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Not Just a Walk in the Park: Methodological Improvements for Determining Environmental Justice Implications of Park Access in New York City for the Promotion of Physical Activity

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Abstract

The purpose of this study is to test the hypothesis that access to parks in New York City is not equitable across racial and ethnic categories. It builds on previous research that has linked access to parks and open space with increased physical activity, which in turn may reduce the risk for adverse health outcomes related to obesity. Systematic patterns of uneven access to parks might help to explain disparities in these health outcomes across sociodemographic populations that are not fully explained by individual-level risk factors and health behaviors, and therefore access to parks becomes an environmental justice issue. This study is designed to shed light on the "unpatterned inequities" of park distributions identified in previous studies of New York City park access. It uses a combination of network analysis and a cadastral-based expert dasymetric system (CEDS) to estimate the racial/ethnic composition of populations within a reasonable walking distance of 400m from parks. The distance to the closest park, number of parks within walking distance, amount of accessible park space, and number of physical activity sites are then evaluated across racial/ethnic categories, and are compared to the citywide populations using odds ratios. The odds ratios revealed patterns that at first glance appear to contradict the notion of distributional inequities. However, discussion of the results points to the need for reassessing what

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is meant by “access” to more thoroughly consider the aspects of parks that are most likely to contribute to physical activity and positive health outcomes.

Keywords

Park access; environmental justice; network analysis; CEDS; GISc

INTRODUCTION

Over the past several decades, scholars, community organizations, and policy makers in the United States and abroad have worked to understand and intervene in environmental inequalities. This research has examines the uneven distributions of, and procedural disparities around, environmental benefits and burdens in otherwise marginalized communities (Bullard 1994; Holifield et al. 2009). One focus of this research has been analyzing the spatially disproportionate relationships between sources of environmental hazards and socioeconomically vulnerable groups, such as communities of color and poor and working-class populations, and the concomitant effects of these discrepancies on health and environmental disparities (Bullard 1994; Johnston 1994; Bryant 1995). Less prominent in this research is the examination of relationships between sociodemographic factors and beneficial environmental factors, such as health-promoting land uses and positive aspects of the built environment like parks and open spaces.

Previous studies have documented that proximity and ease of access to parks and open spaces has a positive influence on active behaviors like walking and running for exercise (Wendel-Vos et al. 2004; Bedimo-Rung et al. 2005; Roemmich et al. 2006; Diez Roux et al. 2007). Other studies have analyzed how the availability of outdoor space impacts on specific health outcomes, like community-level rates of mortality, cardiovascular disease, diabetes, and obesity (Frank et al. 2004; Gordon-Larson et al. 2006; Taylor et al. 2006; Berke et al. 2007; Papas et al. 2007; Rundle et al. 2008). The underlying hypothesis is that since individual-level risk factors for these diseases do not fully explain disparities in their distribution across sociodemographic populations, features of the built environment, such as access to parks and open spaces, might help us better understand disparities in these health outcomes based on their association with positive health behaviors.

If environmental factors help us to understand the distribution of health outcomes in the population, then one might expect that active outdoor space would be less available to populations with overall worse health outcomes. Since populations with lower socioeconomic status (SES) and racial/ethnic minorities experience worse health outcomes in the United States (Sorlie et al. 1995; Lantz et al. 1998), uneven access to parks and physical activity sites becomes an environmental justice issue. Previous research evaluating the sociodemographic dimensions of park accessibility and outdoor space suggest that the relationship is complex—particularly when considering the positive health aspects associated with parks and outdoor space (Nicholls 2001; Loukaitou-Sideris 2006; Maroko et al. 2009). This research is of interest to public health and policy analysts who are developing interventions and policies that can mitigate health disparities that persist across socioeconomic groups, as well as to environmental justice groups engaged with equity issues in public spaces.

This study extends previous research on park access in New York City conducted by Maroko et al. (2009). Using quantitative methods, that study found “unpatterned inequality,” meaning that parks were not distributed evenly throughout the city, but there were no spatially consistent associations with sociodemographic variables. The quantitative results were used to identify two similarly sized parks with very different sociodemographic access characteristics. These two parks served as case studies for a comparative qualitative analysis of the historical positioning of the parks within the sociodemographics of their surrounding neighborhoods, as well as an assessment of the physical features affecting access to the two parks. They concluded that quantitative models that incorporate features of the built environment into measuring park access would likely improve their reliability and reflection of the realities of park access. In light of these recommendations, this study quantitatively models park access as a function of walkable distances, based on the street networks connecting individual residences to nearby parks. It also looks at the size of parks within walking distance and the number and types of physical activity sites at those parks, since both of these factors can influence the use of parks for physical activity (Cohen et al. 2007; Scott et al. 2007).

In addition to findings of unpatterned inequalities, other park access studies have generally had inconsistent and contradictory results. Some studies found that lower-income residents (Estabrooks et al. 2003; Wolch et al. 2005) and non-white residents (Wolch et al. 2005) have access to fewer parks and physical activity sites. Other studies found the opposite: that non-white and lower-income areas had the greatest access to recreational resources, even after correcting for population density (Moore et al. 2008; Boone et al. 2009; Cutts et al. 2009), however in at least one of these studies, white residents had access to larger facilities (Boone et al. 2009). Other studies found no apparent relationship between racial and/or income factors and park access (Abercrombie et al. 2008), particularly after correcting for population density (Nichols 2001; Timpiero et al. 2007). Talen (1997) found that the relationship between park access and SES variables was place-specific, with park access favoring higher-income areas in one city and lower-income areas in another.

On the one hand, these differences reflect the place-specific histories of each location studied, especially with respect to legacies of racism and uneven economic and urban development (Pulido 2000; Wolch et al. 2005). On the other hand, these differences may also be attributable to the various quantitative spatial techniques used to evaluate access to parks. As detailed in the following section, the spatial techniques used in previous studies are limited in how accurately they account for heterogeneous population distributions and the difficulty of taking into consideration the “walkability” of the built environment. This study uses methods that attempt to account for these shortcomings to improve understanding of park access equity in New York City.

