Measuring Physical Activity in Outdoor Community Recreational Environments: Implications for Research, Policy, and Practice

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Abstract Chronic diseases such as cardiovascular disease (CVD) are major contributors to escalating health care costs in the USA. Physical activity is an important protective factor against CVD, and the National Prevention Strategy recognizes active living (defined as a way of life that integrates physical activity into everyday routines) as a priority for improving the nation's health. This paper focuses on developing more inclusive measures of physical activity in outdoor community recreational environments, specifically parks and trails, to enhance their usability for at-risk populations such as persons with mobility limitations. We develop an integrated conceptual framework for measuring physical activity in outdoor community recreational environments, describe examples of evidence-based tools for measuring physical activity in these settings, and discuss strategies to improve measurement of physical activity for persons with mobility limitations. Addressing these measurement issues is critically important

to making progress towards national CVD goals pertaining to active community environments.

Keywords Parks · Trails · GIS · Measurement · Mobility limitations · Disability · Physical activity · Active living

Introduction

Chronic diseases such as cardiovascular disease (CVD) are major contributors to escalating health care costs, which the Congressional Budget Office projects will be the primary driver of the national debt over the coming decades [1]. Physical activity is an important protective factor against heart disease and stroke, which are the first and fourth leading causes of adult death in the USA [2]. The National Prevention Strategy [3] recognizes active living (a way of life that integrates physical activity into everyday routines) as a priority area for improving the nation's health and emphasizes safe and healthy community environments, along with clinical and community preventive services, empowered people, and elimination of health disparities, as a key strategic direction to guide actions that will demonstrably improve health.

Studies have demonstrated that activity-friendly community environments depend on characteristics such as urban form [4], neighborhood design [5], neighborhood environmental quality [6], streetscapes [7], vegetation [8], greater proportion of greenspace [9, 10], higher residential density [10], safety [10, 11, 12], and policies that support walking, bicycling, and proximity to recreation areas [12, 13]. For example, studies have shown that individuals who live near parks are more likely to achieve recommended levels of physical activity [14, 15, 16]. Accordingly, the Centers for Disease Control and Prevention (CDC) developed state-based policy and environmental indicators to track relevant metrics [17]. Indicators for the recommended strategy to enhance and create access to

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places for physical activity include the following: (i) the percentage of youth with “parks or playground areas, recreation centers, community centers or boys’ or girls’ clubs, and sidewalks or walking paths available in their neighborhood” and (ii) “the percentage of a state’s population that lives within ½ mile of a park.” For the purposes of this paper, we will focus on outdoor community recreational environments, specifically parks and trails, because the direct and indirect health benefits they confer are particularly important to the prevention and management of CVD. For example, emerging research suggests that, in addition to directly promoting physical activity, outdoor community recreational environments may support better mental health [18], stress reduction [19], positive self-esteem [20], and social engagement [21]. Physical inactivity and poor mental health are associated with a higher incidence of heart disease [22] and stroke [23•], and they are also important sequelae of CVD [24].

To maximize the role of outdoor community recreational environments in CVD prevention, such environments must be accessible and usable to all, including those at greatest risk of CVD and other chronic diseases. Population subgroups that are at increased risk of CVD include lower socioeconomic (SES) persons [22], racial/ethnic minorities [25, 26], those living in rural areas of the USA [27], and persons with disabilities such as mobility limitations [28]. “Mobility limitations” describes people who have difficulty ambulating and are unable to walk short distances or climb stairs [29, 30].

While acknowledging that further research needs to be conducted to better understand the unique needs of at-risk populations with respect to their engagement in outdoor community recreation, we focus on examining ways to develop more inclusive measurement tools that can be applied to populations with a range of physical abilities, including those with mobility limitations. This is particularly important for CVD policy because stroke is one of the leading causes of long-term disability in the USA [22], yet persons with mobility limitations are rarely discussed in active-living research, even in related research focused on health disparities [31–33]. With few exceptions [21, 28, 34], research examining the needs of persons with mobility limitations has been published in a relatively distinct body of literature (e.g., disability studies and rehabilitation medicine). This lack of integration has resulted in critical gaps in the measurement of physical activity in outdoor community recreational settings as well as limited development of transdisciplinary planning processes and interventions that address a continuum of mobility needs.

Thus, the purpose of this paper is to support an integrated literature by developing an inclusive conceptual framework that incorporates the needs of persons with mobility limitations into national CVD policy goals pertaining to active living.

