Strategic Priorities for Physical Activity Surveillance in the United States

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ABSTRACT

FULTON, J. E., S. A. CARLSON, B. E. AINSWORTH, D. BERRIGAN, C. CARLSON, J. M. DORN, G. W. HEATH, H. W. KOHL, III, I.-M. LEE, S. M. LEE, L. C. MÂSSE, J. R. MORROW, JR, K. P. GABRIEL, J. M. PIVARNIK, N. P. PRONK, A. B. RODGERS, B. E. SAELENS, J. F. SALLIS, R. P. TROIANO, C. TUDOR-LOCKE, and A. WENDEL. Strategic Priorities for Physical Activity Surveillance in the United States. *Med. Sci. Sports Exerc.*, Vol. 48, No. 10, pp. 2057–2069, 2016. **Purpose**: Develop strategic priorities to guide future physical activity surveillance in the United States. **Methods**: The Centers for Disease Control and Prevention and the American College of Sports Medicine convened a scientific roundtable of physical activity and measurement experts. Participants summarized the current state of aerobic physical activity surveillance for adults, focusing on practice and research needs in three areas: 1) behavior, 2) human movement, and 3) community supports. Needs and challenges for each area were identified. At the conclusion of the meeting, experts identified one overarching strategy and five strategic priorities to guide future surveillance. **Results**: The identified overarching strategy was to develop a national plan for physical activity surveillance similar to the U.S. National Physical Activity Plan for promotion. The purpose of the plan would be to enhance coordination and collaboration within and between sectors, such as transportation and public health, and to address specific strategic priorities identified at the roundtable. These strategic priorities were used 1) to identify and prioritize physical activity constructs; 2) to assess the psychometric properties of instruments for physical activity surveillance; 3) to provide training and technical assistance for those collecting, analyzing, or interpreting surveillance data; 4) to explore accessing data from alternative sources; and 5) to improve communication, translation, and dissemination about estimates of physical activity from surveillance systems. **Conclusion**: This roundtable provided strategic priorities for physical activity surveillance in the United States. A first step is to develop a national plan for physical activity surveillance that would provide an operating framework from which to execute these priorities. **Key Words:** POPULATION HEALTH, MONITORING, EPIDEMIOLOGY, RECOMMENDATIONS, EXERCISE

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Improving physical activity in the United States is a national health priority (65,67). Regular participation in physical activity provides substantial health benefits (43,66). Despite these benefits, only one-half of U.S. adults report participating in enough aerobic physical activity to obtain them (9). The low level of physical activity among Americans is a major contributor to the burden of chronic diseases, premature death, and high medical care costs (13,43,44). In the United States, approximately $117 billion

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(in 2012 U.S. dollars) is spent annually on direct health care costs associated with inadequate physical activity (13).

Public health surveillance is a cornerstone of public health practice used to systematically monitor population-level trends in health and behaviors and guide intervention priorities (56). Existing surveillance systems for physical activity most often assess the aerobic physical activity behaviors of individuals and have been used to monitor secular changes in population levels of physical activity over time (14,35). Surveillance can also be used to monitor factors that can influence changes in physical activity levels. For example, systems can be used to monitor supports for physical activity within the community and within various settings, such as workplaces.

Efforts to improve public health surveillance for physical activity can incorporate the same principles that are used to improve other public health surveillance efforts. Public health surveillance systems should have a clear purpose and are evaluated on their usefulness (contribution to prevention and control of disease) and their attributes. These attributes include simplicity, flexibility, data quality, acceptability, sensitivity, representativeness, timeliness, and stability (Table 1) (25).

In August 2014, the Centers for Disease Control and Prevention (CDC) and the American College of Sports Medicine (ACSM) convened a 2-d roundtable in Atlanta, Georgia, to consider the future of and identify strategic priorities for aerobic physical activity surveillance in U.S. adults. The roundtable focused on research and practice needs in three content areas: 1) behavior, 2) human movement, and 3) community supports.

METHODS

Twenty nationally recognized physical activity and measurement experts gathered to review and summarize the current state of physical activity surveillance. Overall, the scope of the roundtable included the surveillance of adult aerobic physical activity and community supports for physical activity. Physical activity is defined as any voluntary movement produced by skeletal muscles that results in energy expenditure (15). Physical activity results in human movement where human movement is defined as a change in spatial orientation of the body or a part of the body. Physical activity behavior encompasses human movement, yet it also includes a range of other factors such as the purpose, context, and perceived intensity of the activity (41). Although these are important topics because of the time and resources available for this meeting, we limited the scope to aerobic

TABLE 1. Key attributes to consider when developing or evaluating public health surveillance systems.[a]

Attribute	Definition	Key Question(s) to Address	Physical Activity Example
Simplicity	Refers to both its structure and ease of operation. Surveillance systems should be as simple as possible while still meeting their objectives.	Are procedures, training, data collection, computer requirements, etc., simple to use?	Training interviewers or those conducting environmental audits does not take excessive time. Physical activity questions are not overly burdensome for the interviewer or the participant.
Flexibility	Can adapt to changing information needs or operating conditions with little additional cost in time, personnel, or allocated funds. Can accommodate, for example, changes in definitions and variations in reporting sources.	Does the system have the ability to adapt to changing needs and conditions?	Able to adapt to changes in guideline definitions. For example, two definitions of "sufficiently active" (e.g., *Healthy People 2010* and the *2008 Physical Activity Guidelines*) can be assessed in the surveillance system.
Data quality	Completeness and validity of the data recorded in the public health surveillance system.	What percentage report "don't know" to items on the surveillance form?	Respondents are able to accurately answer a question about their physical activity behavior or community supports.
Acceptability	Reflects the willingness of individuals and organizations to participate in the surveillance system	Will dropout be a factor? Does the system, because of its characteristics, discourage participation?	Participants are willing to complete a questionnaire or wear a monitor for the specified specific period. Employers are willing to complete a tool to assess physical activity supports at their workplace.
Sensitivity	The system should be able to accurately classify participants according to the health outcome of interest and should also be able to detect change in the prevalence of the health outcome over time (i.e., trends).	Does the instrument accurately classify participants into meeting guidelines or having a community support?	Questionnaires have been shown to be valid for assessing community supports for physical activity (11).
Representativeness	Accurately describes the occurrence of a health-related event over time and its distribution in the population by place and person.	Are those who participate (or who are included for environmental systems) different from those who are not?	The proportion of adults meeting guidelines should be similar among those who complete the physical activity interview and among those who do not complete the interview or who are unable to be contacted.
Timeliness	Reflects the speed or delay between steps, such as data collection and reporting, in a surveillance system. Timeliness is evaluated in terms of availability of relevant information—either for immediate efforts or for long-term program planning.	Is time from data collection to dissemination reasonable?	In the BRFSS, time from data collection to having data available for analysis is about 6 months.
Stability	Reliability (i.e., the ability to collect, manage, and provide data properly without failure) and availability (the ability to be operational when it is needed) of the public health surveillance system	Are the tools used for data collection stable over time?	The availability of wearable devices that consistently assess human movement over time.

[a]Attributes and definitions adapted from Centers for Disease Control and Prevention (25).

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TABLE 2. Terms and definitions used to guide the CDC/ACSM roundtable on physical activity surveillance.

