

# Potential Measures for Linking Park and Trail Systems to Public Health

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**EXECUTIVE SUMMARY:** The connection between the outdoor environment and general well-being has been intuitively recognized for centuries. Recent research has built a body of knowledge supporting the role of parks and trails in public health regarding physical, mental, social and ecological health domains. However, different populations and communities use parks and trails in varying ways and to different degrees. Understanding these differences can play an important role in guiding systematic park and trail system planning for maximizing beneficial health outcomes. In light of this, a collaborative process involving the National Park Service (NPS) Rivers, Trails, and Conservation Assistance Program (RTCA) and North Carolina State University (NCSU), with support from the Centers for Disease Control and Prevention (CDC), was used to identify potential health measures associated with public parks and trails that could be used for future surveillance, advocacy, and planning. This literature review is the initial step in the process of recommending measures that are both valid and feasible for practitioner and planning use. A systematic strategy was utilized to search for studies that incorporated measures of health or well-being related to parks and trail system planning. A total of 37 study measures were identified that focused on one of five health categories: physical, psychological, social, ecosystem services, and the built environment. Current practices for allocating parks and trails in the planning process are not based on empirical evidence and may or may not support the goals of public health and well-being that were a large part of the original impetus for providing public parks and trails. The health problems agencies are trying to address are not going away, and may be exacerbated by new ones as cities continue to grow and change. The intent of this study is to identify validated metrics, which link parks and trails to public health goals. The collection of park and trail data related to these public health outcomes could be used to inform policies, practices, guidelines, and other strategies for the allocation and management of parks and trails. Results from this research have four important implications for professionals and advocates in the fields of parks, recreation, trails, greenways, open space, and health: (1) to help make the case for public health goals related to park

and trail system planning; (2) guide practitioners in their efforts to provide health-related recreation opportunities; (3) support community recreation and conservation projects; and (4) encourage more productive conversations among planners, advocates, managers, and researchers.

**KEYWORDS:** *Parks, trails, surveillance, metrics, park and trail system planning*

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### Community Health and Public Parks and Trails

The term *well-being* denotes a holistic and community-based focus on health that encompasses several dimensions (Dinnie, Brown, & Morris, 2013). Indeed, the World Health Organization (WHO) defines health as “a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity” (WHO, 1946). However, the holistic well-being of the American population is challenged on many fronts. Although longer lifespans and higher standards of living are among the positive outcomes of improved technology and urbanization, changing lifestyles associated with these advances have also led to new health issues. A reduction in ailments once related to hard physical labor, poor nutrition, and unsanitary conditions, have been counterbalanced by higher stress and sedentary lifestyles. Consequently, in the U.S., noncommunicable diseases are estimated to account for 88% of total deaths (WHO, 2014). Among those mortalities, the leading causes of death include heart disease, cancers, chronic lower respiratory diseases, diabetes mellitus, and intentional self-harm (CDC, 2013).

In addition to mortalities, morbidities leading to poorer health and quality of life have increased significantly in recent years. For example, 69% of U.S. adults (20 years and older) are overweight or obese (CDC, 2013). Only 49.2% of U.S. adults (18 years and older) meet the Physical Activity Guidelines for aerobic physical activity (CDC, 2013).

Additionally, 18.5% of all U.S. adults (18 years and older) have been diagnosed with mental illness (CDC, 2013). In 2013, 15.7 million U.S. adults had at least one major episode of depression. Approximately 9.3 million U.S. adults had serious thoughts of suicide and in 2013, 41,149 deaths resulted from intentional self-harm (CDC, 2013).

In response to today’s health challenges, including rising rates of chronic diseases, healthy places initiatives promote equitable and accessible environments that holistically support the well-being of all people who live, work, and visit there (Urban Land Institute, 2013). In this regard, parks and trails are arguably “the single most important category of publicly owned open space in U.S. cities” (Talen, 2010, p. 473). The availability of public parks and trails are a critical determinant of

community health and well-being. As the world's population shifts from mostly rural to mostly urban and suburban, addressing the needs of urban and suburban residents becomes increasingly important (Bilger & Carrieri, 2013).

Parks and natural spaces have long been associated with public health. In the mid-1800s, government-provided parks were implemented as policy elements intended to protect the health, safety and welfare of residents (Crompton, 2010) as part of reformist movements aimed at treating poor physical health and 'moral degradation' due to urban conditions (Stanley, Stark, Johnston, & Smith, 2012). It was intuitively understood that fresh air and exercise provided relief from disease and mental stress, but only recently has there been a determined effort to study the specific nature of this association. Today, parks and trails provide a framework upon which to create a healthy city. By protecting land from development and providing spaces for leisure, recreation, and community engagement, public parks and trails can address the holistic health needs of a community.