At least two previous studies have approached the question of park access using the same street network distances to parks used in this study. Talen and Anselin (1998), using various methods including network analysis, concluded that the distribution of playgrounds in Tulsa, OK, represented unpatterned inequality. Nicholls (2001) found that approximately 80% of the area studied (Bryan, TX) was not within an 800 meter [m] walkable distance of any park, but that the less affluent neighborhoods tended to be better served by parks than the more affluent areas.

METHODS

Approaches to quantifying access to parks generally rely on Geographic Information Science (GISc) frameworks to determine access based on various measures of proximity, walkability, or park density. In each of these methods, the populations with greater access to parks are compared with those with less access to parks, in terms of their SES, racial/ethnic composition, or other demographic factors. What follows is a short review of four basic GISc methods employed for park access equity determination in previous studies. These are the “container approach” (Talen and Anselin 1998), buffer analysis, kernel density

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estimation, and street network analysis. Street network analysis is the method that was selected for this study.

The most straightforward method for determining proximity is the container approach. In this method, the researcher selects a spatial aggregation unit such as postal ZIP-codes, census tracts, etc., as the resolution for aggregating population demographics (e.g., US Census Bureau [census] data) across the study area. Populations living within each aggregation unit are considered proximate—and therefore as having access—to those parks located within or intersecting the aggregation unit boundaries. Associations between the total number of parks per areal unit (park density) and various population characteristics, such as SES, can be estimated for the chosen unit of aggregation.

The container approach can be problematic because it assumes a park intersecting an aggregation unit implies proximity, however this may not always be a valid assumption (Figure 1). For example, it does not count people who live across the street from a park as part of the population with access to that park if the boundary of the aggregation unit lies between their houses and the park. On the other hand, it would count a park located on one end of an aggregation unit as being accessible to residents living on the other end of the aggregation unit, regardless of whether or not it is reasonably accessible to those populations due to the size or configuration of the aggregation unit. This is particularly problematic for study areas with heterogeneously distributed populations or differently sized aggregation units.

Two methods that overcome some of the shortcomings of the container approach are buffer analysis and kernel density estimation. In buffer analysis, the researcher defines a circular area, or buffer, around each park to represent that park's service area. This service area represents the maximum likely distance residents will travel to access the park (Nicholls 2001), and is discussed in greater detail below. Various techniques, such as dasymetric mapping, are used to estimate the population demographics within the buffers, which are then compared to the demographics across the study area. In kernel density estimation, the study area is divided into a grid and a "park density" is estimated for each cell within the grid. Although the exact method for calculating the park density for a given cell is beyond the scope of this paper, it uses a mathematical representation of the aggregate straight-line distance to each park within the study area. By intersecting spatial population demographics (e.g., Census maps) with the park density grid, park accessibility can be compared across sociodemographic categories.

These two methods improve on the container approach because they concretely define park access in spatial terms involving park distance that lessen the constraints of aggregation unit boundaries. However, they still may not accurately reflect the reality of park access because they do not consider physical access routes to parks. They both fail to account for features of the built environment such as access routes via the existing street network, as well as perceptions of environmental factors such as crime and vehicular traffic, which might require residents to travel significantly farther than the assumed maximum walking distance to access the park (Nicholls 2001; Loukaitou-Sideris 2006).

The spatial method used in this study to measure access to parks and physical activity sites in New York City is street network analysis. It is similar to buffer analysis in that it considers access based on park service areas, defined as the maximum distance people are willing to travel to access a park. But rather than using buffers that extend along straight-line (Euclidean) distances from parks, the GISc-based Network Analyst tool in ArcGIS is used to identify parks having an entrance (discussed in the Data section below) located within reasonable walking distance from individual residential units along pedestrian-accessible

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street networks. The analysis excludes non-walkable features such as highways and railroads to maintain a more realistic representation of walkable routes.

As Nicholls (2001) points out, defining park access in terms of a reasonably walkable distance is important because walking, or an equivalent non-vehicular mode of transportation, is the most widely accessible mode of transportation across age, ability, and class status. Previous studies of park access assume maximum walking distances of 400m to 1,600m (Nicholls 2001; Wolch 2005; Moore et al. 2008). However for this study, a primary maximum walking distance of 400m was selected, with an 800m secondary distance maximum for comparison, based on transit design guides and urban planning studies that recommend similar distances based on 5- to 15-minute maximum walking times (Ritter 1964; NJTransit 1994; Regional Plan Association 1997; New York City 2007; Larsen et al. 2010). Additionally, the City of New York has set a planning goal of having at least one park within a 10-minute walk of all residents in its PlaNYC 2030 city planning roadmap (New York City 2007).

The network analysis technique used in this study more accurately represents walking routes that are likely to be used for park access, but it is not without limitations. While not unique to network analysis, there are the linked problems described above of defining a particular distance as "reasonably walkable," and of considering distances that might be easily walkable for some parts of the population but not others. Additionally, it does not attempt to evaluate environmental conditions that affect perceptions of park access routes or the usability of parks, per se. For example, Loukaitou-Sideris (2006) points to the real and perceived safety and security concerns that can act as deterrents in individual decisions to access and utilize parks, particularly in lower-income communities and among women, children, and the elderly (Loukaitou-Sideris 2006). Similarly, residents with physical access to a park might feel unwelcome there because of the specific cultural or gendered aspects of the park environment or because of park aesthetics, cleanliness, crime, or otherwise unusable facilities. Finally, the quality of the network analysis calculations is dependent on the quality and accuracy of the pedestrian-accessible street network data, something that is not guaranteed for every geographic location.

Following the identification of parks within walking distance of individual residences, sociodemographic characteristics are estimated for each residential unit using a Cadastral-Based Expert Dasymetric System (CEDS). The CEDS method disaggregates census block group demographics to individual residential units (tax lots). The method has previously been used in environmental justice studies of asthma hospitalizations and flood risk in New York City (Maantay et al. 2007; Maantay and Maroko 2009), and produced more consistent results when compared to other methods of data disaggregation. Disaggregating demographic data to individual residential units more accurately models the realities of park access by considering where people travel from to get to parks instead of assuming that populations within the census block groups are homogeneously distributed (Maantay et al. 2007).