Term	Definition in the Context of Physical Activity
Built environment	The human-made physical space where people live, work, and recreate on a day-to-day basis (2)
Construct	A skill, attribute, ability, or behavior that may or may not be directly observable (36)
Device based	Method to assess physical activity movement from a wearable device designed to capture human movement (59)
Measure	The amount or degree of something; a measure can be directly ascertained by using an instrument or device
Physical activity	Any voluntary movement produced by skeletal muscles that results in energy expenditure (15)
Public health surveillance	Ongoing systematic collection, analysis, and interpretation of outcome-specific data for use in the planning, implementation, and evaluation of public health practice (56)
Reported or self-report	Method to assess physical activity behavior in which respondents (or qualified proxies) answer questions about their participation in physical activity (53)

activity in adults and community supports because of the current focus of CDC's Division of Nutrition, Physical Activity, and Obesity in this area and their need to address the challenges in these content areas.

During the roundtable, participants made presentations that described the current state of surveillance in the three content areas and identified key challenges and needs. Participants then participated in a systematic process designed to develop consensus on strategic priorities and actions researchers and practitioners can take to enhance the utility of physical activity surveillance. The process began with a group discussion and brainstorm of actions needed to address the key challenges identified during the presentations and group discussion sessions. Experts then individually rated the initial list of potential actions, and those with the lowest scores were removed from the list. The potential actions that remained were grouped into similar categories and formed the basis for the five strategic priorities. The group voted and agreed by consensus on the five identified priorities and that the highest ranking actions would be provided as example potential actions to fill these priorities.

To assist in the writing of this manuscript, roundtable participants drafted abstracts to summarize their assigned area, suggested key references, and provided extensive comments on the manuscript. Definitions used to enhance clarity of roundtable discussions are provided in Table 2. Experts did not address the surveillance of policies relevant to physical activity, the surveillance of muscle-strengthening physical activity, or the surveillance needs for children and adolescents.

SURVEILLANCE OF PHYSICAL ACTIVITY: CURRENT STATUS, CHALLENGES, AND NEEDS

The following section summarizes the current status of physical activity surveillance related to our three content areas: 1) behavior, 2) human movement, and 3) community supports. It is also discusses the challenge and needs within each content area, which will provide a justification for the strategic priorities identified.

Physical Activity Behavior for Adults

Current U.S. government surveillance systems use questionnaires or activity diaries to assess respondents' aerobic physical activity behaviors. Physical activity behavior is often characterized in four domains: leisure time, active transportation, household, and occupational physical activity.

What measures are currently collected for each domain? ***Leisure time.*** Because of extensive evidence of its association with health (43) and potential to be amenable to intervention, leisure-time (discretionary) aerobic physical activity is the domain most frequently measured within public health surveillance systems and is usually defined as physical activity purposefully performed during nonworking hours. Currently, the National Health and Nutrition Examination Survey (NHANES) and the National Health Interview Survey (NHIS) questionnaires assess the frequency (in a typical week for NHANES and respondent defined for NHIS) and duration (minutes per episode) of all vigorous- and moderate-intensity leisure-time physical activities (20,21). The current Behavioral Risk Factor Surveillance System questionnaire asks adults to report the frequency (times per week or per month) and duration (minutes per episode) of the top two physical activities (identified in an open-ended question) in which they participate during nonworking hours (17) (Table 3). Respondents are often classified into levels based on current guidelines (e.g., active, insufficiently active, and inactive) using responses to these survey questions (14).

Active transportation. Active transportation usually involves walking or bicycling to get from place to place (46) and is important to monitor because it contributes to total physical activity (8). Multiple national surveillance systems assess certain components of active transportation in the United States (19). Walking and bicycling for transportation are measured as part of the 1-d activity diaries of the National Household Travel Survey (NHTS) (71) and the American Time Use Survey (ATUS) (64) (Table 3). In addition, the American Community Survey and the NHTS identify the usual mode of travel to work, including walking and bicycling, in the past week (19). These data may be most useful in providing physical activity estimates for groups (e.g., bicycle commuters) but may be less useful for estimating usual daily physical activity for an individual because they are based on a single 24-h diary per participant and may overlook habitual behavior if is not performed on the queried day. Health-oriented surveys ask about the frequency of participating in active transportation (walking and bicycling combined) (e.g., NHANES) or walking only (e.g., NHIS) over the past week or month (19). This broader approach to time catchment is more likely to capture habitual patterns of active transportation.

Household. Household physical activity occurs as part of maintaining a home and can include activities such as cleaning, child care, gardening, home repair, or shopping

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TABLE 3. Current U.S. government surveillance systems that collect physical activity behavior among U.S. adults.

Survey (website)	Collection Method (\mode)	Physical Activity Domains	Survey Years	Measure
American Community Survey (http://www.census.gov/acs/)	Survey questions (on-line/mail/in person)	Active transportation	2008–2012	Usual mode of transportation to work last week
ATUS (http://www.bls.gov/tus/)	One day activity diary (telephone)	Active transportation	2003–2013	Minutes of specific activity for 24 h
		Leisure time	2003–2013	
		Household	2003–2013	
		Occupational	2003–2013	
Behavioral Risk Factor Surveillance System (http://www.cdc.gov/brfss/)	Survey questions (Telephone)	Nonoccupational	2011–2014[a]	Minutes of top two physical activities in past week or past month
NHTS (http://nhts.ornl.gov/)	One day travel diary survey question (telephone)	Active transportation	1969–2009	Participants logged all trips on 1 d, including mode of travel and purpose; mode of transportation to work used for most of the distance in the past week
NHANES (http://www.cdc.gov/nchs/nhanes.htm)	Survey questions (in person)	Active transportation	2007–2014	Minutes of walking and bicycling for transportation in typical week
		Leisure time	2007–2014	Minutes of vigorous- and moderate-intensity leisure-time activity in typical week
		Work (paid/unpaid)	2007–2014	Minutes of vigorous- and moderate-intensity work activity in typical week
NHIS: Cancer Supplement (http://www.cdc.gov/nchs/nhis.htm)	Survey questions (in person)	Active transportation	2005, 2010	Minutes of transportation walking in past 7 d
NHIS: Sample Adult Survey (http://www.cdc.gov/nchs/nhis.htm)	Survey questions (in person)	Leisure time	1997–2014	Minutes of vigorous- and light- to moderate-intensity activity in respondent selected recall period

[a]Inactivity surveyed every year, all physical activity surveyed in odd years.

(1). The surveillance of household activities has been obtained largely from time use surveys (Table 3). The ATUS has been used to examine household activities, such as light-intensity cleaning, food preparation, and caring for household members (62).

Occupational physical activity. Data sources that currently monitor occupational physical activity include the ATUS and NHANES (Table 3) (21,64). The NHANES defines work broadly "as the things that you have to do such as paid or unpaid work, studying or training, household chores, and yard work" (21). Other surveys, such as NHIS, collect information about job classification and industry categories for employed persons that can be used to create estimates for occupational physical activity (61), although the estimation process used with this type of classification differs from those used when information about physical activity is queried directly. For example, when a respondent reports working in an occupation classified as a health care practitioner, they are assigned as participating in light-intensity activity for the hours they report working without any information on the specific activities or intensity-level (61).

Challenges and needs. Researchers and practitioners face several challenges working with physical activity behavior data captured by questionnaire. One challenge is interpreting differences in the reported physical activity estimates across surveillance systems. Systems can differ in what is captured by their aerobic physical activity questions, such as the domains assessed, survey cues, the duration of recalled period, how activities are assessed (summative [i.e., use of broad-intensity categories for recall] or separate activity-specific questions), and intensity definition (12). Current systems also differ in other characteristics that can influence estimates, such as mode of survey administration (e.g., in person, by telephone) (29,53). A thorough understanding of the details of the physical activity items is an important need for the data analyst and data users, as the inferences that one makes based on these data will likely vary based on the assessment strategy or method.