Specifically, this paper aims to:

1. Develop an integrated, inclusive conceptual framework for measuring physical activity in outdoor community recreational environments
2. Describe examples of evidence-based tools for measuring physical activity in outdoor community recreational environments
3. Apply the conceptual framework to consider how tools may be combined and/or adapted to provide more inclusive measurement of physical activity for at-risk populations, such as those with mobility limitations

Conceptual Framework

Our conceptual framework for more integrated, inclusive measurement of physical activity in outdoor community recreational environments builds upon the work of Sallis [35•] and Gray et al. [36•] who reviewed the contributions of diverse literatures to the development of contemporary measures of physical activity in community environments, including outdoor settings such as parks and trails. Sallis [35•] reviewed the contributions of three distinct literatures to physical activity measurement in community environments: (1) public health, (2) urban planning, and (3) leisure studies. Gray et al. [36•] extended this work to include research from the fields of disability studies and rehabilitation medicine, underscoring the importance of measuring physical activity among persons with mobility limitations, who are among the most sedentary sub-populations in the USA [34]. Research suggests that persons with mobility limitations often lack access to health-promoting environments [34, 37], despite being at greater risk for CVD and other chronic diseases [38].

Our conceptual framework, shown in Fig. 1, advances this integration by defining specific *convergent domains* as precursors to developing more inclusive measurement tools, ultimately allowing us to better assess the impact of active-living policies with respect to CVD outcomes for populations with diverse mobility needs. The shaded area in Fig. 1 delineates the integration of the disability studies to complement the public health, urban planning, and leisure study literature.

Measuring Convergent Domains in Outdoor Community Recreational Environments

In order to develop a coherent, inclusive framework for measuring physical activity in outdoor community recreational environments, differences in terminology across scholarly fields must be examined, and a set of operational definitions proposed. As described by Iwarsson and Stahl [39], several

Fig. 1 Conceptual framework illustrating convergent domains for integrated, inclusive measures of physical activity in outdoor community recreational environments

key terms are used similarly, but not synonymously, across different disciplines to describe how people interface with outdoor community environments. These convergent domains include “access,” “accessibility,” “use,” “usability,” “quality,” “safety,” “barriers,” and “facilitators.”

Some researchers conceptualize these domains in a nested, hierarchical manner, such that each subsequent domain implies greater measurement specificity and draws upon more granular constructs [36•, 39]. Below, we provide a brief operational definition for each convergent domain. Examples of tools and how measures have been applied are shown in Table 1.

Access refers to how easily people can reach, enter, and leave a community environment. For example, this includes characteristics such as whether the space is frequently locked or rented out to others, public transit availability, sidewalks, paths, and bike lanes leading to the facility, and physical proximity. Other researchers define access as the match between the characteristics and expectations of users and the features of a system, including sub-domains such as availability, accessibility, affordability, accommodation, and acceptability [40]. However, as noted by Butler et al. [41], active-living research has focused primarily on measuring the availability and proximity-related components of access, with relatively little measurement specificity for the other dimensions. The disability community draws attention to features such as disability-accessible parking spaces, entrances that are wide enough to accommodate mobility aids, and special restroom facilities that must be considered under inclusive conceptualizations of access.

The term *accessibility* considers a more comprehensive set of characteristics that support access for all, regardless of physical ability [42, 43]. For example, Iwarsson and Stahl [39] focus on the notion of “person-environment fit,” which posits a dynamic relationship between a person’s functional capacity and their environment. From this perspective, accessibility requires integration of personal (qualitative) and environmental components. For example, research suggests that factors such as obstacle-free paths, surface texture, slope, curb cuts, and signage can differentially affect accessibility to community settings [21, 44••].

The terms *use* and *usability* take the domain of accessibility one step further by describing how certain characteristics restrict or support a person’s engagement with a given environment for a particular purpose [39]. Use tends to be employed more frequently in the literature pertaining to the general population, while usability tends to appear more frequently in the disability literature. For example, measuring park use may include measuring how many people visit the park each day, what activities they participate in, and which programs they engage in [45•, 46–48]. Usability, as defined in the disability community, contends that not only should people with mobility limitations be able to access outdoor community settings just like their non-disabled counterparts, but also they should be able to fully engage in activities in those environments [39]. For example, if people with mobility limitations can enter a park but the walkways are uneven or too narrow, then the area is accessible but it may not be usable [49••]. Researchers have reported poor usability of many types of community environments for persons with mobility limitations [44••, 50].