Because urban parks and trail systems have significant potential to improve and enhance community health, development of suitable metrics to quantify and evaluate their impacts is needed to guide public planning and policy actions. This study sought to identify measures that allow for the collection of park and trail data related to these public health outcomes. Such measures can be used to provide a foundation for planning, evaluating, and promoting the provision of parks and trails at municipal, regional, and national levels. Through the use of such measures, park and trail system planners, public health professionals, community leaders and researchers can work to identify and quantify the impact of parks and trails within local communities and compare those results across jurisdictions and time. The goal of this effort was to provide a starting point for improving and, ultimately, recommending methods for evaluating, monitoring and maintaining park and trail systems as they relate to community health outcomes. Specifically, this study first examines how parks and trails benefit community health outcomes and then assesses established metrics related to these health outcomes.

### **Health Benefits of Parks and Trails**

Providing access to public parks and trails has the potential to improve community health through four unique health outcome dimensions: physical, psychological, social, and ecosystem services.

**Physical.** Over the past several years, evidence connecting public parks and trails to active living behaviors has increased (e.g., Veitch, Ball, Crawford, Abbott, & Salmon, 2012; Wolf & Wohlfart, 2014). Availability and proximity of parks are associated with greater levels of physical activity among adults and youth (Brownson, Baker, Houseman, Brennan, & Bacak, 2001; Gordon-Larsen, Nelson, Page, & Popkin, 2006). Physical activity, in turn, has been shown to reduce the risk of cardiovascular diseases, type 2 diabetes mellitus, obesity, some cancers, osteoporosis, and psychological disorders (USDHHS, 2008). Specifically, parks and trails have been identified as community assets for encouraging healthier community behaviors due to their low-cost access and widespread availability (e.g., Bedimo-Rung et al., 2005; Chiesura, 2004; Mowen, Kaczynski, & Cohen, 2008). However, the relationship between parks, trails, and physical activity is much more complex than simply facilitating higher levels of physical activity. For example, parks and trails may influence the types and quality of physical activities. The presence of parks and trails does not necessarily guarantee increased physical activity levels nor is the influence of parks and trails a linear upon physical activity. The influence of access to parks and trails on levels of physical activity may differ among people, who have different preferences, experiences, backgrounds, and constraints.

**Psychological.** Research suggests that time spent in nature can buffer against stressors and fatigue caused by modern life in highly developed environments. Living near green elements has been connected to improved longevity, decreased mortality rates (Pasanen, Tyrväinen, & Korpela, 2014), stress reduction and coping, less mental fatigue, and improved sleep quality (Beute & de Kort, 2014). Other research has indicated that

nature can serve as a buffer from environmental stressors (Nilsson & Berglund, 2006) and has restorative benefits important for human mental functions and achieving positive psychosocial outcomes (Hartig, Mitchell, De Vries, & Frumkin, 2014; Home, Hunziker & Bauer, 2012; Kaplan, 1995). Contact with nature has also been shown to improve mental function and lessen children's attention deficit/hyperactivity disorder (ADHD) symptoms, reduce aggression, alleviate stress, stimulate creative play, and encourage social interaction (Burton, 2011; Kuo & Faber Taylor, 2004; Taylor, Kuo, & Sullivan, 2001).

**Social.** Parks and trails play an important role in visitors' satisfaction and facilitate the development of a sense of place and community (Dunstan et al., 2005; Ellis, Lee, & Kweon, 2006). These spaces also facilitate pro-social behaviors, foster social capital, and support community cohesion, mutual trust and willingness to help one another (Kuo, 2010). Furthermore, a high perception of social capital has been positively related to park use and physical activity (Broyles, Mowen, Theall, Gustat, & Rung, 2011). Parks and trails are important spaces for people to meet and interact, regardless of their sociodemographics (Thompson, 2002). Indeed public parks and trails provide opportunities for socialization for those who often have limited transportation options including children and the elderly.

**Ecosystem services.** Access to fresh air, sunlight, greenery, and freedom from stresses brought on by urban conditions have long been considered benefits available through public parks and trails, and current research indicates these are indeed linked to health and well-being (Brown & Bell, 2007). Parks and trails are increasingly recognized for their role in making cities resilient to natural disasters and promoting community sustainability (Chiesura, 2004; Kellett & Rofe, 2009). Resiliency includes the ability to absorb floodwaters, buffer wildfires and provides wildlife habitat; but can also provide recreational opportunities and refuge following natural disasters (LaGasse & Cook, 1965; Tidball & Krasny, 2007). Additionally, parks and trails fulfill multiple functions such as biodiversity enhancement, disaster mitigation, carbon sequestration, and climatic pollution reduction all of which impact community health. Urban trees, for example, can shield people from ultraviolet (UV) radiation reducing the risks of skin cancers and cataracts while helping to provide cooler air temperatures and have been associated with lower prevalence of asthma (Lovasi, Quinn, Neckerman, Perzanowski, & Rundle, 2008; Millward & Sabir, 2011). At the same time, however, pollen from urban trees can trigger asthma and other allergies.