A second challenge is that unlike other measures of health (e.g., blood pressure), the essential measures necessary to capture physical activity behavior have not yet been clearly identified. For example, measures focused on the leisure-time domain are important to assess given that much of the existing evidence related to the health benefits of physical activity is specific to reported leisure-time physical activity (43). However, current aerobic physical activity guidelines (66) are expressed in terms of minutes per week, regardless of domain, and assessing a single domain may be insufficient to capture all opportunities for meeting guidelines. The selection of which measure of physical activity to assess can also depend on what other data are collected as part of the survey or the surveillance system. For example, active transportation may be an essential domain to monitor as part of a transportation survey because it may be the domain most closely correlated with other variables on the survey, such as car ownership and distance to the workplace. Additional guidance on the selection of physical activity measures for surveillance

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purposes is needed for different sectors (73) and for key stakeholders such as local officials or decision makers.

A final challenge is that the psychometric properties of physical activity surveillance questions are infrequently examined. For example, what is the reliability and validity of questionnaires in measuring whether a person meets current aerobic guidelines? Concerns about overly high estimates of physical activity resulting from the potential measurement error (53) are issues that need to be addressed. Understanding the psychometric properties of physical activity items from a questionnaire is important when selecting questions for surveillance purposes, and it is also important because it facilitates the interpretation and translation of any estimates derived from the data.

Human Movement

Measuring human movement is an integral component of a comprehensive effort to assess physical activity (41). Accelerometers and pedometers have been used to characterize human movement in research and consumer applications. Waist-worn accelerometers and pedometers are both sensitive to ambulatory movements and can be used as step counting devices to provide simple estimates of steps per day. Accelerometers also offer the potential for time-stamped outputs congruent with surveillance needs for capturing time spent at various intensities of physical activity.

What methods are currently used to collect data? Accelerometers have been used in the NHANES to measure human movement. In the NHANES 2003–2004 and 2005–2006 cycles, all ambulatory survey participants age 6 yr or older were asked to wear the ActiGraph 7164 device on a waist belt during waking hours for 7 d and to remove the device only for water-based activities (21). The NHANES 2011–2012 and 2013–2014 cycles asked all survey participants age 6 yr and older (age 3–5 yr were added in 2012) to wear the water-resistant ActiGraph GT3X+ on a wrist band around the clock for 7 d and eight nights (21).

Most commonly, accelerometer output has been translated into categories of activity intensity based on predicted energy expenditure, which is then used to create national estimates of physical activity prevalence (57,74). Accelerometers can also provide step counts, and these have been used to provide steps per day estimates at the national level (6).

Challenges and needs. Device-based assessment methods can measure human movement, an important component of physical activity behavior, and remove the measurement error associated with reported behavior. However, their incorporation into a surveillance framework presents several challenges. The current cost and complexity of accelerometer-based devices and the rapidly evolving technology make it difficult to consistently measure and track trends. Pedometers have few of the cost and complexity limitations associated with accelerometers, but they have similar challenges related to step recording as well as proprietary instrument designs and algorithms that affect sensitivity across devices (63). As these challenges begin to be addressed, the integration of a device-based measure on a continual basis may be worth considering. New technologies, methodologies, and mobile applications designed to measure physical activity continue to be developed. In the future, devices that can be incorporated into surveillance systems may have, for example, sophisticated algorithms that can allow for the measurement of overall physical activity. The role of wearable devices and their feasibility as surveillance tools will need to be regularly evaluated.

An important challenge to consider when using the output from wearable devices is the lack of a standard metric for accelerometer output to define participation in moderate- and vigorous-intensity activity. For example, on the basis of common proprietary accelerometer activity count-based cut points, the proportion of adults meeting current guidelines for aerobic physical activity ranged from 6% to 98% (74). For surveillance purposes, a consistent metric is needed for a range of activities, and that metric needs to be relevant for different demographic subgroups.

The desire for a consensus intensity-based metric is predicated on the need to assess compliance with current physical activity guidelines (66). However, current guidelines were established on an evidence base of physical activity behavior, not human movement (43). At this time, guidelines have not been established based on the relationship between device outputs and health benefits. Findings from cross-sectional studies using device-based assessments show an association between human movement and some chronic disease risk factors (4,75). Research linking device-based measurement of physical activity and mortality has begun to appear (31). Additional findings from longitudinal studies could lead to guidelines for device-based indicators of movement.

Contemporary accelerometer-based devices support the collection of high-resolution raw acceleration signals in standard gravitational or acceleration units, removing the need to rely on proprietary units, such as counts. Computational approaches are being developed for these data to classify raw units into physical activity type and intensity. These methods, as well as other device-based metrics, such as daily activity volume (5), that are able to assess human movement as part of physical activity behaviors (e.g., playing tennis) may provide feasible surveillance approaches to consider with accelerometry.

Community Supports

Communities can facilitate physical activity for all ages and abilities through built environment supports (16), such as places to be active (e.g., sidewalks, trails, parks, and fitness facilities), attractive scenery, convenient destinations for walking (e.g., shops and restaurants), and safety features (e.g., crosswalks and lighting). Indicators of supports for physical activity measure a variety of attributes in a specified geographical area or within a certain setting (e.g., workplace).

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Periodically collecting data on essential aspects of community supports for physical activity would be valuable for public health planning, as would be linking individual measures of physical activity behavior/movement to community supports and to health and economic outcomes.

Some indicators of community supports for physical activity (e.g., presence of places to be active and perceptions about neighborhood safety) have been assessed on topic-specific surveys or survey supplements (37,54) and some indicators (e.g., residential and employment density, land use diversity, access to destinations, and distance to transit) are compiled in current databases at the Census Block Group level (68,72). However, no national surveillance system routinely and comprehensively monitors community supports for physical activity.

The surveillance of supports for physical activity may be especially important in settings where adults spend large proportions of their time, such as workplaces. Approximately 150 million U.S. adults participate in the labor force (69), and workplaces can encourage physical activity through multilevel approaches (10). Although some data are available related to occupational physical activity, no national surveillance system routinely and comprehensively monitors workplace supports for physical activity.

The surveillance of indicators of the community supports for physical activity can be conducted in several ways. For example, individuals can be asked about their perceptions of their neighborhood environment for physical activity (e.g., availability of sidewalks or parks) or key informants (e.g., employers) can be interviewed about physical activity supports in specific settings (e.g., workplaces). In addition, surveillance can be conducted through environmental audits or by using geographically coded data.

What Methods Are Available to Assess Community Supports for Physical Activity?

Surveys of the built environment. Several surveys are used to assess perceived neighborhood built environment features (11). The Neighborhood Environment Walkability Scale (NEWS) has been used frequently, and an abbreviated version (NEWS-A) exists, although its usefulness for surveillance is limited because it is still considered to be too long (22,50). The Physical Activity Neighborhood Environment Survey is considerably shorter, and separate single item indicators that assess the same construct have been shown to be equivalent to multi-item scales from the NEWS-A (51,52). Survey questions related to the built environment also exist on supplements conducted by the U.S. government, such as the 2012 National Survey of Bicyclist and Pedestrian Attitudes and Behavior (54) and the 2015 NHIS Cancer Control Supplement (37).