The *quality* of outdoor community recreational environments, including characteristics such as the amenities offered, aesthetics, maintenance, equipment, layout, and lighting, can greatly affect its use and usability. For example, research suggests that parks that are consistently well maintained, aesthetically appealing, and safe are associated with increased use and higher levels of physical activity compared to parks without these characteristics [14, 51, 52]. A study conducted in 28 parks suggests that moderate-to-vigorous physical activity (MVPA) was more likely to occur in parks that included athletic courts, sports fields, and playgrounds [53]. Findings from another recent study suggest that parks with trails and wooded areas were much more likely to be used for physical activity compared to parks that did not have these characteristics [48]. In a study of persons with mobility limitations, Kirchner et al. [28] found that curb cuts and well-maintained paved paths were particularly important for wheelchair users compared to persons who did not use wheelchairs. Christensen et al. [54] found that features such as pathway texture, disconnected pedestrian ways, signage, and slope have more influence on physical activity participation among people with disabilities compared to people without disabilities. Furthermore, the quality of park features may differ by

Table 1 Convergent domains pertaining to characteristics of outdoor community recreational environments for physical activity, and ways they have been measured

Examples of tools and measures	Convergent domains							
	Access ^a	Accessibility ^b	Use ^c	Usability ^d	Quality ^e	Safety ^f	Barriers ^g	Facilitators ^h
Percieved								
• Presence of recreational facilities index [74]	X				X			
• Access to facilities and destinations questionnaire [75]	X				X		X	
• Neighborhood Environment Walkability Scale (NEWS A) [76]	X							
• Youth perceptions of environmental factors from the Trial of Activityin Adolescent Girls (TAAG) [77]	X							
• Facilitators and Barriers Survey (FABS) measures subjective features of an environment from the perspective of the user. Developed for persons with disabilities; includes a tool (FABS/M) specifically for persons with lower limb mobility limitations [90] ⁱ	X	X		X			X	X
• Park use questionnaire [94]			X					
• Park use and benefits questionnaire [95]	X		X					
• Physical activity in the park setting questionnaire (PA-PS) [96]. This instrument also asks about social factors (who a person visited the parkwith).			X					
• Trail use survey [86]	X		X					
• Craig Hospital Inventory of Environmental Factors (CHIEF) includes items jointly developed by persons with disabilities, health professionals, and other stakeholders. Although the tool is not specific to outdoor recreational environments, it includes items pertaining to terrain, temperature, lighting, as well as social and policy-related factors that could be considered in outdoor recreational environments [98] ⁱ		X				X		
• Trail intercept survey [106]	X		X		X	X		
• Barriers to Physical Activity and Disability Survey (B-PADS) [44••] ⁱ	X	X		X		X		
• Qualitative interview [127, 128]	X		X		X	X	X	X
Observed:								
• Quick Pathways Assessment Tool (Q-PAT); measures features such as whether there is a minimum 60×60 in. clearance for entrances [78] ⁱ	X	X		X	X			
• Bedimo-Rung Assessment Tools using Direct Observation (BRATDO) [79]; measures features such as width of pathways ⁱ	X	X		X	X			
• System for Observing Play and Recreation in Communities (SOPARC) [80]; measures presence of people in park target area and accessibility features	X	X	X					
• Path Environment Audit Tool (PEAT) [91]; measures features pertaining to quality and safety (e.g., presence of call boxes) ⁱ	X	X	X	X	X			
• Community Park Audit Tool (CPAT) [99]		X		X	X	X		
• Accessibility Instruments Measuring Fitness and Recreation Environments (AIMFREE) [100] ⁱ		X		X	X	X	X	X
• Community Health and Environment Checklist–Mobility (CHECM) [93] ⁱ		X		X	X	X	X	X
• New York City park quality [87]		X		X	X	X		
• King County Design for Active Communities Taskforce checklist [102] ⁱ		X		X	X	X	X	X
• Physical Activity Resource Assessment (PARA) [103]		X		X	X	X		
• Environmental Assessment of Public Recreation Spaces (EAPRS) [104] ⁱ		X		X	X	X	X	X

Table 1 (continued)