The CEDS technique used in this study disaggregates census data from the block group level to individual residential tax lots using the proportion of either the residential area (i.e., square feet of living space per lot) or number of residential units (i.e., number of individual dwelling units per lot) as weightings for distributing the block group population across tax lots relative to the total residential area or number of residential units in the entire block group. Both the residential area and number of residential units can misrepresent the number of occupants since neither truly accounts for variations in occupant density or unit size, particularly in census blocks containing greater variety in types of housing (e.g., single-family and large apartment complexes). The expert system attempts to minimize these sources of error by determining whether the residential area or number of residential units provides more accurate population estimates. It does this by first disaggregating the census tract data to estimate individual tax lot demographics using both residential area and number of residential units, then re-aggregating the individual tax lot estimates back up to the census block group level. These two block group estimates are compared to the actual census block group demographics data and the estimation method that more accurately represents the block group demographics is selected as the method to be used for disaggregating the data for that census block group. In this study, approximately 47% of the block groups were more accurately estimated using residential area and 50% using the number of residential units. The remaining 3% were equally estimated by both methods and were arbitrarily assigned the estimate based on the number of residential units.

Previous studies using the CEDS method for disaggregating population data have described its advantages over other methods for estimating populations proximate to various spatial phenomena, particularly in heterogeneous urban spaces (Maantay et al. 2007). One of the disadvantages to this method, however, is that the population estimates for individual residential tax lots belonging to the same census block group are not independent from one another in terms of proportions of sub-populations (e.g. percent Latino). Therefore, the CEDS populations are most useful when they are re-aggregated, as in this study where all of the residential tax lots with a park within 400m were aggregated to derive a population within walking distance of at least one park. This can limit the potential statistical methods employed in the data analysis.

Descriptive statistics, including park acreage, number of physical activity sites, and the varieties of physical activity sites, are compiled for each park in the study area. The CEDS population demographics data for each residential tax lot is then joined with the network analysis data for the same residential tax lots, and re-aggregated to create citywide demographics for each of the park characteristic categories. This provides estimates of, for example, the number of non-Hispanic Black residents who live within walking distance of no parks, one park, two parks, etc.

Finally, odds ratios comparing the proportion of each racial/ethnic group to the citywide population are calculated for each of the park access and physical activity site characteristics. In addition to being compatible with the data-aggregation limitations inherent in the CEDS technique described above, odds ratios are useful because they provide an estimated likelihood of someone within a racial/ethnic grouping to be among the portion of the citywide population whose residence has a particular park access or physical activity site characteristic. For example, an odds ratio of 1.25 indicates that someone is 25% more likely than the general population to fall into the specified category.

DATA

The park extent data used in this study was created by the New York City Department of Parks and Recreation. The dataset represents all land owned by the Parks Department, including parks and open spaces, as polygons (Figure 2) with an associated size (acreage) attribute. As an initial study of park accessibility in New York City using street network analysis, this study includes all of the Parks Department facilities even though some of the smaller parks and open spaces might not provide adequate space or physical activity sites for health-promoting physical activity (Kaczynski et al. 2008). The decision not to filter the park extent data allows for a broader analysis of the relationships between sociodemographics and park acreage since any data filtering would depend on unsubstantiated assumptions about how residents use different sizes and classes of parks that are beyond the scope of this study.

Furthermore, while the City of New York's PlaNYC roadmap for open space includes additional recreational spaces such as public school playgrounds (New York City 2007), this study is limited only to the Parks Department properties. It does not include sites such as public school yards or sidewalks and streets. Nor does it include privately owned, restricted-access areas, such as private parks like the well-known Gramercy Park, individual backyards, and pay-for-use facilities like gyms or YMCA facilities. Having access to these types of amenities may decrease the importance of access to public parks, making it difficult to compare populations with access to these facilities with those dependent on public parks for recreation and physical activity. Since these types of privately owned recreational spaces are more likely to be associated with wealthier and less-dense neighborhoods, one might expect lower demand for and access to parks in such areas.

The park features data (elements within the parks) were created as a collaboration between the New York City Department of Parks and Recreation and Lehman College of the City University of New York. Researchers traveled to all of the New York City parks carrying portable GPS units and recorded the locations of many of the parks' features, including park entrances, sports facilities, ball fields, and other recreational areas (Figure 3). Researchers used aerial photos and other remote sensing GISc technologies to rectify the GPS park features data and further supplement the dataset in locations where features such as park entrances were not recorded. For parks without specific points of entry (e.g., open spaces without fences) and parks not included in the GPS survey, the researchers coded entrance points at roughly 30m intervals around the accessible parts of the parks' perimeters.

There have been a number of previous studies showing positive associations between the types, quantity, and quality of park activity sites and physical activity and/or perceptions of access to activity sites (Cohen et al. 2006; de Vries et al. 2007; Scott et al. 2007; Potwarka et al. 2008). Taking the importance of physical activity sites into consideration, the supplemental features added to the parks dataset allow this study to assess the quantity and differentiation in physical activity sites for parks within walking distance of residents.

The street network data used for the network analysis is the New York City Department of City Planning DCPLION 2008 Single Line Street Base Map dataset. It represents all New York City streets and includes address ranges, street classifications (e.g., roads, highways), and other transportation infrastructure. The street network analysis method used in this study only considers pedestrian-accessible streets, excluding highways and railroads.

The data for individual residential units used in the CEDS method comes from the LotInfo™ 2001 dataset to correspond with the Census 2000 data used in the study (see below). The dataset contains polygons representing individual tax lots in New York City, and is a combination of tax lot data and building features such as the number of residential units and total residential area. Individual tax lots also contain land use information to differentiate residential units from non-residential lots.

In order to evaluate the possibility of unequal access to these park measures based on sociodemographic characteristics of the population, information was gathered from summary file 1 (SF1) and summary file 3 (SF3) of the 2000 United States census at the block group level. Without discounting the value of census data, it is important to acknowledge several underlying problems with its accuracy. One of the most significant sources for inaccuracy is the potential for undercounting populations (Edmonston 2002). This is a particularly large problem for New York City, which has consistently had the lowest response rates of all major cities in the US (US Census Bureau 2000). Undercounting occurs most frequently among socioeconomically marginalized populations including the poor, homeless, foreign-born, and undocumented immigrant populations.