Surveys of workplace supports. Workplace supports for physical activity can be assessed from two points of view—the employee and the employer. Multiple instruments are available that focus on workplace environments and policies, and these instruments frequently include items related to physical activity supports (e.g., access to physical activity facilities or program supports and point-of-decision prompts) (28). Nationally representative data have been collected from employers as part of the National Worksite Health Promotion Survey (32) and the Workplace Wellness Programs Study (34). However, these surveys have not been conducted on a routine basis. The National Workplace Health Promotion Survey (32) is to be administered again in 2016 and could potentially be used for surveillance purposes.

Environmental audits. Environmental audits provide detailed examinations of physical activity environments at the individual or neighborhood level (38). Like surveys, audits can assess a variety of built environment features. Audit instruments are normally used for research purposes, and their feasibility as part of a public health surveillance system is being explored. For example, in 2014, a multimodal collaboration led by the Federal Highway Administration, the Federal Transit Administration, the National Highway Traffic Administration, the Federal Railroad Administration, and the Federal Motor Carrier Association was initiated to conduct at least one walk/bike road safety assessment in every state (70) to examine the challenges and barriers of implementing walk/bike road safety assessments across different communities.

Geographically coded (or "geocoded") data. To connect physical activity behavior to measures of the respondent's built environment, location data from diverse sources (e.g., health studies and surveillance systems) need to be geographically coded (or "geocoded"). Currently, national surveys, such as NHANES, NHIS, and the NHTS, collect residential address data, and these data have been geocoded for analyses. Privacy concerns dictate that these data be used only in restricted data centers, and not be made publicly available. Extending such address data collection to include other locations where people spend their time, such as workplace addresses for employed respondents, could help strengthen efforts to link physical activity behavior with community supports.

Many types of data are collected regularly and evaluated on a geographic level. For example, environmental features of a walkable community, such as residential and employment density, land use diversity, access to destinations, and distance to transit, are available at the Census Block Group level in a database available from the U.S. Environmental Protection Agency (72). In some cases, data at a geographically finer level of detail are available, such as data about pedestrian fatalities (39).

Challenges and Needs

All of the methods described to assess community supports have challenges related to assessing the psychometric properties of the measure collected. For surveys, evaluating the validity for measures of the perceived built environment is challenging because some forms of validity testing require a criterion or gold standard against which to compare a

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perceived measure. However, for some constructs, such as safety and esthetics, perceptions may be the key determinants of behavior (11), and identifying a gold standard for a perception can be especially challenging. For audits, observers or raters (for remote audits) must be trained, and interobserver reliability must be monitored throughout the data collection process (11). The psychometric properties of features of the built environment collected with geographic information systems (GIS) will depend on the accuracy and completeness of existing data sources and the geographic scale at which measures are available and aggregated (11).

Another challenge is lack of knowledge regarding the most important features of the built environment to measure and monitor, as well as the necessary frequency of measurement. For example, is any one element of the pedestrian infrastructure most critical or are several attributes needed to improve walking or other physical activity? How sensitive is physical activity to changes in these elements? Does this sensitivity change over time between demographic groups or based on other factors, such as the price of gasoline? Understanding these deeper relationships could help inform the revision of surveys or audit tools and inform the development of technological approaches that are brief and focused on the most important environmental features on which to conduct surveillance.

Beyond identifying what specific features of the built environment can be measured and monitored separately for a community, it is also desirable to have a single summative measure, such as one measure to indicate the walkability of a community. However, several challenges exist to create these summative measures, such as the essential features to be included, whether measures are available at similar geographical units for each feature, and how measures of separate features should be combined into a single summative measure. In addition, clear communication is needed to describe the methodology used in their creation and how accurately they capture the construct of interest.

Workplace supports for physical activity may be characterized by many features, making assessment tools relatively long (28,45). More evidence is needed to know which features are most important to measure because this knowledge will help to create assessment tools that are acceptable within this setting while also considering the other key attributes (Table 1). Adding survey questions to existing systems to assess workplace supports from the employee perspective poses additional challenges because it requires inclusion of additional dimensions about the workplace, such as workplace culture, company size, and worker demographics (28,45). To meet this challenge, brief modules to assess topics related to workplace environments and policies are needed.

The length of most existing built environmental questionnaires often leads to their rejection for existing surveillance systems, where survey time and space are limited. Although questionnaires with seven or nine items exist (37,52), demand exists for even shorter questionnaires to increase the feasibility of routinely assessing key features of the environment as part of question-based surveillance systems where space is limited. Balancing the need for short questions and the ability to capture complex constructs with a small number of questions is a challenge that needs to be addressed.

Conducting audits at even a modest scale (e.g., citywide) may not be feasible because they require large time and resource commitments, including training required to standardize data collection and subsequent quality control assurance. Additional information and pilot testing are needed to evaluate the feasibility of audits as practical and useful surveillance tools. The use of remote online observations (e.g., street view maps and crowdsourcing) can help reduce the time and cost of conducting on-the-ground environmental audits of walkability (27,48), but these approaches have not yet been implemented for surveillance over time or on a wide spatial scale. In addition, various sectors (e.g., public health and transportation, land use, and community design sector) collect data for a limited number of features and geographical areas, but improved and expanded cross-collaboration at the local, state, and national level can optimize resources to collect information about the built environment. For example, developing shared data infrastructure for locally collected data might help lead to larger data sets, opportunities for analysis, and ultimately a kind of "crowd-sourced" surveillance system.

Geocoded data have limitations. First, residential address data are used to geocode data from health surveys but may not adequately capture other places people spend their time, such as the workplace, or places where most physical activity takes place (7). The boundaries of the geographic radius that influence behavior of an individual or community may also vary with the individual, age, time of day, or season (47), thereby challenging the utility of using simple geographic analysis to assess environmental supports for physical activity. Although protocols for collecting GIS data have been developed (26), the data have a wide variety of primary purposes, and therefore, boundaries, protocols, and measures are not consistent across data sets (26). Understanding and managing these differences is integral to correctly using these types of data for physical activity surveillance.

To better characterize environmental influences on physical activity, continued data integration is needed, which maximizes the interplay between available technology and geospatial data. Efforts to layer geospatial built environment data with health information might also benefit by including geospatial information about the location of physical activity. Again, as wearable technologies evolve, this may become easier.

STRATEGIC PRIORITIES FOR THE SURVEILLANCE OF PHYSICAL ACTIVITY

Roundtable participants found that the needs and challenges across the topic areas of behavior, human movement, and community supports were similar. As a result, they were able to

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identify one overarching strategy and five strategic priorities for physical activity surveillance in adults and communities.

The overarching strategy was to develop a national plan for physical activity surveillance, akin to the National Physical Activity Plan (73) for promotion. Such a plan would enhance coordination and collaboration within and among societal sectors to address recommendations from the roundtable experts. The development of such a plan would need resources and a defined process to be fully executed.

Experts also identified five strategic priorities to guide the future of physical activity surveillance (Table 4). They were as follows: 1) to identify and prioritize physical activity constructs; 2) to assess the psychometric properties of instruments for physical activity surveillance; 3) to provide training and technical assistance for those collecting, analyzing, or interpreting surveillance data; 4) to explore accessing data from alternative sources; and 5) to improve communication, translation, and dissemination about estimates of physical activity from surveillance systems (Table 4). These five priorities, along with associated potential actions for researchers and practitioners, provide a roadmap that can, in part, guide a national plan for physical activity surveillance. Many individuals and groups are already involved in addressing these strategic priorities, but more engagement is needed to increase the reach, breadth, and impact of these efforts.