Examples of tools and measures	Convergent domains							
	Access ^a	Accessibility ^b	Use ^c	Usability ^d	Quality ^e	Safety ^f	Barriers ^g	Facilitators ^h
•National Program for Playground Safety Standardized Survey [107]						X		
•ADA Checklist for Readily Achievable Barrier Removal (not specific to outdoor recreational environments, but offers general guidance) ⁱ	X		X	X	X	X		
•Spivok et al. (2007) study of neighborhood-level active living supports (buoys) [63] ⁱ	X		X	X			X	
GIS-based								
•Number of parks or park acres per unit area or population [32, 81–83]	X							
•Percent of tract population within one-quarter mile of a park boundary; park acres per 1000 population living within one-quarter mile bufferzone [83]	X							
•Total number of facilities in the park or number of unique facility types accessible from the census tract [32]	X							
•Population weighted distance to parks [82]	X							
•Percent of census blocks that had parks within their block or within 0.5 miles of the block boundary [17, 129]	X							
•Distance from home to a park entrance or areas around the perimeter of the park that were accessible [85]	X							
•Distance from home to a specific trail [86]								
•Proportion of buffer around home that was park space [32, 87, 88]	X							
•Kernel densities of parks near home [89]	X							
•Amount of green space within each county; distance from census tract centroid to the nearest green space; amount of green space within buffers around the census tract [92]	X							
•Amount of green space within each county; distance from census tract centroid to the nearest green space; amount of green space within buffers around the census tract [92]	X							
•Percent of green space (using the National Land Cover Classification database) within a certain distance from home [130]	X							
•Public participation geographic information system (participatory GIS); park benefits [68]	X		X					X
•Accessibility to public open space [131]	X							X
•Participatory photo mapping: Photovoice and community mapping [69–71]		X	X	X	X	X	X	X
•Road distance to nearest green space; number and area of green spaces within 2-km radius of each resident; accessibility index that weighted distance to a park and also considered size and quality of parks; quality based on attractiveness of greenspace (overview of methods [105])	X				X			

For reviews of further examples, see Brownson et al. [66••], Butler et al. [41], and Grey et al. [36••]

PA physical activity, *GIS* geographic information systems

^a Access. Physical proximity to a setting; ways to enter and leave the setting; spatial distribution of settings in relation to population subgroups

^b Accessibility. The fit between a person's functional capacity and their environment; this includes, but is not limited to, ADA compliance

^c Use. Presence of individuals in a park (being physically active)

^d Usability. Characteristics that restrict or support a person's engagement with a given environment for physical activity

^e Quality. The types of amenities offered, equipment, maintenance, supervision, and programming

^f Safety. Includes various sub-domains such as crime rates, fear of crime, protection from injury, and protection from traffic

^g Barriers. Characteristics that prevent or limit accessibility, usability, and participation in physical activity

^h Facilitators. Characteristics that enhance accessibility, usability, and participation in physical activity

ⁱ Tools that include items relevant to persons with disabilities/mobility limitations

sociodemographic context, contributing to disparities in physical activity [32].

Notably, research has demonstrated that both perceived and objectively measured characteristics of the built environment are independently associated with physical activity [55] and that perceptions of aesthetics, safety, and social cohesion may be important mediators of the relationship between the built environment and physical activity [56]. However, researchers are just beginning to explore how perceived and objectively measured indicators of quality may differentially affect physical activity among diverse population subgroups [57, 58], such as those with mobility limitations.

Safety, although frequently considered a sub-domain of quality, is important to highlight because it includes several different components (e.g., safety from crime, safety from injury/falls, safety from traffic), each of which may be perceived differently by various population subgroups [58, 59]. Overall, debris, inadequate lighting, graffiti, overgrown vegetation, unleashed dogs, and vacant lots are associated with feeling unsafe in community environments [11•, 60]. However, studies have also shown that boys and girls have different perceptions of safety regarding different types of outdoor recreational settings [61] and activities [62]. In contrast, a small study of older adults with mobility limitations found that most respondents reported feeling safe overall and did not report feeling that they were at greater risk because of their disability [49••]. Examining perceptions of safety among different population subgroups is a key area for future research.

Barriers are characteristics that prevent or limit accessibility, usability, and participation in physical activity in outdoor community recreational settings. Prior research has identified many aspects of the built environment that create barriers to participation in outdoor community recreation for people with mobility limitations [63, 64]. For example, poorly designed and maintained curb cuts, routes, ramps, parking, and restroom areas have been identified as barriers for this population [34, 49••]. Research suggests that many of these factors remain unaddressed, even in light of the Americans with Disabilities Act (ADA) [21, 28, 65].