The measures included in this analysis were percent each of non-Hispanic white, non-Hispanic black, non-Hispanic Asian, and Hispanic. While socioeconomic factors were not included in this initial study, future research should expand the sociodemographic analysis to include factors such as income, education, population density, and housing status (i.e., owner/renter), particularly since previous research has found a positive association between the presence of parks and increased real estate value (Nicholls 2001; Crompton 2005), which might affect the populations that can afford to live near parks. Age is also an important consideration when studying access to parks as sites of physical activity since childhood obesity can lead to serious health problems later in life. And finally, racial/ethnic and class distributions across the five New York boroughs is highly heterogeneous so aggregating data across the entire city might mask localized disparities that would be more apparent in a borough-level analysis, but this is a level of analysis left to future studies.

RESULTS

Odds ratios comparing the proportion of each racial/ethnic group to the citywide population are included as Table 1. There are two primary measures of walkable access to parks within this study: the distance to the closest park and the number of parks within 400m. It should be noted that citywide, nearly 66% of residents live within 400m of at least one park, while an overwhelming 95% of residents live within 800m of at least one park. However, of the small population not living within 800m of any parks, non-Hispanic white and non-Hispanic Black residents were both overrepresented. Related to this, non-Hispanic white residents were roughly 30% less likely to live within either 400m or 800m of any parks, while Hispanic/Latino residents were heavily overrepresented in both categories. Non-Hispanic Asian residents were less likely to live within 400m of any parks, but more likely than the citywide population to live within 800m of the closest park. One factor that might account for some of these findings is the effect of density levels in residential construction. In areas with lower-density housing built on larger lots more closely representing suburban-type development, parks density tends to be lower and they are located farther from residents (Wolch et al. 2005), whereas the denser urban areas of the city, which have been shown to be positively associated with non-white populations in New York City (Rundle et al. 2007), are likely to have greater park density (Diez Roux et al. 2007). Future research should more closely examine the relationships between access to parks, density of residential construction, and availability of additional physical activity resources.

The second set of measures deal with differential access to park space: the size of the closest park and the combined park space within 400m, and the number of physical activity sites and types of physical activity sites within 400m. The odds ratios for these measures were initially problematic because of their dependence on whether or not residents had any parks within 400m. Therefore, an alternate odds ratio was calculated for each racial/ethnic group, where populations with no parks within 400m were excluded. These adjusted measurements are not meant to represent overall access to park features, since that is captured by the walkable access measurements. Rather, they shed light on how well existing parks serve those populations that live within an easily walkable distance.

Based on the adjusted odds ratios, most of the racial/ethnic groups are represented relatively close to parity compared to the citywide population that lives within 400m of any parks. Parks were classified as small, medium, and large according to even distributions of park areas across the citywide population (Table 2), with the underlying assumption that larger parks have larger service areas, serve larger populations and provide greater opportunities for physical activity (Giles-Corti et al. 2005; New York City 2007). Non-Hispanic Asian residents are underrepresented in the populations living within walking distance to large parks and in the category representing the greatest combined park area within walking

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distance, and along with non-Hispanic black residents, are overrepresented in the middle-sized park category, while non-Hispanic white residents are inversely represented in the same three categories. Latino residents, on the other hand, are overrepresented in the population whose closest park is small, but are evenly represented in the combined park area categories. Despite these differences in access to park space, access to physical activity sites was relatively uniform across all categories.

DISCUSSION

The initial purpose of this study was to determine whether different spatial techniques would be useful for uncovering discrepancies in access to New York City parks where previous methods were only able to identify that parks are not distributed evenly, but also don't appear to be distributed in a systematically inequitable pattern with regard to socioeconomic factors (Maroko et al. 2009). A network analysis technique was used for each residential tax lot in New York City to identify the closest park and all of the parks within reasonable walking distances of 400m and 800m. This data was combined with racial/ethnic demographic estimates for each tax lot, which were disaggregated from Census 2000 block group data using the CEDS technique. Park size, distance, number of physical activity sites, and types of physical activity sites were considered.

The data showed that the majority of New York City residents live within walking distance of at least one park, with almost the entire population living within 800m of at least one park. It also revealed that there are racial/ethnic differences in who lives within walking distance of parks and in the size of those parks. From these results, several observations can be made that complicate claims of distributive (in)justice, and suggest the need for further research and ways that future research might better assess the environmental and health justice aspects of park access.

First, it may be significant that 95% of the citywide population lives within 800m of at least one park. It is worth noting that this number includes all of the Parks Department parks regardless of size, including spaces that might not accommodate a wide range of physical activities. But the question remains of whether walking-distance access to the nearest park is a relevant concern in a densely built and populated area like New York City. Comparing this with Nicholls' (2001) network analysis results from Bryan, TX, where 80% of the population did not live within 800m of any parks, and Cohen et al's. (2007) finding that in Los Angeles, CA, physical activity related to park use dropped off most significantly for residents living further than approximately 1,600m (1 mile) from the closest park, it is clear that equity in park access is going to be highly contextual. Someone living in Los Angeles or Bryan might be willing to travel farther to use a park for physical activity because of the lower park and population densities of those cities. However, someone living in New York, where transportation is less dependent on personal vehicle ownership, might be less willing or able to travel more than 400m, particularly when considering young children and the elderly who tend to be less mobile or more dependent on alternative means for transportation.

Another consideration is that the overall greater population density of New York means that parks need to accommodate larger populations. One or two small parks in a very densely populated neighborhood might not be as accommodating as a small park in a suburban neighborhood due to park overcrowding, which forms the basis for the City of New York’s PlaNYC 2030 open space initiative to make more park space available in the most densely populated neighborhoods (New York City 2007). A thorough understanding of park access in New York City as an environmental justice issue would require additional investigation into how factors such as neighborhood density, park size, and use of alternative physical activity spaces affect usage and access patterns. Future research might incorporate these and other factors such as environmental perception factors or requirement of fee-based permits (e.g., tennis courts at all New York City parks) by developing a park quality index, where different types of features could be assigned point values based on their potential impact on quality of or access to physical activity (Loukaitou-Sideris and Stieglitz 2002; Potwarka et al. 2008).

