (type)						

System	Physical Activity Measure	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19
	• Physical activity outside of school • Sports or physical activity clubs																				
	Muscle-strengthening activity														**2013–16** (ages 12–15) (frequency)						
NHIS[a] *(ages 18+)*	Light to moderate LTPA	**1998–2018** (frequency, duration)																			
	Vigorous LTPA	**1998–2018** (frequency, duration)																			
	Muscle-strengthening activity	**1998–2018** (frequency)																			
	Walk/bicycle for transportation	**X**																			
	Stretching (frequency, duration)		**X**																		
	Yoga, Tai chi, Qi Chong			**X**										**X**							
	Frequency and duration of (asked separately): • Leisure walking • Transportation walking						**X**					**X**					**X**				
National Household Travel Survey (NHTS) (ages ≥ 5 years unless otherwise noted)	24-hours travel log (mode, purpose, duration, distance)[b]		**X**								**X**								**X**		
	Episodes outside (asked separately): • Walking for exercise • Biking for exercise		**X**								**X**										
	Episodes outside (asked separately): • Walking overall and for exercise • Biking overall and for exercise																		**X**		
	Active transportation to work (employed persons aged ≥16 years)		**X**								**X**								**X**		

System	Physical Activity Measure	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19
	Active transportation to school (2009, ages 5–15; 2017, students aged ≥5 years)										X								X		
	Days of vigorous activity ≥30 min																		X		
	Days of moderate activity ≥30 min																		X		
NSCH (ages 6–17)	Days of vigorous activity ≥20 min				X				X				X								
	Days of physical activity ≥60 min																	**2016–19**			
	Participation in sports team/ lessons				X				X				X					**2016–19**			
YRBS (High school students only)	Days of moderate activity ≥30 min	**Odd years, 1999–2009**																			
	Days of vigorous activity ≥20 min	**Odd years, 1993–2009**																			
	Number of sports teams participated on	**Odd years, 1991–2019** 1991–97: 2 questions (one regarding school-based sports, one regarding non-school-based sports); 1999–2019: 1 combined question																			
	Days of moderate to vigorous physical activity ≥60 min						**Odd years, 2005–2019** Questionnaire changes preclude comparison of ≤ 2009 and ≥ 2011														
	Muscle-strengthening activity	**Odd years, 1991–2003** (frequency)											**Odd years, 2011–19** (frequency)								
	Physical education classes[c]	**Odd years, 1991–2019** (frequency)																			

ACS, American Community Survey; ATUS, American Time Use Survey; BRFSS, Behavioral Risk Factor Surveillance System; LTPA: Leisure-time physical activity; NHANES, National Health and Nutrition Examination Survey; NHIS, National Health Interview Survey; NHTS, National Household Travel Survey; NSCH, National Survey of Children's Health; YRBS, Youth Risk Behavior Survey; X, Indicator that survey was administered in that year unless otherwise specified

[a]The NHIS has periodically included the complementary and alternative medicine supplement which assessed participation in yoga, tai chi, and qi ching in children and adults. The NHIS has also periodically included other supplements which assessed physical activity, such as physical activity associated with a person's job or main daily activity and for alternative health.

[b]The 24-hours travel log has not been consistent across years. For example, in 2017 there was a major change in the method used to collect trip distance which incorporated the use of the shortest path route between geocoded origins and destinations. There was also a difference in the definition of a trip where, in 2017, it did not matter how long you were there. Loop trips were also identified as starting and ending in the same location (https://nhts.ornl.gov/assets/2017_nhts_summary_travel_trends.pdf).

[c]Minutes of exercise during physical education classes was assessed in odd years from 1991–2009, although response options differed for 1991–99 and 2001–09.

Note: All measures listed at a minimal can indicate participation (yes/no) unless otherwise noted. Additional measures collected are so noted and include frequency, duration, and type.