However, many of these factors have alternately been cited as *facilitators* or *enablers*—characteristics that enhance accessibility, usability, and participation—when they are designed and maintained properly [49••]. In the disability literature, facilitators are sometimes referred to as “buoys” [63]. For example, Rimmer et al. [34] cited family changing rooms as one of the most frequently reported facilitators of physical activity in community settings, enabling parents or personal assistants to help persons with disabilities dress for physical activity.

Types of Measures

In a comprehensive review, Brownson et al. [66••] emphasized that the development of high-quality measures is

essential to facilitating a better understanding of the impact of the built environment on physical activity. Three categories of measures were reviewed as follows: (1) *perceived measures* collected through the use of interviews, surveys, or self-administered questionnaires; (2) *observational measures* collected through systematic methods such as audits and checklists; and (3) *geographic information system (GIS)-based measures* (archival data sets that are often layered and analyzed with spatial software). Multiple modes of assessment can be especially important in terms of including the perspectives of persons with different needs, such as those with mobility limitations. Brownson et al. [66••] underscore the need for further research to improve the quality of various measures (e.g., psychometric properties, specificity), to better understand their relevance to various population subgroups as well as to improve their utility for research, practice, and policy.

Pertinent to this study, the convergent domains of accessibility, usability, quality, safety, barriers, and facilitators become increasingly difficult to measure using observational or GIS-based assessments alone because perceptions of the “user” are inherent in the interpretation of the domain. Including perceptions can be achieved by complementing GIS and/or observational tools with qualitative assessment modes such as ethnography [28], interviews [12, 49••], Photovoice [61, 67], ecological momentary assessment [72], or using blended methodologies such as participatory GIS [68] and photo mapping [69–71]. The aforementioned examples align with community-based participatory research and participatory action research, which have the added benefit of fostering empowerment of community members [73].

Measuring Physical Activity in Outdoor Community Recreational Environments

The next step in maximizing the role of outdoor community recreational environments for CVD prevention involves measuring the extent to which diverse populations are using these settings for physical activity. Measurement of physical activity includes assessing whether people are participating in physical activity, and determining the type, frequency, duration, and intensity of physical activity. This is particularly relevant for CVD prevention because MVPA, performed for at least 30 min on ≥ 5 days per week, confers the greatest cardiovascular health benefits [110]. Convergent domains pertaining to measuring physical activity in outdoor community recreational environments, and examples of their application, are shown in Table 2.

Notably, if the type or mode of physical activity is reported, then intensity can be assigned a metabolic equivalent of task (MET) value reflecting energy expenditure by using the Compendium of Physical Activity for youth [111] or adults [112]. However, as described by Lee et al. [113], the

Table 2 Convergent domains pertaining to measuring physical activity in outdoor community recreational environments, and examples of applications

Examples of tools and their application in outdoor community recreational environments	Convergent domains			
	Participation ^a in PA	Type ^{b,c}	Intensity ^d	Frequency and duration ^e
Perceived:				
•Ecologic momentary assessment (Dunton, 2013 no. 10)	X	X		X
•Park use questionnaire [94]	X	X		
•Physical activity in the Park Setting questionnaire [96]	X	X		
•Physical Activity Scale for Individuals with Physical Disabilities (PASIPD) queries the number of days a week and hours daily (categories) of participation in recreational, household, and occupational activities over the past 7 days [117, 118] ^f	X	X		X
•PARA-SCI measures the intensity of physical activity, averaging the number of mild, moderate, and heavy activities across three recall days. Developed for persons with spinal cord injuries [115]	X	X	X	
•Trail intercept survey [106]	X			X
Observed:				
•System for Observing Play and Recreation in Communities (SOPARC) records physical activity in specified target areas within parks [80]; assigns one of three intensity levels (sedentary, walking, vigorous) for each person in a park target area [80].	X	X	X	
•System for Observing Physical Activity and Recreation in Natural Areas (SOPARNA) records the type of physical activity performed within wilderness areas and natural open spaces [120]; assigns one of three intensity levels (sedentary, moderate, vigorous).	X	X	X	
•Collins et al. [114] determined the energy expenditure for 27 different types of physical activity commonly performed by individuals with a spinal cord injuries (e.g., hand cycling, wheeling on grass). ^f	X	X	X	
GIS-based				
•Combined accelerometry and GPS units worn by participants can indicate the location and the intensity of the physical activity [16•, 72]; can be combined with qualitative methods such as interviews [49••] or surveys	X	X (with interview)	X (with accelerometry)	X (with PA diary/survey)
•Public participation geographic information system (Participatory GIS) [68]	X	X (with interview)	X (with accelerometry)	X (with PA diary/survey)
•Participatory Photo Mapping [69–71]; Photovoice and community mapping can be combined with GIS, accelerometry surveys, interviews	X	X (with interview)	X (with accelerometry)	X (with PA diary/survey)