The second observation is that based on the results of this study it would appear that park access is not an issue of distributive injustice (Boone et al. 2009) since those portions of the population living farthest from parks tend to be overrepresented by non-Hispanic white residents (although not insignificantly, non-Hispanic Asian residents also fall into this category), while those living closest to parks are overrepresented by Latino residents. However, the results raise questions about park features and quality that require closer examination. Specifically, what does it mean for health equity that populations living near the smallest parks are disproportionately represented by Latino residents, while populations living near large parks are overrepresented by non-Hispanic white residents and underrepresented by Asian and Latino populations? Is there a way of untangling the tradeoff between distance to the closest park and park size? Loukaitou-Sideris and Stieglitz (2002) used a "park score index" that included park size and facilities to compare access to different parks. This might be particularly useful in assessing New York City parks based on the results of this study that indicate inequities in park distance and park size.

These inequities lead to the third observation, which is that there are a lot of very small parks in New York City that are not particularly well-suited to vigorous physical activity. While these parks doubtlessly contribute to the emotional and physical well being of residents as vital public spaces (Sullivan 2004), and promote walkability within the neighborhood (Cohen et al. 2006), their benefits should be evaluated differently from parks that are regularly used for active recreation. The use of a park score index or excluding those spaces, such as vest-pocket parks, that lack the space for physical activities, would likely lead to different conclusions from the current study. However, it is worth noting that the relatively even distribution of physical activity sites amongst populations living within walking distance of parks seems to indicate that even the smaller parks still provide opportunities for physical activities.

The final observation is that the network analysis and CEDS methods seem to have produced meaningful results. That is, the results indicate the presence of spatial patterns between parks and racial/ethnic demographics that were not apparent in the previous study of park access in New York City by Maroko et al. (2009) that used kernel density estimation and local regression analysis. This method represents an improvement over other spatial techniques for measuring park access, such as the container methods or Euclidean distance proximity methods described above, because it more accurately represents the distribution of populations throughout the built environment (Maantay et al. 2007) and incorporates the physical realities of walking routes between individual residences and parks. The network analysis method also allowed for a more detailed approach to park access by taking advantage of a parks dataset containing supplemental features of factors that affect access and physical activity, such as park entrances and basketball courts.

CONCLUSION

Past research linking access to parks and open space with increased physical activity (Bedimo-Rung et al. 2005; Cohen et al. 2006; Roemmich et al. 2006; Diez Roux et al. 2007) suggests that ensuring equitable access to parks is an important policy consideration for promoting physical activity and reductions in obesity (Bedimo-Rung et al. 2005; Godbey et al. 2005), particularly for sociodemographic populations more at risk for preventable illnesses such as diabetes and heart disease. This is particularly timely given the City of New York's PlaNYC 2030 objective to increase park access for all residents (New York City 2007). But it is also a social and environmental justice issue since uneven access to these environmental amenities have historically been shaped by structurally and institutionally racist processes of housing discrimination, redlining, gentrification, and uneven development (Pulido 2000). Therefore, a better understanding of which populations lack access to parks and physical activity sites, as well as how well those facilities promote physical activity, can assist in identifying neighborhoods and communities that might be targeted by public policy and health education for positive health interventions. But future research should also consider the social, political, and cultural processes that may exacerbate and reproduce the health outcomes resulting from uneven physical, social, and perceived access to health-promoting resources.

This study is not designed to provide conclusive evidence that distributional inequities do or do not exist in park access throughout New York City. Rather, it serves to answer several questions about what was missing in previous research on the topic, and presents a new method for measuring access to parks that can be combined with the other recommendations to more thoroughly examine the issue of park access related to health-promoting physical activity. As discussed above, this study is limited both in its scope and application of quantitative methods, but just as this study compliments previous research by Maroko et al. (2009), future studies are planned to incorporate recommendations from this study to better understand both the current distributions of environmental amenities and the historical processes that led to them.

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REFERENCES

Abercrombie LC, Sallis JF, Conway TL, Frank LD, Saelens BE, Chapman JE. Income and racial disparities in access to public parks and private recreation facilities. American Journal of Preventive Medicine. 2008; 34(1):9–15. [PubMed: 18083445]

Bedimo-Rung AL, Mowen AJ, Cohen DA. The significance of parks to physical activity and public health: A conceptual model. American Journal of Preventative Medicine. 2005; 28(2S2):159–168.

Berke EM, Koepsell TD, Moudon AV, Hoskins RE, Larson EB. Association of the built environment with physical activity and obesity in older persons. American Journal of Public Health. 2007; 97(3): 486–492. [PubMed: 17267713]

Boone CG, Buckley GL, Grove JM, Sister C. Parks and People: An Environmental Justice Inquiry in Baltimore, Maryland. Annals of the Association of American Geographers. 2009; 99(4):767–787.

Bryant, B., editor. Environmental justice: Issues, policies, and solutions. Washington, DC: Island Press; 1995.

Bullard, R., editor. Unequal protection: Environmental justice and communities of color. San Francisco, CA: Sierra Book Club; 1994.

Cohen DA, Ashwood JS, Scot MM, Overton A, Evenson KR, Staten LK, Porter D, McKenzie TL, Catellier D. Public parks and physical activity among adolescent girls. Pediatrics. 2006; 118(5):e1381–e1389. [PubMed: 17079539]

Cohen DA, McKenzie TL, Sehgal A, Williamson S, Golinelli D, Lurie N. Contribution of public parks to physical activity. American Journal of Public Health. 2007; 97(3):509–514. [PubMed: 17267728]

Crompton JL. The impact of parks on property values: empirical evidence from the past two decades in the United States. Managing Leisure. 2005; 10:203–218.

Cutts BB, Darby KJ, Boone CG, Brewis A. City structure, obesity, and environmental justice: an integrated analysis of physical and social barriers to walkable streets and park access. Social Science & Medicine. 2009; 69(9):1314–1322. [PubMed: 19751959]

de Vries SI, Bakker I, van Mechelen W, Hopman-Rock M. Determinants of activity-friendly neighborhoods for children: results from the SPACE study. American Journal of Health Promotion. 2007; 21(4Suppl):312–316. [PubMed: 17465176]

Diez Roux AV, Evenson KR, McGinn AP, Brown DG, Moore L, Brines S, Jacobs DR. Availability of recreational resources and physical activity in adults. American Journal of Public Health. 2007; 97(3) 493-399.

Edmonston, B. The Undercount in the 2000 Census. The Annie E. Casey Foundation and The Population Reference Bureau; 2002.