Identify and Prioritize Physical Activity Constructs

Determining the most important constructs of physical activity that need to be captured by surveillance is paramount. Prioritizing constructs will make it easier for decision makers to identify what surveillance measures should be revised or eliminated and what measures should remain the same, keeping in mind the key evaluation criteria (Table 1). Interest in maintaining continuity over time should be considered to the extent warranted. In establishing the priorities, it will be important to consider the strength of the evidence of the constructs' links to health in the case of behavior and human movement and the links with facilitating physical activity in the case of community supports. Another important consideration is how well the constructs relate to initiatives to promote physical activity being implemented by different sectors, such as by public health departments, transportation planners, parks professionals, and workplaces, and how often the constructs need to be measured to capture change. Once the physical activity constructs have been identified and prioritized, they can be used to revise current surveillance systems and develop new systems or instruments (e.g., questionnaires, audit tools, and technological approaches) to reflect the priorities. These constructs can also help inform the methods proposed to monitor national health objectives related to community supports for physical activity (65).

Decisions will also need to be made about whether measures of aerobic physical activity should (or can) be consistent across surveillance systems. For example, should all systems include the same physical activity questions and same device-based measurement protocols, or should different systems use different measures or methods to assess aerobic physical activity? Coordinating which measures are assessed across data systems can help to balance data needs with survey space. Standardization may not always be desirable, as surveys have different goals and constituents. Identifying and prioritizing constructs can also help in the development of tools or repositories where local communities can pool data that are consistently collected, and this may fill some local needs for comparison data without being cost prohibitive.

Prioritizing physical activity surveillance constructs also requires decisions about how device-based measures can be incorporated into the surveillance architecture. Currently, device-based measures included as part of surveillance systems are limited to the measurement of human movement; however, there is much work being done to develop better devices and algorithms that may be considered for future application as measures of physical activity. It is important to regularly evaluate the role of wearable devices and their feasibility as surveillance tools. Additional work is also needed to guide decisions on how to interpret the output from these devices with thresholds and guidelines based on associations with health outcomes. Opportunities to integrate reported physical activity assessments and device-based methods in unique but complementary roles should also be explored (59).

It is important to evaluate current systems as well as newly developed systems or instruments to be sure they measure the essential constructs. Once the construct priorities are set, characteristics of surveillance systems need to be examined and evaluated across the key criteria (Table 1). As modifications to constructs and systems are suggested or as new systems are developed, their feasibility in different settings and scenarios will need to be evaluated.

Stakeholders from all sectors of the National Physical Activity Plan and from local, state, and national levels should be included throughout the process of prioritizing essential constructs for physical activity surveillance, and findings should be clearly communicated. Physical activity practitioners should be queried on the essential constructs that will best inform local-level physical activity promotion. Information about revised questions or newly developed instruments should be included within toolkits that can be accessed by data users. These toolkits would describe the instruments in detail, the constructs they measure, how to interpret the data, and their strengths and limitations.

Assess the Psychometric Properties of Instruments for Physical Activity Surveillance

A careful review of all the psychometric properties of instruments used to assess physical activity behavior, human movement, and community supports should be conducted before their use in surveillance systems to ensure their psychometric qualities are adequate. For example, how accurate is the instrument at measuring a given construct and does it

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TABLE 4. Strategic priorities and potential actions to guide physical activity surveillance for research and practice.

Priority	Potential Actions	
	Research	**Practice**
Identify and prioritize physical activity constructs	• Assess the state of surveillance by conducting a review of the literature and resources for physical activity surveillance conducted in essential sectors. • Prioritize constructs for sectors such as transportation, workplaces, and parks • Determine and prioritize which current systems or questions should be revised and which should remain the same • Select new systems or instruments (e.g., questionnaires, audit tools) to be considered for development and validation • Supplement existing surveillance systems on a regular basis with content-specific modules (e.g., community supports) • Determine feasibility of instruments in different settings and scenarios. Include issues related to cost, response or return rates, technical ability needed, and aggregation potential	• Query practitioners on the essential constructs that will inform local-level physical activity promotion • Communicate to local, state, and national level practitioners the essential constructs to assess within physical activity • Use findings to develop tools for local-level practitioners to assess prioritized constructs if not available from other sources
Assess the psychometric properties of instruments for physical activity surveillance	• For current and proposed surveillance questions assess the reliability and validity of the construct (or questionnaire item) from which the interpretation of the data is made • Conduct measurement error modeling studies to quantify the error associated with questionnaire items • Develop and test questionnaire modules for workplaces and for community supports • Develop cut points for device-based assessments based on prospective associations with health outcomes	• Coordinate questionnaire development and testing with local-level surveillance and program efforts, especially for community supports
Provide training and technical assistance for those collecting, analyzing, or interpreting surveillance data	• Develop consistent definitions and data analysis methods • Provide technical assistance to aid in the selection of data collection methods • Educate data users about data collection, analysis, and interpretation	• Assess surveillance needs at the local level • Develop training models (e.g., train the trainer) for physical activity surveillance • Create translation and dissemination strategies to share information with target audiences
Explore accessing data from alternative sources	• Explore opportunities for examining data captured using alternative assessment methods • Explore accessing repositories to examine data from alternative device-based methods and develop techniques to improve representativeness	• Develop partnerships between public health and those who work with device-based assessment technologies • Develop partnerships with transportation organizations that may also use information about the built environment and how it can support walking and bicycling
Improve communication, translation, and dissemination of information about estimates of physical activity from surveillance systems	• Produce and disseminate materials for research audiences that describe the strengths and situational appropriateness of reported and device-based methods • Provide potential explanations for the differences in prevalence estimates across measures. Incorporate this information into widely accessed materials, such as codebooks and manuals for national data sets • Conduct analyses and report results from new analytic techniques to quantify physical activity and movement • Avoid using terms that could lead to misinterpretation, for example, using "reported" (rather than subjective) and "device-based" (rather than objective) in publications • Develop a plan to transition surveillance systems from reported to device-based assessments where feasible and when it more accurately reflects the construct of interest • Translate scientific findings into practical guidance and recommendations for key audiences (e.g., policy makers) across sectors, including health care, transportation, city planning, parks and recreation, and occupational health.	• Produce and disseminate materials for practitioner audiences that describe the strengths and situational appropriateness of reported and device-based methods • Engage communications experts to develop talking points and frequently asked questions to explain strengths of the methods and provide potential explanations for the differences in physical activity prevalence estimates • Package key scientific pieces for practitioners in user-friendly formats • Develop consistent messages about the amount of physical activity needed for substantial health benefits

measure what it is supposed to measure? Does the validity evidence support using the collected data to estimate population prevalence of meeting aerobic guidelines, to monitor change over time, and to assess associations with health? Has the validity evidence been determined with a large and broad enough sample to afford generalizability of the instrument's accuracy within the population? Knowing the reliability, validity, sensitivity, and type and degree of measurement error associated with physical activity questions can provide insights about under- or overestimation, misclassification, and

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bias. Similarly, as new questions or question modules are developed or modified from existing versions, it will be essential to build psychometric testing into the process.

One issue with instruments used to capture both physical activity behavior and human movement is not simply that they "lack validity evidence" but that the interpretation made from the data is inconsistent with the data on the instrument's validity. For example, if the goal is to report on the percentage of the population who meet specific physical activity guidelines, it is important that the tool measures the same components of physical activity as those that form the basis of the guidelines. It is not appropriate to estimate prevalence of meeting the physical activity guidelines for Americans that were developed from studies of reported behaviors with measures of movement determined by devices (58). Selecting an appropriate surveillance instrument with the majority of the evidence originating requires determining what aspects of physical activity are measured, how the data will be used, and what interpretations one intends to make from the data collected with a given instrument (33,55,59). It will be important to develop national physical activity guidelines that are linked to device-based measures and then use these guidelines as the basis for categorizing individuals using these types of measures.