### **Need for Health Outcome Measures**

While the body of knowledge relating parks and trails to public health has grown in recent years, large gaps in the literature remain. As the economy rebounds from a deep and lengthy recession, pent-up demand for development is spurring rapid growth in many U.S. cities. Recent trends indicate that, after decades of decay, the centers of cities are again becoming desired residential destinations, particularly for Millennials and older adults (Flint, 2014). More than 80% of the U.S. population lives in urban areas (U.S. Census Bureau, 2012). Urban areas are characterized by greater ethnic and socioeconomic diversity. Evolving demographics adds complexity to planning for more accessible park and trail systems to support public health goals. Changes in what communities look like and how they function are happening now, and without the benefit of evidence-based strategies to guide park planning to address the health issues associated with growth and development.

Since park and trail systems have the potential to improve community health the development of suitable metrics to assess their impacts is needed. Recent efforts have begun identifying health equity metrics (Prevention Institute, 2015); however, there is a need for park and trail focused health outcome indicators. This study presents measures needed to guide public planning and policy actions that allow for the collection of park and trail data related to public health outcomes. Without appropriate park and trail system planning, this new growth will bring at best a continuation of the health problems faced today, and at worst a whole new set of health issues that are yet to be revealed.

## Methods

A collaborative process involving the National Park Service (NPS) Rivers, Trails, and Conservation Assistance Program (RTCA) and North Carolina State University (NCSSU) with support from the Centers for Disease Control and Prevention (CDC) was used to identify potential health measures associated with public parks and trails. The search for peer-reviewed studies and relevant data was facilitated through electronic databases and libraries. Eligibility was determined by screening article titles, keywords, abstracts, and full text articles according to a search strategy. Papers were included in the literature review if they met the following criteria: collection of data on any measure of health or well-being related to natural spaces, greenspace, parks and trails. Excluded from the review were: non-peer-reviewed articles, articles not in English, and studies without an explicit tie to human health or well-being.

The search was conducted through CAB Abstracts, CAB Archive, MEDLINE, PubMed, ProQuest Health Management, PsycINFO, and SportDiscus. A broad combination of search terms was used: including *Environment, Environmental, Greenspace, Greenspaces, Greenways, Health, Indices, Matrices, Mental, Metrics, National Parks, Nature, Natural Environment, Open Space, Park, Park Greenway System Planning, Park System Planning, Parks, Physical Activity, Psychological, Public Open Space, Quality of Life, Rural Parks, Social Cohesion, Stress, Trails, Urban Parks, Wellbeing, Well-being, Well being*. These terms were selected through expert consultation with a content expert librarian in order to establish clear parameters for the search process.

An initial search conjointly performed by two of the researchers identified 500 potential peer-reviewed articles. Journal titles, keywords, and abstracts were used as a first screening process and resulted in the rejection of 290 articles that failed to meet the inclusion criteria. The remaining 210 articles were reviewed for measures that were used to study the impact of parks and trails upon health and well-being.

## Results

Through the literature review, 37 measures were identified. Each identified health measure for parks and trails was initially organized into one of four categories: physical, psychological, social, and environmental. However, to provide clarity, we subdivided the environmental category into ecosystem services and built environments. Within the following tables (Tables 1–5), each measure is paired with an example health outcome to highlight its potential usefulness. An operational definition has been provided to clearly identify what the measure is. Additionally, common methods for the collection of the data is provided under “How to Measure.” Suggested references to academic papers are provided that highlight the measure and its common methodology as related to a health outcome. A more detailed description of the tables’ contents follows.

### Physical

Seven total measures were identified related to human physical health. These include activity-related energy expenditure (EE), direct observation of physical activity (PA) level, self-report of PA level, time/duration of PA, frequency of PA, mortality rates, and body mass index (BMI).