Table 5:

Summary of Sedentary Behavior Surveillance Measures and Data Availability by National Surveillance System, United States 2000–2019

System	Sedentary Measure	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19
ATUS	24-hour log				**Every year, 2003–2019** (ages 15+)																
NHIS (ages 18+)	Sitting time weekdays	X					X					X									
	Sitting time weekend	X					X					X									
	Usual daily activities (sit to 'walk around' most of the day)	X					X														
NHANES	Time spent sitting or reclining on a typical day								**Ages 12+**												
	Time spent sitting on a typical day										**Each cycle, 2009–2020** (2009–16, ages 12+; 2017–20, ages 18+)										
	TV watching yesterday (ages 2–15)	X																			
	Computer use yesterday (ages 2–15)	X																			
	Combined TV watching/ computer use on a typical day (ages 16+)	**Each cycle, 1999–2002**																			
	Combined TV watching/ smartphone or computer use/ playing video games on a typical day during the school year (ages 2–17)																				X
	Average TV watching in past 30 days		**Each cycle, 2001–2018** (2001–02, ages 2–15; 2003–06, ages 2+; 2007–10, ages 2–11; 2011–16, ages 2+; 2017–18, ages 2–17)																		
	Average computer use in past 30 days (changes in gaming platforms in 2011 and 2017)		**Each cycle, 2001–2010** (in 2007 'outside of school' is added; 2001–02, ages 2–15; 2003–06, ages 2+; 2007–10, ages 2–11);										**Each cycle, 2011–2018** (2011–16, ages 2+; 2017–18, ages 2–17)								
NSCH (ages 0–17, unless otherwise noted)	Times spent watching TV or videos or playing video games on average weekday (ages 6–17)				X				X				X					X	X		
	Time spent using computer for purposes other than schoolwork								X												

System	Sedentary Measure	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19
	on average weekday (ages 6–17)																				
	Time spent watching TV or videos or playing video games on average weekday (ages 0–5)								X				X					X	X		
	Time spent with computers, cellphones, handheld video games, and other electronic devices, other than schoolwork, on average weekday												X					X	X		
	Time spent on TV, computers, cellphones, games, internet, or social media, other than schoolwork, on most weekdays																			X	X
YRBS	Hours of TV watching on average school day	**Odd years, 1999–2019**																			
	Hours of video games, computer use, other than school work, on average school day				**Odd years, 2003–2019** Examples changed over time, same example for 2003/2005 (no example), 2007/2009, and 2013/2015.																

ATUS, American Time Use Survey; BRFSS, Behavioral Risk Factor Surveillance System; NHANES, National Health and Nutrition Examination Survey; NHIS, National Health Interview Survey; NSCH, National Survey of Children's Health; YRBS, Youth Risk Behavior Survey; X, Indicator that survey was administered in that year unless otherwise specified

Table 6:

Summary of Human Movement and Fitness and Strength Assessment Measures and Data Availability by National Surveillance System, United States 2000–2019

System	Measure	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19
NHANES	Movement via waist-worn accelerometer				**Each cycle, 2003–06** (ages 6+)																
	Movement via wrist-worn accelerometer												**Each cycle, 2011–14** (ages 6+ (2012: 3+))								
	Muscle strength via isokinetic strength of the quadriceps	**Each cycle, 1999–2004** (ages 50+ years)																			
	Cardiovascular fitness via submaximal treadmill exercise test (2012, ages 6–15 years)	**Each cycle, 1999–2004** (ages 12–49 years)												**X**							
	Muscle strength via core muscle-strength, isokinetic strength of the quadriceps, and isometric grip strength (ages 3–15 years)													**X**							
	Muscle strength via isometric grip strength												**Each cycle, 2011–14** (ages 6+)								
	Motor skills via Test of Gross Motor Development (ages 3–5 years)													**X**							

NHANES, National Health and Nutrition Examination Survey; X, Indicator that survey was administered in that year unless otherwise specified