Estabrooks P, Lee RE, Gyurcsik NC. Resources for physical activity participation: Does availability and accessibility differ by neighborhood SES? Annals of Behavioral Medicine 2003. 2003; 25:100–104.

Frank LD, Andresen MA, Schmid TL. Obesity relationship with community design, physical activity and time spent in cars. American Journal of Preventive Medicine. 2004; 27(2):87–96. [PubMed: 15261894]

Gatrell AC, Bailey TC, Diggle PJ, Rowlingson BS. Spatial point pattern analysis and its application in geographical epidemiology. Transactions of the Institute of British Geographers. 1996; 21:256–274.

Godbey GC, Caldwell LL, Floyd M, Payne L. Contributions of leisure studies and recreation and park management research to the active living agenda. American Journal of Preventive Medicine. 2005; 28(2S2):150–158. [PubMed: 15694523]

Gordon-Larsen P, Nelson MC, Page P, Popkin BM. Inequality in the built environment underlies key health disparities in physical activity and obesity. Pediatrics. 2006; 117:417–424. [PubMed: 16452361]

Herrmann, C.; Maroko, AR. Crime pattern analysis: exploring Bronx auto thefts using GIS. In: Maantay, JA.; Ziegler, J., editors. GIS for the Urban Environment. Redlands, CA: Environmental Systems Research Institute (ESRI); 2006. p. 407-413.

Holifield R, Porter M, Walker G. Introduction spaces of environmental justice: frameworks for critical engagement. Antipode. 2009; 41(4):591–612.

Johnston, B., editor. Who pays the price? The sociocultural context of environmental crisis. Washington, DC: Island Press; 1994.

Kaczynski AT, Potwarka LR, Saelens BE. Association of park size, distance, and features with physical activity in neighborhood parks. American Journal of Public Health. 2008; 98(8):1451–1456. [PubMed: 18556600]

Lantz PM, House JS, Lepkowski JM, Williams DR, Mero RP, Chen J. Socioeconomic factors, health behaviors, and mortality results from a nationally representative prospective study of US adults. Journal of the American Medical Association. 1998; 279(21):1703–1708. [PubMed: 9624022]

Larsen J, El-Geneidy A, Yasmin F. Beyond the quarter mile: Re-examining travel distances by active transportation. Canadian Journal of Urban Research: Canadian Planning and Policy. 2010; 19 supplement(1):70–88.

Levine, N. CrimeStat III: A Spatial Statistics Program for the Analysis of Crime Incident Locations (version 3.0). Vol. Volume 8. Washington DC: Ned Levine & Associates; 2004.

Loukaitou-Sideris A. Is it safe to walk? Neighborhood safety and security considerations and their effects on walking. Journal of Planning Literature. 2006; 20(3):219–232.

Loukaitou-Sideris A, Stieglitz O. Children in Los Angeles parks: A study of equity, quality and children’s satisfaction with neighborhood parks. The Town Planning Review. 2002; 73(4):467–488.

Maantay JA, Maroko AR, Herrmann C. Mapping population distribution in the urban environment: The cadastral-based expert dasymetric system (CEDS). Cartography and Geographic Information Science. 2007; 34(2):77–102.

Maantay J, Maroko A. Mapping urban risk: Flood hazards, race, & environmental justice in New York. Applied Geography. 2009; 29:111–124. [PubMed: 20047020]

Maroko AR, Maantay JA, Sohler NL, Grady KL, Arno PS. The complexities of measuring access to parks and physical activity sites in New York City: a quantitative and qualitative approach. International Journal of Health Geographics. 2009; 8(1):34–56. [PubMed: 19545430]

Moore LV, Diez Roux A AV, Evenson KR, McGinn AP, Brines SJ. Availability of recreational resources in minority and low socioeconomic status areas. American Journal of Preventive Medicine. 2008; 34(1):16–22. [PubMed: 18083446]

New York, The City of (New York City). [accessed on 10/10/2010] PlaNYC: A Greener, Greater New York. 2007. http://www.nyc.gov/planyc

Nicholls S. Measuring the accessibility and equity of public parks: A case study using GIS. Managing Leisure. 2001; 6:201–219.

Papas MA, Alberg AJ, Ewing R, Helzlsouer KJ, Gary TL, Klassen AC. The built environment and obesity. Epidemiologic Reviews. 2007; 29(1):129–143. [PubMed: 17533172]

Potwarka LR, Kaczynski AT, Flack AL. Places to play: association of park space and facilities with healthy weight status among children. Journal of Community Health. 2008; 33(5):344–350. [PubMed: 18484170]

Pulido L. Rethinking Environmental Racism: white privilege and urban development in Southern California. Annals of the Association of American Geographers. 2000; 90(1):12–40.

Regional Plan Association. Building Transit-Friendly Communities A Design and Development Strategy for the Tri-State Metropolitan Region. New York, New Jersey, Connecticut: 1997.

Ritter, P. Planning for Man and Motor. New York: Pergamon Press; 1964.

Roemmich JN, Epstein LH, Raja S, Yin L, Robinson J, Winiewicz D. Association of access to parks and recreational facilities with the physical activity of young children. Preventive Medicine. 2006; 43:437–441. [PubMed: 16928396]

Rundle A, Field S, Park Y, Freeman L, Weiss CC, Neckerman K. Personal and neighborhood socioeconomic status and indices of neighborhood walk-ability predict body mass index in New York City. Social Science & Medicine. 2008; 67(12):1951–1958. [PubMed: 18954927]

Scott MM, Evenson KR, Cohen DA, Cox CE. Comparing perceived and objectively measured access to recreational facilities as predictors of physical activity in adolescent girls. Journal of Urban Health. 2007; 84(3):346–359. [PubMed: 17401691]

Sorlie PD, Backlund E, Keller JB. US mortality by economic, demographic, and social characteristics: the national longitudinal mortality study. American Journal of Public Health. 1995; 85(7):949–956. [PubMed: 7604919]

Sullivan WC, Kuo FE, Depooter SF. The Fruit of Urban Nature: Vital Neighborhood Spaces. Environment and Behavior. 36(5):678–700.

Talen E. The social equity of urban service distribution: An exploration of park access in Pueblo, Colorado, and Macon, Georgia. Urban Geography. 1997; 18(6):521–541.