Continued work is needed on the psychometric properties of questions aimed at community supports for physical activity. Some information is available on the reliability and validity of questionnaires used to measure perceived neighborhood built environments (11,23,50). Many instruments that assess workplace environments and policies have reported high reliability, whereas less information is available on the validity of these instruments (28). As modules are developed or as instruments are modified to fit with existing surveillance tools, psychometric properties must be continuously assessed and findings included as part of the decision-making process.

Provide Training and Technical Assistance for Those Collecting, Analyzing, or Interpreting Surveillance Data

Providing training and technical assistance for physical activity surveillance stakeholders enables standardized collection, analysis, and interpretation of data. Stakeholders may need help in learning how to analyze and interpret data, for example, when a new accelerometer protocol is introduced or when questions are changed in an existing surveillance system. Successful public health training models, such as train-the-trainer or peer-to-peer learning, are methods to consider. Collaborative training models between state health departments and academic partners might also be considered. Training and technical assistance may especially need to be targeted to local stakeholders, as improvements to the built environment are usually made locally.

Providing information collected from a surveillance system in standardized formats will help local stakeholders understand and interpret the information so it is more relevant to decision making at the local level. Geographic data used to map environmental physical activity resources often are not comparable across jurisdictions and, therefore, need to be standardized. Standards are also needed for data collection and data storage. For example, standard descriptors or terminology are needed for aspects of the built environment, such as parks, which may take many forms, and sidewalks, which may vary greatly in quality. A useful tool could be a data repository, where those already conducting environmental audits can store and share standardized data.

Explore Accessing Data from Alternative Sources

New technologies and assessment methods may provide alternative sources that capture data from individuals throughout their day, to link physical activity with specific locations, and to collect information about the built environment. Widely used commercial device-based assessment methods (e.g., Fitbit®, Apple Watch) and mobile applications for smartphones have the ability to measure and track physical activity and the locations where physical activity occurs (40). Data from these assessment techniques can be stored by the individual or by the mobile application provider. With a growing percentage of U.S. adults (64% in 2014) owning smartphones (42), this large-scale collection and storage of physical activity information could conceivably lead to a greater understanding of the population's physical activity based on data collected through these devices. The potential role of this type of data in systematic surveillance efforts is not yet known. Roundtable experts suggested exploring and evaluating the use of these methods as part of physical activity surveillance. Public health surveillance leaders may wish to explore partnerships with those working in these industries to assist with defining how data are captured, to promote efforts to improve the validity of measures, to identify sampling strategies to improve representativeness, to develop solutions to data access and privacy concerns, and, overall, to further explore the use of these tools for surveillance.

New technologies and assessment methods could help capture information about places where people engage in physical activity. These technologies may supplant techniques that formerly relied on human observers or self-report, allowing more widespread adoption. For example, conducting counts of pedestrians or bicyclists on a sidewalk or trail was historically conducted by a person watching for pedestrians or bicyclists to pass. Electronic methods, such as infrared counters, inductive loops, and video and software technologies that count the number of people who use physical activity facilities can obtain this same information and for longer periods (24,49). Methods that can supplement data from these devices with information from mobile devices are also emerging. Consistent methods are needed to improve the comparability of data collected by different cities and agencies (3). Current limitations in data collection, compilation (including addressing concerns about privacy), and analysis methods must first be addressed, however, before these alternative technologies can be used in national surveillance.

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Several data collection methods hold promise for assessing the built environment. Approaches such as remote observation (e.g., through online mapping resources) may provide similar measures of the built environment as on-the-ground audits, reducing the time and cost of data collection (30). Additional innovations (e.g., machine learning or crowdsourcing) may reduce the time needed to process and extract environmental data from remote sources. Online tools for workplace assessments can also present surveillance opportunities. For example, the CDC Worksite Health ScoreCard assesses workplace supports, such as having on-site exercise facilities and signage to encourage physical activity, (18) and data could be compiled across the workplaces completing the ScoreCard.

Moving forward, it will be important to standardize these types of innovative data collection methods for their use in surveillance and subject them to similar evaluations as used with other measures (Table 1).

Improve Communication, Translation, and Dissemination about Estimates of Physical Activity from Surveillance Systems

The importance of effective communication spans across all the topics and priority areas discussed during the roundtable. An especially important and complex topic relates to the comparison between measures of reported physical activity behavior and device-based measures of movement. Although these measures are both related to physical activity, they measure different constructs. Not surprisingly, the proportion of the adult population meeting aerobic physical activity guidelines differs dramatically when comparing reported and device-based measures (60). For example, using data from NHANES 2005–2006, the estimates were 62.0% using reported and 9.6% using accelerometer measures (60). Initial thoughts of the scientific community were that reports represented a biased assessment, and that accelerometer measures more accurately reflected "truth." However, because reported and device-based measures are measuring different constructs, they cannot be directly compared (58). For example, activity estimates may differ between a report of playing an hour of tennis (behavior) and the motion detected during the stop and start movements of playing tennis (movement). Clear communication for those less familiar with this area is needed to note how both methods provide useful information and to explain why and how they are different.

Accurate terminology is also important for clear communication. When terminology does not accurately represent a situation or construct, it may produce a bias in use or interpretation. For example, it is common to refer to reported or questionnaire-based assessments of physical activity as "subjective" and to device-based assessments as "objective." These terms suggest that one method is superior to the other. To reduce the potential for bias, roundtable experts recommended using the terms "reported" and "device-based" instead. Those who oversee publishing for research and practice audiences may wish to adopt similar terminology standards.

NEXT STEPS

An essential interplay exists between public health practice and research, particularly around the issue of surveillance. Practitioners advise researchers about their needs. Researchers address the needs by developing tools, collecting data, sharing information, and providing training and technical assistance. Practitioners then use the information from these tools and provide feedback to researchers on what works and where gaps exist. The cycle repeats. As such, practitioners and researchers both have vital roles to play in mapping the future of physical activity surveillance.

The five strategic priorities and associated actions recommended by the roundtable experts can guide the future of surveillance of physical activity behavior, human movement, and community supports in the United States. Although beyond the scope of this roundtable, it will be important in a comprehensive surveillance plan to include constructs such as physical activity behavior in youth, muscle-strengthening activity, sedentary behavior, and policy supports of physical activity. Some of the issues and actions identified as part of this roundtable may resonate across these additional topic areas; therefore, others may wish to conduct similar meetings that focus on these topics.

The priorities identified during this roundtable represent areas in need of focused attention by public health practitioners and researchers and highlight opportunities for cross-disciplinary, collaborative partnerships between public health and nonhealth partners, such as transportation. For those who will lead the surveillance priorities, it will be vital to focus on areas that are essential for advancing public health practice as well as the science of physical activity assessment. Results from this scientific roundtable offer an important roadmap that can lead to the improved surveillance of physical activity in the United States.

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REFERENCES

1. Ainsworth BE, Haskell WL, Herrmann SD, et al. 2011 Compendium of Physical Activities: a second update of codes and MET values. *Med Sci Sports Exerc.* 2011;43(8):1575–81.

2. Ainsworth BE, Macera CA. *Physical Activity and Public Health Practice*. Boca Raton: Taylor & Francis; 2012. pp. 259–76.