Self-reported measures are a common method for assessing physical activity. However, a number of direct observation tools have been developed in recent years to augment self-reporting. Examples include System for Observing Play and Recreation in Communities (SOPARC), System for Observing Play and Leisure Activity in Youth (SOPLAY) or the Systematic Pedestrian and Cycling Environmental Scan (SPACES) for categorizing and recording physical activity behavior. As technologies such as cloud computing and crowd-sourcing advance, the capability for researchers to generate larger amounts of data using these existing measures will expand. One limitation of the measurements in this category is that while they are effective strategies for measuring physical activity, they lack the physiological health outcomes or markers that are directly correlated to physical health

**Table 1***Park- and Trail-Related Outcome Measures for Physical Health*

<b>Metric</b>	<b>Health Outcome</b>	<b>Operational Definition</b>	<b>How to Measure</b>	<b>Example Reference(s)</b>
Activity-related Energy Expenditure (AEE)	Parks and trails expected to have positive relation on users' total energy expenditure.	AEE (J/min/kg) is a direct measure of the energy cost of physical activity and may be used to measure the energy cost of a specific activity.	Assessment of the energy expended during physical activity through the use of measurement tools such as pedometers, accelerometers, GPS, heart rate monitors, etc.	Quigg et al., 2010
Physical Activity Level (Direct Observation)	Parks and trails expected to have positive relation on users' physical activity levels.	Categorization of observed physical activity by a trained observer into designations (i.e., sedentary, moderate, vigorous) undertaken by participants over time in specific settings (i.e., park, trail, playground.)	Use of an observation system such as System for Observing Play and Recreation in Communities (SOPARC), System for Observing Play and Leisure Activity in Youth (SOPLAY) or the Systematic Pedestrian and Cycling Environmental Scan (SPACES) for categorizing and recording physical activity behavior.	Bohn-Goldbaum et al., 2013; Veitch et al., 2012
Physical Activity Level (Self-Reported)	Parks and trails expected to have positive relation on users' physical activity levels.	Self-reported categorization of individual behavior regarding the type and frequency of leisure time physical activity during a specified time period.	Use of developed scales (ex. Youth Risk Behavior Surveillance Survey, Behavioral Risk Factor Surveillance State Questionnaire) to assess the frequency and type of physical activity.	Wolf & Wohlfart, 2014

**Table 1 (cont.)**

Time/Duration	Parks and trails may encourage user engagement into physical activity thus positively increasing the time/duration of activity.	Expressed as total time engaged in leisure time physical activity per chosen time frame.	Frequently measured as an average or total hours of physical activity that is self-reported.	Brownson et al., 2012; Bedimo-Rung et al., 2005
Frequency of Activity	Ease of accessibility and/or quality of the setting of parks and trails may positively encourage more frequent engagement in leisure time physical activity.	Expressed as how often physical activity is engaged in by an individual.	Usually measures specific physical activity behavior over a defined time frame (ex. past 3 weeks, past month, last year).	Brownson et al., 2012; Bedimo-Rung et al., 2005
Mortality Rates	The presence of parks and trails expected to have a negative relationship to mortality rates.	Uses the numbers and rates of deaths within a community to measure the burden of disease.	Access community/state/national health databases.	Pasanen et al., 2014
Body Mass Index	Parks and trails expected to have a negative relationship to body mass index.	Calculation of weight (kg) divided by height (m <sup>2</sup> ) to categorize the BMI as underweight, normal weight, overweight, or obese. Most reliable as a population measure.	Measured as self-reported values or in cooperation with healthcare providers.	Norman, 2006

**Table 2**  
*Park- and Trail-Related Outcome Measures for Psychological Health*

<b>Metric</b>	<b>Health Outcome</b>	<b>Operational Definition</b>	<b>How to Measure</b>	<b>Example Reference(s)</b>
Stress	Exposure to nature through environments such as parks and trails can lower stress levels.	Array of both physiological indicators (e.g., salivary cortisol concentrations, blood pressure, pulse rate) and psychological indicators	Six dimensions of the Profile of Mood States (POMS)	Beute & de Kort, 2014; Sullivan & Chang, 2011
Mood	Exposure to nature through environments such as parks and trails can improve mood.	Self-reported measure of psychological state based on identified characteristics.	POMS, Positive and Negative Affect Schedule (PANAS)	Song et al., 2013
Personal Well-being	Exposure to greenspace may improve the overall psychological state of an individual that reflects upon their individual health.	Use of seven indicators (emotional wellbeing, satisfying life, vitality, resilience and self-esteem and positive functioning) to provide a measure of psychological health.	Quality of Life Survey	Ellis, 2006
Mental Fatigue	Exposure to nature provides restorative benefits to recover from mental fatigue.	Measure of affect and cognitive performance.	Zuckerman Inventory of Personal Reactions, Overall Happiness Scale, Backwards Digit Span Test	Kaplan, 1995
Attention Functioning	Exposure to nature provides restorative benefits to recover from mental fatigue and improve attention functioning.	Measure of cognitive functioning abilities for directed attention.	Backwards Digit Span Test	Kaplan, 1995