PA physical activity, GIS geographic information systems

^a Participation. Engagement in physical activity in outdoor community recreational settings

^b Type. The kinds of physical activities that are being performed

^c If type or mode of PA is reported, then intensity can be assigned using the compendium for youth [111] or adults [112]

^d Intensity. Classification of physical activity into categories related to energy expenditure (e.g., MVPA.)

^e Frequency and duration. How often physical activity is performed, and for how long

^f Denote specific applicability of the tool for persons with mobility limitations

compendium may not be appropriate for persons with certain types of disabilities. For example, people with paraplegia have been shown to have a low resting metabolic rate, which can alter the MET thresholds for different physical activities. Lee et al. [113] underscore the need for a supplement to the compendium to address the needs of populations with different types of disabilities. Specifically, they identify two key research gaps that must be addressed in order to develop more inclusive measures of MVPA in community environments: (1) exercise science/physiology research to determine alternative MET values for people with different types of mobility limitations and (2) research to classify the types of physical activities that persons with mobility limitations perform into appropriate categories based on energy expenditure characteristics.

Collins et al. [114] provide a foundation for this work by determining the energy expenditure of activities commonly performed by individuals with spinal cord injuries and measuring the energy expenditure at rest (1 MET) as well as the energy expenditure for 27 different types of physical activities (e.g., hand cycling, wheeling on grass). Another tool developed specifically for persons with spinal cord injuries, the PARA-SCI [115], measures the intensity of physical activity, taking into account activities of daily living and averaging the number of mild, moderate, and heavy activities across three recall days [116]. These initiatives should be expanded through future research.

Recommendations for Inclusive Measurement of Physical Activity in Outdoor Community Recreational Environments

We suggest four key recommendations for more inclusive measurement of physical activity in outdoor community recreational environments. First, through greater use of collaborative research paradigms such as community-based participatory research, participatory action research, and community-engaged research, groups with different perspectives (such as those with mobility limitations) should be engaged in the research process from start to finish [73]. This means involving community members in developing research questions, considering appropriate methodological approaches, re-thinking how to combine various modes of assessment (e.g., perceived, objective, GIS-based), testing new measures/metrics, and interpreting results. Examples of such collaborative processes include the development of the Prevention Research Center Healthy Aging Network audit tool [101] and the King County Active Community Checklist [102], which emphasize the inclusion of at-risk populations such as older adults and persons with disabilities in the planning process.

Other existing tools that were developed using a collaborative approach include the Accessibility Instruments Measuring Fitness and Recreation Environments

(AIMFREE) [100], which provides two complementary modules to capture the perspectives of “consumers” (persons with disabilities) alongside those of other stakeholders such as urban planners, parks/recreation staff, landscape designers, and policymakers. This tool includes six subscales pertaining to accessibility of the built environment, equipment, information, policies, swimming pools, and professional behavior. Similarly, the Community Health Environment Checklist (CHEC) and corresponding Community Accessibility Maps [93] were created in partnership with persons with disabilities. These tools focus primarily on indoor environments, but the method could be expanded to assess and map outdoor community recreational environments. The emerging field of participatory GIS [68] intentionally draws upon the meanings and perceptions of community members in combination with objective GIS constructs. Innovative technologies such as ecological momentary assessment [72] are inherently situated at the nexus of the “person-environment” dynamic and can be utilized by people with many types of mobility limitations.