Copyright © 2016 by the American College of Sports Medicine. Unauthorized reproduction of this article is prohibited.

3. Alliance for Biking and Walking. *Bicycling and Walking in the United States. 2014 Benchmarking Report*. Washington (DC): Alliance for Biking and Walking; 2014. pp. 223–4. Available from: Alliance for Biking and Walking.
4. Atienza AA, Moser RP, Perna F, et al. Self-reported and objectively measured activity related to biomarkers using NHANES. *Med Sci Sports Exerc*. 2011;43(5):815–21.
5. Bassett DR, Troiano RP, McClain JJ, Wolff DL. Accelerometer-based physical activity: total volume per day and standardized measures. *Med Sci Sports Exerc*. 2015;47(4):833–8.
6. Bassett DRJr, Wyatt HR, Thompson H, Peters JC, Hill JO. Pedometer-measured physical activity and health behaviors in U.S. adults. *Med Sci Sports Exerc*. 2010;42(10):1819–25.
7. Berrigan D, Hipp JA, Hurvitz PM, et al. Geospatial and contextual approaches to energy balance and health. *Ann GIS*. 2015;21:157–68.
8. Berrigan D, Troiano RP, McNeel T, Disogra C, Ballard-Barbash R. Active transportation increases adherence to activity recommendations. *Am J Prev Med*. 2006;31(3):210–6.
9. Blackwell DL, Lucas JW, Clarke TC. Summary health statistics for U.S. adults: National Health Interview Survey, 2012. *Vital Health Stat 10*. 2014;(260):1–161.
10. Blake H, Zhou D, Batt ME. Five-year workplace wellness intervention in the NHS. *Perspect Public Health*. 2013;133(5):262–71.
11. Brownson RC, Hoehner CM, Day K, Forsyth A, Sallis JF. Measuring the built environment for physical activity: state of the science. *Am J Prev Med*. 2009;36(4 Suppl):S99–123 e12.
12. Carlson SA, Densmore D, Fulton JE, Yore MM, Kohl HW 3rd. Differences in physical activity prevalence and trends from 3 U.S. surveillance systems: NHIS, NHANES, and BRFSS. *J Phys Act Health*. 2009;6(1 Suppl):S18–27.
13. Carlson SA, Fulton JE, Pratt M, Yang Z, Adams EK. Inadequate physical activity and health care expenditures in the United States. *Prog Cardiovasc Dis*. 2015;57:315–23.
14. Carlson SA, Fulton JE, Schoenborn CA, Loustalot F. Trend and prevalence estimates based on the 2008 Physical Activity Guidelines for Americans. *Am J Prev Med*. 2010;39(4):305–13.
15. Caspersen CJ, Powell KE, Christenson GM. Physical activity, exercise, and physical fitness: definitions and distinctions for health-related research. *Public Health Rep*. 1985;100(2):126–31.
16. Centers for Disease Control and Prevention. *Promoting Physical Activity. A Guide for Community Action*. 2nd ed. Champaign (IL): Human Kinetics; 2009. pp. 93–118.
17. Centers for Disease Control and Prevention (CDC). Adult participation in aerobic and muscle-strengthening physical activities—United States, 2011. *MMWR Morb Mortal Wkly Rep*. 2013;62(17):326–30.
18. Centers for Disease Control and Prevention [Internet]. Worksite Health ScoreCard. U.S. Department of Health and Human Services; [cited 2016 January 29]. Available from: http://www.cdc.gov/dhdsp/pubs/worksite_scorecard.htm.
19. Centers for Disease Control and Prevention. Active transportation surveillance—United States, 1999–2012. *MMWR*. 2015;64(7):1–17.
20. Centers for Disease Control and Prevention, National Center for Health Statistics (NCHS) [Internet]. National Health Interview Survey (NHIS). [cited 2016 January 29]. Available from: http://www.cdc.gov/nchs/nhis.htm.
21. Centers for Disease Control and Prevention (CDC), National Center for Health Statistics (NCHS) [Internet]. National Health and Nutrition Examination Survey (NHANES). [cited 2016 January 29]. Available from: http://www.cdc.gov/nchs/nhanes.htm.
22. Cerin E, Conway TL, Saelens BE, Frank LD, Sallis JF. Cross-validation of the factorial structure of the Neighborhood Environment Walkability Scale (NEWS) and its abbreviated form (NEWS-A). *Int J Behav Nutr Phys Act*. 2009;6:32.
23. De Bourdeaudhuij I, Sallis JF, Saelens BE. Environmental correlates of physical activity in a sample of Belgian adults. *Am J Health Promot*. 2003;18(1):83–92.
24. Federal Highway Administration. *Pedestrian and Bicycle Data Collection: Task 2—Assessment*. Washington (DC): U.S. Department of Transportation 2011. pp. 7–23. Available from: U.S. Department of Transportation.
25. German RR, Lee LM, Horan JM, Milstein RL, Pertowski CA, Waller MN, et al. Updated guidelines for evaluating public health surveillance systems: recommendations from the Guidelines Working Group. *MMWR Recomm Rep*. 2001;50(RR-13):1–35.
26. Goldberg DW. *A Geocoding Best Practices Guide*. Springfield (IL): North American Association of Central Cancer Registries 2008. pp. 161–73.
27. Hara K, Le V, Froehlich J. Combining crowdsourcing and Google Street View to identify street-level accessibility problems. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. 2013:631–40.
28. Hipp JA, Reeds DN, van Bakergem MA, et al. Review of measures of worksite environmental and policy supports for physical activity and healthy eating. *Prev Chronic Dis*. 2015;12:E65.
29. Jacobs DRJr, Ainsworth BE, Hartman TJ, Leon AS. A simultaneous evaluation of 10 commonly used physical activity questionnaires. *Med Sci Sports Exerc*. 1993;25(1):81–91.
30. Kelly CM, Wilson JS, Baker EA, Miller DK, Schootman M. Using Google Street View to audit the built environment: inter-rater reliability results. *Ann Behav Med*. 2013;45(1 Suppl):S108–12.
31. Koster A, Caserotti P, Patel KV, et al. Association of sedentary time with mortality independent of moderate to vigorous physical activity. *PLoS One*. 2012;7(6):e37696.
32. Linnan L, Bowling M, Childress J, et al. Results of the 2004 National Worksite Health Promotion Survey. *Am J Public Health*. 2008;98(8):1503–9.
33. Masse LC, de Niet JE. Sources of validity evidence needed with self-report measures of physical activity. *J Phys Act Health*. 2012;9(1 Suppl):S44–55.
34. Mattke S, Liu H, Caloyeras J, et al. *Workplace Wellness Programs Study: Final Report*. Santa Monica (CA): Rand Corporation; 2013. pp. 1–174. Available from: Rand Corporation.
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):587–91.
36. Morrow JJr, Jackson A, Disch J, Mood D. *Measurement and Evaluation in Human Performance*. Champaign (IL): Human Kinetics; 1995. pp. 93–5.
37. National Center for Health Statistics. 2015 NHIS Questionnaire: Cancer Control Supplement. In. Hyattsville (MD): National Center for Health Statistics, Centers for Disease Control and Prevention; 2015.
38. National Collaborative on Childhood Obesity Research [Internet]. Meaures Registry. Washington (DC): National Collaborative on Childhood Obesity Research; [cited 2014 September 15]. Available from: http://nccor.org/nccor-tools/measures/index.php.
39. National Highway Traffic Safety Administration [Internet]. State Traffic Safety Information for Year 2013. [cited 2015 January 7]. Available from: http://www-nrd.nhtsa.dot.gov/departments/nrd-30/ncsa/STSI/USA%20WEB%20REPORT.HTM.
40. Patel MS, Asch DA, Volpp KG. Wearable devices as facilitators, not drivers, of health behavior change. *JAMA*. 2015;313(5):459–60.
41. Pettee Gabriel KK, Morrow JRJr, Woolsey AL. Framework for physical activity as a complex and multidimensional behavior. *J Phys Act Health*. 2012;9(1 Suppl):S11–8.
42. Pew Research Center [Internet]. Smartphone Use in 2015. [cited 2015 January 29]. Available from: http://www.pewinternet.org/2015/04/01/us-smartphone-use-in-2015/.
43. Physical Activity Guidelines Advisory Committee. *Physical Activity Guidelines Advisory Committee Report*. Washington (DC): U.S. Dept of Health and Human Services; 2008. pp. A–1-10. Available from: U.S. Dept of Health and Human Services.
44. Pratt M, Macera CA, Wang G. Higher direct medical costs associated with physical inactivity. *Phys Sportsmed*. 2000;28(10):63–70.