**Table 3**  
*Park- and Trail-Related Outcome Measures for Social Health*

<b>Metric</b>	<b>Health Outcome</b>	<b>Operational Definition</b>	<b>How to Measure</b>	<b>Example Reference(s)</b>
Social Capital	Social capital is a marker of individual and community well-being.	A marker of individual and community well-being, it is a collective asset that grants members social value that can be used to facilitate future actions.	Reported trust, social cohesion, sense of community (ex. Social Capital Scale).	Wood & Giles-Corti, 2007
Social Density	The density of people within a given space can have positive impact on use (sense of security and belonging) or negative (overcrowding)	The physical measure of the total number of people within a given space (that can be used as an indicator to crowding (psychological measure)).	Direct measures (ex. number of people per square feet, acre etc.) and Behavior Mapping.	Sallis, 2009; Sullivan & Chang, 2011
Aggressive Behavior	Greenspace and nature can help alleviate aggression and support civil social interactions.	Measure of self-reported aggression and violence typically through formalized measures	Conflict Tactics Scale	Sullivan & Chang, 2011
Social Ties	Social aspect of greenspace influences use; the presence of strong social ties can encourage use of the space, which affects health outcomes.	Network of social relations by which individuals received social and mental support.	Measured by the frequency of contact, total number of ties, and reciprocity of the relation.	Wood & Giles-Corti, 2007
Collective Efficacy	Social aspect of greenspace that influences use; greenspace provides a platform for community member exchanges of social controls related to physical and mental health.	Perception of mutual trust and willingness to help other community members (i.e., measure of social cohesion) can be measured.	Individual Perception of Social Cohesion, and Informal Social Control in Neighborhood (LAFANS survey items)	Wood & Giles-Corti, 2007

**Table 3 (cont.)**

Social Interaction	Greenspace provides location for social interaction, which can reduce loneliness, encourage active living, and improve emotional well-being.	Indicated the amount of social relations within a community.	One specific measure includes quantifying the number of trees in a given area as an indicator for potential social interaction.	Coley et al., 1997
Levels of Crime	Perceptions of safety as related to perception of crime can have a negative or positive affect of use of greenspace.	Based on reported police crime reports, can provide a longitudinal measure of behavioral manifestations (correlational not causal data).	Secondary police data, spatially sensitive Geographic Information System (GIS) file.	Troy & Grove, 2008
Property Values	Home ownership and home values may improve the level of 'neighborhood satisfaction' one has and result in a sense of pride and well-being.	Also, monitoring property values and factoring in economic impacts when new greenspace is created.	Real Estate Trends (ex. secondary market reports, real estate values)	Ellis, 2006

**Table 4**

*Park- and Trail-Related Outcome Measures for Ecosystem Services Health*

<b>Metric</b>	<b>Health Outcome</b>	<b>Operational Definition</b>	<b>How to Measure</b>	<b>Example Reference(s)</b>
Noise Pollution Index	Greenspace features can lower noise levels. Noise pollution affects stress levels and neighborhood satisfaction, which in turn affect health.	Measure of the direct noise levels within a specific spatial area.	Indexing noise values by HUD classifications.	Cohen et al., 2014
Air Pollution Index	Air pollution negatively affects human health and enjoyment of outdoor spaces such as trails and parks. Greenspace features can reduce air pollutants.	Measure of pollutants as defined by government agencies (e.g., CO, SO <sub>2</sub> , PM <sub>10</sub> , and O <sub>3</sub> ) through assessments and indexing	Air Quality Index	Cohen et al., 2014

**Table 4 (cont.)**

Thermal Sensations Index	Greenspace can help alleviate “heat island” affects, moderate temperatures and provide shade from UV rays.	Measure of climatic variables (e.g., air temperature and relative humidity) to assess human thermal perception	Physiological Equivalent Temperature Index (PET)	Cohen et al., 2014
Leaf Surface Area	Human health is improved (including new evidence of link between particulate matter and autistic spectrum disorder) and mortality rate is reduced by removal of particulate matter from atmosphere	Leaf surface area is computed using several variables. The method varies for different places, but is dependent on land coverage of trees and shrubs	Leaf Area Index (LAI), Aerial Mapping and Computation	Nowak et al., 2013; Raz et al., 2014
Tree Inventory and Leaf Coverage	Tree canopy can lower noise, air pollutants and thermal sensations improving the quality of the ecosystem which in turn impacts human health.	Identification of the species, diameter, height and canopy width of greenspace trees through a inventory process	Systematic tools such as the Street Tree Resource and Assessment Tool for Urban Forest Managers (STRATUM) can be used as well as Aerial mapping, and Computation	Millward & Sabir, 2011; Nowak et al., 2013
Levels of Nearby Vegetation/ Naturalness	“Greenness” and “leafiness” affect perceptions of greenspace, degree of social interaction, neighborhood satisfaction and property values, and potentially other health indicators. Proximity of this greenness is a factor in its value for these outcomes.	Assessment of greenness levels through a systematic measure of conditions surrounding a given location	Four-Item Naturalness Scale is one specific measure. Data can be collected via observation, GIS, RSI, etc.	Mackett & Paskins, 2008; McCormack et al., 2010; Giles-Corti et al., 2005

such as indicators related to cardiovascular health. For example, direct observation can capture that a visitor is engaged in vigorous physical activity, but it does not capture how that activity affects the individual's maximal oxygen consumption ( $VO_2$  max).