Talen E, Anselin L. Assessing spatial equity: An evaluation of measures of accessibility to public playgrounds. Environment and Planning A. 1998; 30:595–613.

Taylor WC, Poston WSC, Jones L, Kraft MK. Environmental justice: Obesity, physical, activity, and healthy eating. Journal of Physical Activity and Health. 2006; 3 Suppl1:30–54.

Timperio A, Ball K, Salmon J, Roberts R, Crawford D. Is availability of public open space equitable across areas? Health & Place. 2007; 13(2):335–340. [PubMed: 16581285]

U.S. Census Bureau. [accessed 06/02/2010] Well done, America! Nation achieves 67 percent response rate in Census 2000, two points higher than 1990. 2000. p. 9http://www.census.gov/Press-Release/www/2000/cn57.html

Wendel-Vos GC, Schuit AJ, de Niet R, Boshuizen HC, Saris WHM, Kromhout D. Factors of the physical environment associated with walking and bicycling. Medicine & Science in Sports & Exercise. 2004; 36:725–730. [PubMed: 15064601]

Wolch J, Wilson JP, Fehrenback J. Parks and park funding in Los Angeles: An equity mapping analysis. Urban Geography. 2005; 26(1):4–35.

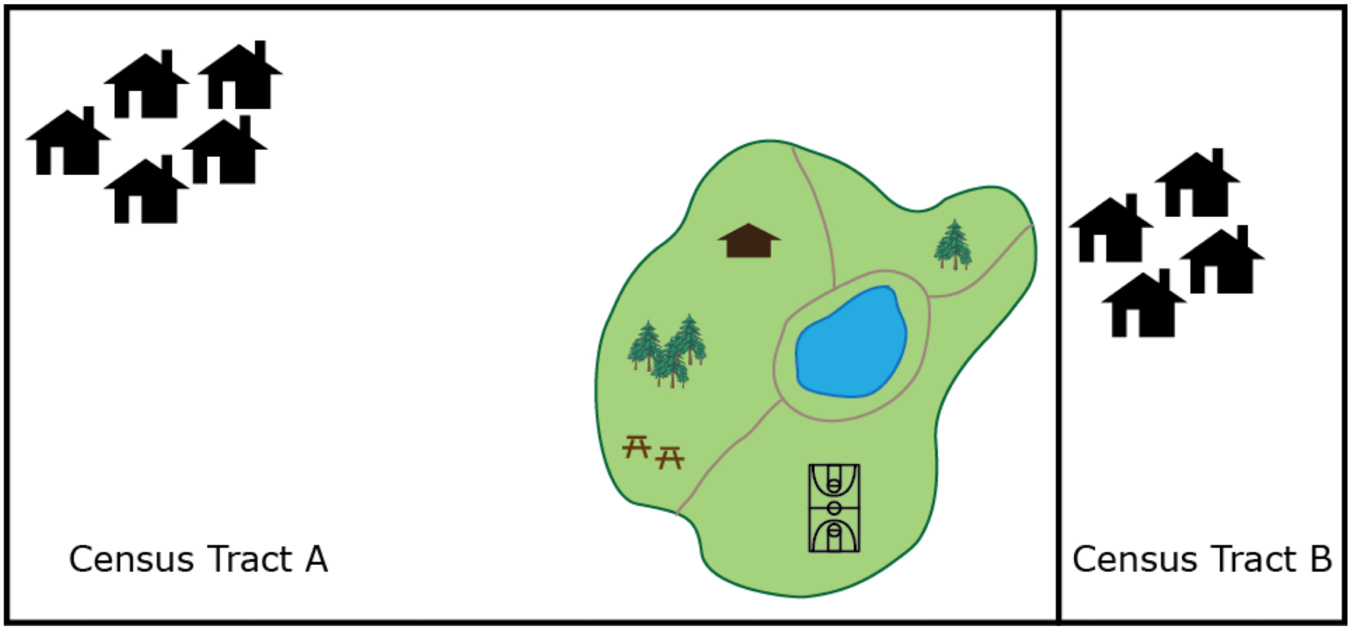

Figure 1.
The problems with the container approach: In Census Tract A, the concentration of residences is not within walking distance to the park contained within the tract but they are still counted as being proximate since they are in the same tract; in Census Tract B, the population is within walking distance of the park but are not counted since the tract boundary lies between the residential units and the park.