As shown in Table 1, several existing tools already include items relevant to persons with mobility limitations [36•], and many can also be adapted to be more inclusive. For example, systematic observation is a direct observational method of data collection that does not place burden on participants and can be applied in parks. The System for Observing Play and Recreation in Communities (SOPARC) [80] tool captures park use and attributes about the park at the time of measurement. The tool could be made more inclusive by expanding the dichotomous (yes/no) park descriptor questions asked at the beginning of each park scan to include information about attributes of usability (e.g., slopes, surface textures, path widths, availability of accessible bathrooms, and changing areas). SOPARC currently captures only three categories of physical activity (sedentary, walking, and vigorous) without providing guidance about how activities such as wheeling or hand cycling could be classified. SOPARC could also be combined with other modes of assessment (e.g., interviews, surveys, photo mapping, environmental surveillance data [97]) to better understand how park users with different mobility needs engage with their environment. The interaction of social and environmental barriers/facilitators also warrants further study. For example, Rimmer et al. [44•] found that stroke survivors frequently reported knowledge-related barriers to participation in physical activity (e.g., lack of awareness of nearby recreational environments; no knowledge of where to exercise). Involving persons with mobility limitations in adapting various modes of assessment to better serve the needs of their community could also serve to build capacity and empower individuals.

Combining observational tools such as SOPARC with perceptual or GIS-based tools can also be used to evaluate the impacts of environmental interventions. For example, if a park constructs more facilities or programs for differentially

abled persons, does this increase park use and/or physical activity in the park? It is important to note that while many observational tools have been developed, many of these tools currently lack information on reliability, validity, and other psychometric properties. Gray et al. [36••] provide a useful review summarizing this information.

A second critical gap pertains to the need for more research to develop measures of physical activity intensity (e.g., MVPA) in populations with different types of disabilities. Studies by Kayes et al. [119], Lee et al. [113, 121], and Collins et al. [114] have provided a strong foundation by developing metabolic equivalents for physical activity among persons with certain types of disabilities (e.g., spinal cord injuries, paraplegia), but there is a paucity of research regarding how metabolic equivalents should be determined for other disabled populations, including stroke patients.

Third, as more inclusive measures of physical activity in outdoor community recreational environments are developed, findings should be effectively translated to inform practice and policy. Involving community members, practitioners, and decision makers in the research process is one step towards facilitating ownership of results, thus creating a shared place-based perspective and potentially providing impetus to implement feasible solutions. The ADA provides a checklist for “readily achievable barrier removal,” [109] which focuses on the specific context of a community. Riley et al. [21] describe strategies to deconstruct the process of barrier removal into a series of manageable steps through the use of Accessibility Transition Plans (ATPs). Iwarsson and Stahl [39] suggest a shift away from merely removing barriers to encouraging more inclusive types of design, such as Universal Design [122]. Universal Design includes principles such as equitable use, tolerance for error, flexibility, perceptible information, size and space for approach, and simple/intuitive features which can inform the development or retrofit of environments to make them more inclusive of users with diverse needs [36••, 42]. The National Park Service has operationalized Universal Design principles for park contexts [123]. These approaches can enable decision makers, urban planners, and other stakeholders to work towards creating more inclusive environments.

Fourth, to achieve national CVD prevention goals, high-quality outdoor community recreational environments must become more accessible and usable to at-risk populations who need them most. For example, many studies of access to parks and trails take a social/environmental justice approach and seek to assess the equity of distribution of resources across population subgroups [84, 108, 124]. Research suggests that parks in disadvantaged areas may be smaller, of lower quality, and have more incivilities such as litter and graffiti [32]. Further studies of quality and safety domains are particularly important

because sociodemographic variables alone have demonstrated relatively limited power to predict which populations use parks for recreation, and how often [104]. Although little is known about the interaction of poverty and disability with respect to outdoor community recreational environments, parks and trails may be among the few affordable spaces for physical activity in disadvantaged areas. Furthermore, although this paper focuses on physical activity, the mental health and social benefits associated with outdoor community recreational environments warrant further study in diverse populations. The National Prevention Strategy, supported by new financial incentives created by the Affordable Care Act to facilitate population health and recent private sector interest in health-related community investing [125, 126], provide an unprecedented opportunity to create healthier community environments for all Americans.

Conclusion

As public health practitioners and others have increasingly sought environmental and policy-level changes for CVD prevention, research related to the health benefits associated with outdoor community recreational environments has expanded greatly. By developing inclusive measurement tools that incorporate the needs of at-risk populations, utilizing community-engaged research processes, and more effectively translating research to policy, the National Prevention Strategy’s key strategic directions—safe and healthy community environments, empowered people, and elimination of health disparities—are more likely to be implemented. Achieving these goals holds great potential for reducing the burden of CVD for future generations.

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Compliance with Ethics Guidelines

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Human and Animal Rights and Informed Consent This article does not contain any studies with human or animal subjects performed by any of the authors.

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