### **Psychological**

Five measures were identified that examine health outcomes related to psychological health, including stress, mood, personal well-being, mental fatigue, and attention functioning.

Similar to physical health measures, these measures capture individual human characteristics and therefore are subject to similar limitations of privacy and the difficulty of data acquisition. However, they seem to be emerging in the literature as a critical aspect of public health ever since the publication of the seminal work by Kaplan in 1995, which found that nature had restorative benefits for cognitive fatigue. The availability of psychological tools and techniques continues to expand.

### **Social**

Eight metrics were identified that measure social health. These include social capital, social density, aggressive behavior, social ties, collective efficacy, social interaction, levels of crime, and property values.

Social measures rely more on aggregated data and collective measures of human characteristics (i.e., crime statistics and social density). The advantage associated with collective social measures is that they are less susceptible to issues of privacy and easier to acquire since data is focused at the group level and does not require individual identification. Self-reported personal data on thoughts, moods, and perceptions, is also a significant source for collecting these measures. Self-reported data is commonly obtained through survey methods. However, obtaining representative samples can be limited by resource constraints. For example, random sampling is not always possible due to the lack of sampling frame. Obtaining a sample large enough to represent the population could be beyond the available study resources as well.

### **Ecosystem Services**

Six measures were identified that measure health outcomes related to ecosystem services. These include noise pollution index, air pollution index, thermal sensations index, leaf surface area, tree inventory and leaf coverage, and levels of nearby vegetation/naturalness.

The measures in this category can be easily quantified. For example, noise and pollutant levels can be quantitatively measured using scientific instruments, GIS mapping, and remote sensing. The relative ease with which these quantitative measurements can be obtained makes them highly useful for the purposes of planning and managing parks and trails for the benefit of human health. These measures provide detailed information at a specific geographic location that may be difficult to extrapolate broadly.

### **Built Environment**

Eleven measures were identified that examine health outcomes related to the built environment. These include size of greenspace, percentage of green, availability/accessibility of parks and trails, proximity to parks and trails (distance), walking time to parks and trails, distance buffers around parks and trails, population density, types of facility, types of amenities, condition of parks and trails, and incivilities.

These measures are also easily measured and quantifiable. Many of these measures have been traditionally applied to the planning and management of parks and trails. However, a limitation of these measures is that they are not collected or assembled in systematic and consistent ways that would allow for them to be aggregated and shared. For instance, proximity to parks and trails is measured using various distance-based buffers varying in distances and approximate travel times. Collecting this data in a systematic way would enhance their usefulness to the goal of improving health through the allotment and

**Table 5**  
*Park- and Trail-Related Outcome Measures for Built Environments Health*

<b>Metric</b>	<b>Health Outcome</b>	<b>Operational Definition</b>	<b>How to Measure</b>	<b>Example Reference(s)</b>
Size of Greenspace	The spatial size of greenspace may promote use and physical activity if it is sufficient for the intended activity.	2-dimensional extent of individual greenspace location	Mapping of area using GIS or similar methodology provides information on the size and details of a given space.	Giles-Corti et al., 2005
Percentage of Green	“Greenness” and “leafiness” affect perceptions of greenspace, degree of social interaction, neighborhood satisfaction, and property values.	Measure of a designated spatial area in which the total land area is divided by the total green area to derive the percentage of green.	Aerial mapping, computation	Nowak et al., 2013
Availability/Accessibility of Trails and Greenways	Improved, high-quality, traffic-free routes for walking and cycling may help to increase overall physical activity.	Rigorous studies evaluating the effects of walking and cycling infrastructure has been limited and the results have been mixed. However, pre/post intervention studies indicate some correlation and the potential for further studies to find stronger effects.	(1) Presence/absence of a facility within a measured proximity of home (2) Distance from home to facility (3) Total length of all facilities (4) Connectivity offered by the network (5) Characteristics of facilities (slope, viewshed, etc.) that affect user choice	Goodman et al., 2014
Distance (Proximity to Green)	Being outdoors and walking increases physical activity and mental well-being. Proximity is a correlate of physical activity and improved mood.	Measurement of geographical space between residence and greenspace location.	Euclidian distance of greenspace from residence	Giles-Corti et al., 2005
Distance (Walking Time)	Being outdoors and walking increases physical activity and mental well-being. Proximity is a correlate of physical activity and improved mood.	Measure of travel routes as a function of distance able-bodied people are able/willing to span in a set duration of time.	Network distance of greenspace from home	McCormack et al., 2010