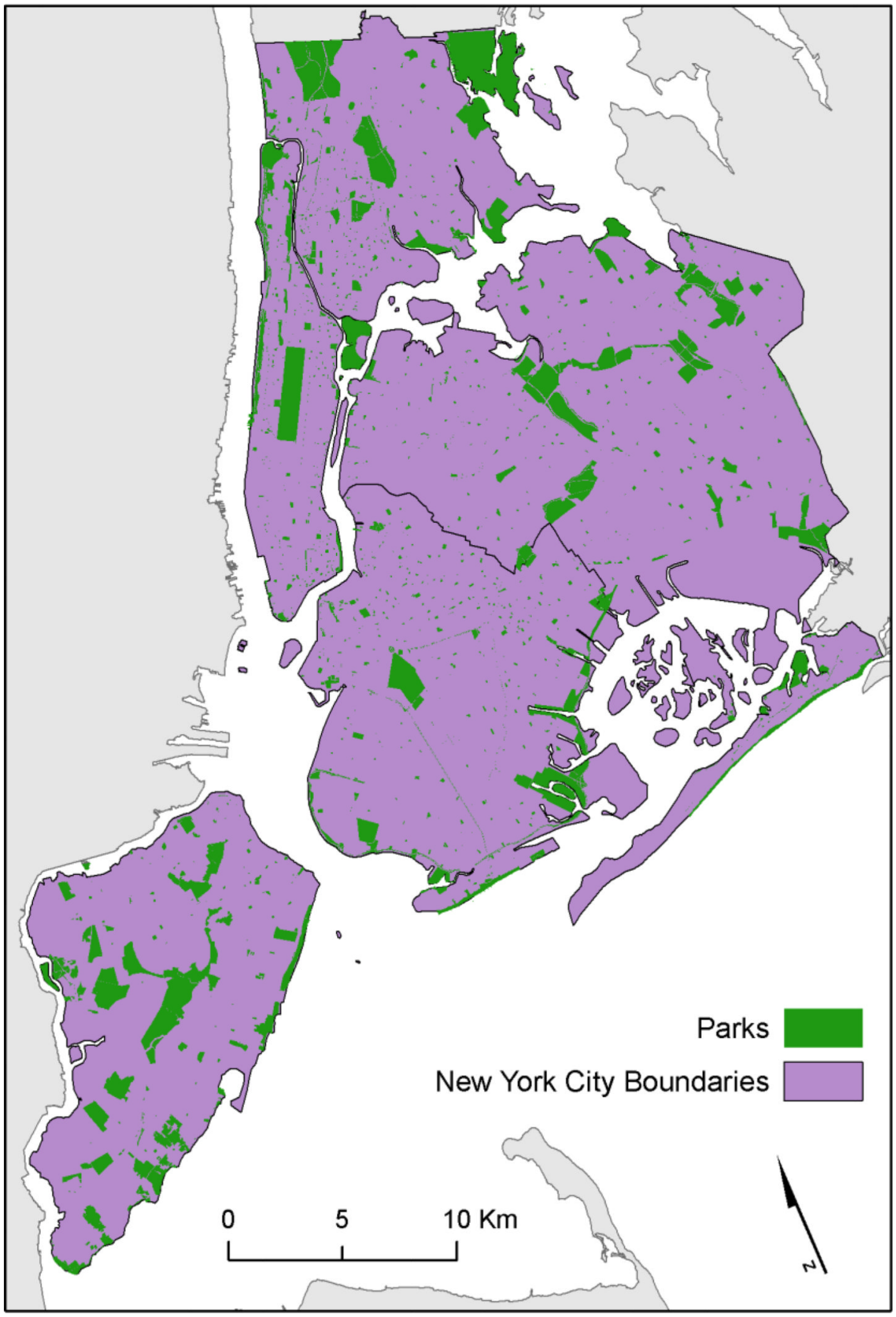

Figure 2.
All parks and open spaces in New York City owned by the NYC Dept. of Park and Recreation. Source: NYC Dept. of Parks and Rec., New York State Office of General Services, New Jersey Office of Information Technology.

Figure 3.
Example of the geocoded park activity sites and access points at Watson Gleason Park in the Bronx (Maroko et al. 2009).

Table 1

Odds ratios and 95% confidence intervals comparing individual racial/ethnic groups with the overall New York City population.

	Population[1]	NHWH	NHBL	NHAS	HISP
Distance to Closest Park [m]					
0 – 400	5,252	0.75 (0.74,0.75)	1.04 (1.04,1.04)	0.85 (0.85,0.86)	1.65 (1.64,1.65)
0 – 800	7,561	0.74 (0.74,0.75)	0.82 (0.81,0.83)	1.23 (1.21,1.24)	2.29 (2.27,2.31)
800+	420	1.34 (1.33,1.35)	1.22 (1.21,1.23)	0.81 (0.80,0.82)	0.44 (0.43,0.44)
Number of Parks within 400m					
0	2,730	1.34 (1.34,1.34)	0.96 (0.96,0.97)	1.17 (1.17,1.18)	0.61 (0.61,0.61)
1	2,534	1.04 (1.04,1.05)	0.96 (0.96,0.96)	1.08 (1.07,1.08)	0.95 (0.95,0.96)
2+	2,718	0.69 (0.69,0.69)	1.08 (1.08,1.08)	0.78 (0.78,0.78)	1.60 (1.60,1.61)
Size of Closest Park [ha][2]					
0 – 0.4	1,758	0.91 (0.91,0.92)	0.83 (0.83,0.84)	1.00 (1.00,1.01)	1.23 (1.23,1.24)
0.4 – 1.5	1,824	0.90 (0.89,0.90)	1.21 (1.21,1.22)	1.21 (1.20,1.21)	0.89 (0.89,0.90)
1.5+	1,670	1.22 (1.21,1.22)	0.97 (0.97,0.98)	0.81 (0.80,0.81)	0.90 (0.89,0.90)
Combined Size of Parks within 400m [ha][2]					
0 – 1	1,991	1.05 (1.05,1.05)	0.90 (0.89,0.90)	1.24 (1.23,1.24)	0.95 (0.95,0.95)
1 – 4	1,510	0.80 (0.79,0.80)	1.17 (1.17,1.18)	0.96 (0.95,0.97)	1.10 (1.10,1.11)
4+	1,751	1.16 (1.15,1.16)	0.96 (0.96,0.97)	0.82 (0.81,0.82)	0.96 (0.96,0.96)
Combined number of physical activity sites within 400m[2]					
0 – 3	1,548	1.12 (1.11,1.12)	0.84 (0.84,0.84)	1.09 (1.09,1.10)	0.98 (0.97,0.98)
4 – 10	1,845	0.91 (0.91,0.92)	1.08 (1.08,1.09)	0.98 (0.98,0.99)	1.03 (1.02,1.03)
11+	1,859	0.99 (0.98,0.99)	1.07 (1.07,1.08)	0.94 (0.93,0.94)	0.99 (0.99,1.00)
Combined different types of physical activity sites within 400m[2]					
0 – 2	2,163	1.08 (1.08,1.09)	0.94 (0.93,0.94)	1.06 (1.05,1.06)	0.94 (0.94,0.95)
3 – 4	1,360	1.00 (0.99,1.00)	1.01 (1.01,1.01)	1.03 (1.03,1.04)	0.97 (0.97,0.98)
5+	1,729	0.92 (0.91,0.92)	1.06 (1.06,1.07)	0.91 (0.91,0.92)	1.09 (1.09,1.10)

NHWH = non-Hispanic white; NHBL = non-Hispanic Black; NHAS=non-Hispanic Asian; HISP = Hispanic/Latino, any race

[1] Estimated population, in thousands

[2] Calculated in comparison to the population living within 400m of at least one park

Table 2

Park size classifications based on even distributions of the population within 400m of at least one park.

Classification	Size [ha]	Population[1]	Proportion of Total
Small	0 – 0.4	1,758	0.33
Medium	0.4 – 1.5	1,824	0.35
Large	1.5+	1,670	0.32

[1]Estimated population, in thousands, of residents within 400m of at least one park