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45. Pronk NP. Fitness of the US workforce. *Annu Rev Public Health*. 2015;36:131–49.
46. Pucher J, Buehler R, Merom D, Bauman A. Walking and cycling in the United States, 2001–2009: evidence from the National Household Travel Surveys. *Am J Public Health*. 2011;101:S310–7.
47. Rainham D, McDowell I, Krewski D, Sawada M. Conceptualizing the healthscape: contributions of time geography, location technologies and spatial ecology to place and health research. *Soc Sci Med*. 2010;70(5):668–76.
48. Rundle AG, Bader MD, Richards CA, Neckerman KM, Teitler JO. Using Google Street View to audit neighborhood environments. *Am J Prev Med*. 2011;40(1):94–100.
49. Ryus P, Ferguson E, Laustsen KM, et al. *Guidebook on Pedestrian and Bicycle Volume Data Collection*. Washington (DC): Transportation Research Board of the National Academies; 2014. pp. 75–99. Available from: Transportation Research Board of The National Academies.
50. Saelens BE, Sallis JF, Black JB, Chen D. Neighborhood-based differences in physical activity: an environment scale evaluation. *Am J Public Health*. 2003;93(9):1552–8.
51. Sallis JF, Bowles HR, Bauman A, et al. Neighborhood environments and physical activity among adults in 11 countries. *Am J Prev Med*. 2009;36(6):484–90.
52. Sallis JF, Kerr J, Carlson JA, et al. Evaluating a brief self-report measure of neighborhood environments for physical activity research and surveillance: Physical Activity Neighborhood Environment Scale (PANES). *J Phys Act Health*. 2010;7(4):533–40.
53. Sallis JF, Saelens BE. Assessment of physical activity by self-report: status, limitations, and future directions. *Res Q Exerc Sport*. 2000;71(2 Suppl):S1–14.
54. Schroeder P, Wilbur M. *2012 National Survey of Bicyclist and Pedestrian Attitudes and Behavior. Volume 1: Summary Report*. Washington (DC): National Highway Traffic Safety Administration; 2013. pp. 13–8. Available from: National Highway Traffic Safety Administration.
55. Sternfeld B, Goldman-Rosas L. A systematic approach to selecting an appropriate measure of self-reported physical activity or sedentary behavior. *J Phys Act Health*. 2012;9(1 Suppl):S19–28.
56. Thacker SB, Berkelman RL. Public health surveillance in the United States. *Epidemiol Rev*. 1988;10:164–90.
57. 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.
58. Troiano RP, McClain JJ, Brychta RJ, Chen KY. Evolution of accelerometer methods for physical activity research. *Br J Sports Med*. 2014;48(13):1019–23.
59. 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*. 2012;9(1 Suppl):S68–75.
60. Tucker JM, Welk GJ, Beyler NK. Physical activity in U.S.: adults compliance with the Physical Activity Guidelines for Americans. *Am J Prev Med*. 2011;40(4):454–61.
61. Tudor-Locke C, Ainsworth BE, Washington TL, Troiano R. Assigning metabolic equivalent values to the 2002 census occupational classification system. *J Phys Act Health*. 2011;8(4):581–6.
62. Tudor-Locke C, Johnson WD, Katzmarzyk PT. Frequently reported activities by intensity for U.S. adults: the American Time Use Survey. *Am J Prev Med*. 2010;39(4):e13–20.
63. Tudor-Locke C, Rowe DA. Using cadence to study free-living ambulatory behaviour. *Sports Med*. 2012;42(5):381–98.
64. U.S. Bureau of Labor Statistics [Internet]. American Time Use Survey. [cited 2016 January 29]. Available from: http://www.bls.gov/tus/.
65. U.S. Department of Health and Human Services [Internet]. Healthy People 2020. Washington, D.C.; [cited 2015 January 7]. Available from: http://www.healthypeople.gov/2020/default.aspx.
66. U.S. Department of Health and Human Services. *2008 Physical Activity Guidelines for Americans: Be Active, Healthy, and Happy!* Washington (DC): U.S. Dept. of Health and Human Services; 2008. pp. 7–14.
67. U.S. Department of Health and Human Services. Step It Up! The Surgeon General's Call to Action to Promote Walking and Walkable Communities. Washington (DC): U.S. Dept of Health and Human Services, Office of the Surgeon General; 2015. p. 46.
68. U.S. Department of Housing and Urban Development, U.S. Department of Transportation, Sustainable Communities [Internet] Location Affordability Portal Version 2 website. Understanding the Combined Cost of Housing and Transportation. Washington (DC): U.S. Dept of Housing and Urban Development; [cited 2015 April 7]. Available from: http://www.locationaffordability.info/.
69. U.S. Department of Labor, Bureau of Labor Statistics [Internet]. Economic News Release: Employment Situation Summary Table A. Household Data, Seasonally Adjusted. Washington (DC); [cited 2015 April 15]. Available from: http://www.bls.gov/news.release/empsit.a.htm.
70. U.S. Department of Transportation [Internet]. Road Safety Assessments Website. [cited 2015 April 18]. Available from: http://www.dot.gov/policy-initiatives/ped-bike-safety/road-safety-assessments.
71. U.S. Department of Transportation Federal Highway Administration [Internet]. National Household Travel Survey. Our Nation's Travel. [cited 2015 February 6]. Available from: http://nhts.ornl.gov.
72. U.S. Environmental Protection Agency. Smart Location Mapping website. [Internet]. Interactive Maps And Data For Measuring Location Efficiency and The Built Environment. [cited 2015 January 21]. Available from: http://www.epa.gov/smartgrowth/smartlocationdatabase.htm.
73. U.S. National Physical Activity Plan Coordinating Committee [Internet]. National Physical Activity Plan. [cited 2015 March 20]. Available from: http://www.physicalactivityplan.org/NationalPhysicalActivityPlan.pdf.
74. Watson KB, Carlson SA, Carroll DD, Fulton JE. Comparison of accelerometer cut points to estimate physical activity in US adults. *J Sports Sci*. 2013;32(7):660–9.
75. Woolf K, Reese CE, Mason MP, Beaird LC, Tudor-Locke C, Vaughan LA. Physical activity is associated with risk factors for chronic disease across adult women's life cycle. *J Am Diet Assoc*. 2008;108(6):948–59.

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