**Table 5 (cont.)**

Distance (Buffers)	Distance from home to greenspace affects use and therefore health outcomes.	Determination of the areal extent within which greenspace destinations are accessible from residential locations (ex. Euclidian or Network buffer).	GIS mapping	Cho & Choi, 2005
Population Density	Higher population density is positively associated with higher rates of walking, which is supportive of health goals, but could be negatively associated with amount of greenspace under some parkland allocation strategies, and impossible to accomplish under others. Getting as many people as possible within walking distance of an adequate and appropriate supply of greenspace would be expected to support health goals.	Calculation of the number of people per a defined geographic location. Can be used to determine the concentration of population around or adjacent to greenspace.	Defining the appropriate area and method to use (gross vs. net? homes vs. people? daytime vs. nighttime?) for calculating density related to greenspace may need further research. Also, defining how much/what type of greenspace to provide (i.e. dose rate) needs further research.	Brownson et al., 2010; Kellert & Rofe, 2009; Newell et al., 2007
Type of Facility	Features found in greenspace positively and negatively influence use, affecting health outcomes	Inventory and audit of greenspace facilities (e.g., features that are primary settings for activities such as a trails or sport courts) that provides a quantitative assessment of presence and condition	Park/Greenspace Audit tools (ex. EAPRS, CPAI)	Kaczynski et al., 2012; Saelens et al., 2006
Type of Amenity	Amenities found in greenspace positively and negatively influence use, affecting health outcomes	Inventory and audit of greenspace amenities (e.g., features that support activity such as drinking fountain, restrooms).	Park/Greenspace Audit tools (ex. EAPRS, CPAI)	Kaczynski et al., 2012; Saelens et al., 2006
Condition of Greenspace	Condition of features greenspace influences use, affecting health outcomes	Assessment/audit of park and trail conditions	Park/Greenspace Audit tools (ex. EAPRS, CPAI)	McCormack, et al., 2010; Saelens et al., 2006
Incivilities	Presence of incivilities negatively impacts use and satisfaction of greenspace, resulting in fewer health benefits	Measure of the presence or prevalence of certain environmental factors such as litter, drug paraphernalia, etc.	Audit tools	Giles-Corti et al., 2005

distribution of parks and trails. While recent research has resulted in the development of a series of tools to audit the physical environment and link it with human behaviors related to health, more work is needed to synchronize the various tools so that they can be used to build data that can be shared, merged, compared, and otherwise used to understand and manage the connections between parks and trails and human well-being. For example, the Community Park Audit Tool (CPAT; Kaczynski, Wilhelm Stanis, & Besenyi, 2012) and Environmental Assessment of Public Recreation Spaces (EAPRS; Saelens, Frank, Auffrey, Whitaker, Burdette, & Colabianchi, 2006) both measure the physical environments of parks but do not include connections to existing distance-based buffers for approximate travel times.

## Discussion

Application of these 37 measures can begin moving park and trail system planning forward by gathering more evidence regarding the influence of public parks and trails on community health and well-being. These measures can be used to identify how parks and trails are supporting broader public health goals and outcomes. The collection of data based upon common measures and methodologies will help inform planners and decision-makers as to the needs and opportunities of their community and track both spatial and temporal changes.

### Limitations and Challenges

This research had several limitations that should be acknowledged. First, this study was limited to English articles; the exclusion of non-English articles from European and Scandinavian research on urban park design and health outcomes may limit the comprehensiveness of this study. Additionally, this project was constrained by the lack of universal definitions regarding several important terms. Concepts such as public park, trail, public open space, and greenspace are not universally recognized under one definition. Hence, there is ambiguity within the literature and popular use of these terms. For example, the term park is quite ambiguous and may refer to a range of places from natural areas to formal gardens, public or private. A lack of a universal definition means that different fields have developed a specialized vernacular that hampers interdisciplinary and international dialogue and coordinated data collection.

Second, the importance of public parks and trails and related measures of public access may not be universally applicable to different communities. The literature reviewed here tends to be focused on parks or trails that are near or within urban areas as opposed to rural or remote locations. This is not intended to exclude or devalue the importance of rural parks and trails, but rather highlights that efforts thus far have focused on where the largest impacts to public health seem to occur. Future research is recommended to determine the validity of these measures along the urban to rural continuum.

Third, the measures presented in the study are based on the results of a systematic literature review and may not be a comprehensive assessment of the state of the science across all disciplines. The compilation of the measures presented is intended as a first step in coming to consensus on a set of measures to enable planners, managers, and administrators of parks and trails to provide facilities in ways that best support public health goals. Further dialogue could help inform and direct the usefulness of these measures and help identify fruitful areas for future research and application.

Fourth, the measures are not intended to be prescriptive. They measure what is and not what should be. They should be used in combination with one another and with other evidence and techniques to arrive at strategies for improving the contributions of parks and trails to public health at the various policy and planning levels. For example, knowing that the average number of visits to a park is low for a particular jurisdiction compared to other nearby jurisdictions does not suggest that the jurisdiction simply tell its residents to visit parks and trails more frequently. However, using the average number of visits per week as a baseline, the jurisdiction can look at measures of park and trail availability, access, and

distance to determine if it has a deficiency in the allocation and distribution of its parks and trails and formulate strategies to address these deficiencies.

### **Implications for Practice**

Results from this research have numerous implications for professionals and advocates in the fields of parks, recreation, trails, greenways, open space, and health. A basic tenet of outcomes focused planning and management is that outcomes can be assessed in meaningful and useful ways (Hurd, Barcelona, & Meldrum, 2008). This is not possible without valid, reliable, credible, and accepted metrics. The primary aim of this study was to begin to identify such meaningful measures. Specifically, we believe our findings have four particularly important implications.

First, and most basic, it is possible to identify and refine metrics that could be used to help make the case that park and trail systems contribute to achieving public health goals. Increasingly, parks and trails are being recognized for their potential for, and influence on, promoting public health. Only by measuring the health related impacts of parks and trails in credible and comparable ways, can advocates present compelling data to decision-makers regarding the critical importance and significance of parks and trails, thereby helping to reposition the role of parks and trails in the minds of practitioners and the public.

Second, having established methods and metrics like the ones presented here would help guide practitioners as they strive to provide recreation opportunities that better promote health-related outcomes. The results presented here provide information on securing and/or collecting data for each measure that could be readily adopted by park and trail system planners, managers, and advocates.

Broad use of common measures and practices would allow for comparison of data among multiple communities, states, or regions. For example, if these or similar metrics were used in State Comprehensive Outdoor Recreation Plans (SCORP), regional open space plans, and similar planning efforts, data and outcomes could be readily compared within and among states and other jurisdictions. Processes like these often include objective measures and related competitive grant scoring criteria. Having metrics linked to public health goals could encourage agencies at many levels to more systematically consider the public health impacts.

A third implication of this research is that it could facilitate development of community recreation and conservation projects and help prioritize investment in such efforts. Metrics could be used to create proactive approaches to planning and designing park and trail systems. For example, analysis of collected data would help identify high potential locations for active recreation opportunities and likely identify areas where expanding and connecting transportation networks would improve access. By using credible and easily comparable data, decision-makers would be better informed regarding community recreation and resource protection needs. Results could also help grant recipients invest wisely in local park and greenway capital projects by linking them to critical public health issues.

Finally and perhaps most significant, the metrics identified here can be used as a starting point for more concerted and productive conversations among planners, advocates, managers, and researchers. Because these metrics have been used with some success in previous research and have now been initially vetted by experts, they provide a logical starting point for developing a more refined collection of measures and methods that could become broadly accepted. Our research could even provide some momentum for facilitating such conversations and potentially encouraging new and strengthened partnerships between the park and trail and health communities. Including public, private and not-for-profit sector organizations in these discussions could also encourage broader and more effective partnerships. The large number of park and trail related NGOs and less formal advocacy organizations should not be overlooked in this regard. Such partners can be very effective in generating public support and could be valuable partners in helping to actually gather data related to some of the proposed measures, particularly time-intensive ones such as observing levels of physical activity among park and trail visitors. Research

that utilizes common measures can be generalized more easily; therefore a framework that makes it easy for local jurisdictions to contribute data is needed.

### Conclusion

An expanding body of knowledge over the past two decades has begun providing empirical evidence of the relationship between parks and trails and public health; however, specific metrics are still needed to serve as a measure of indicators and outcomes for parks and trails. Without these, it is difficult to replace the outdated standards that are deeply entrenched in the practice of parks and recreation with strategies that produce measureable health outcomes. Practitioners and planners increasingly need to connect parks and trails to public health, but the planning practices of the past are not adequate for creating modern planning systems that promote and provide for both social and ecological health outcomes. Recent research has begun examining the evidence of healthy park and trail planning. As that continues to happen, we can begin to refine measures that better inform local, regional and national decisions that make park and trail systems even better contributors to community health.

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