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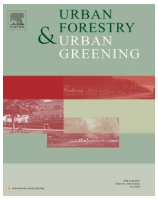

# Park equity: Why subjective measures matter

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ABSTRACT

Due to the various social and environmental benefits provided by urban parks and open spaces, ensuring that residents have equitable access to high-quality parks is paramount for planners and allied professionals. While research has identified inequities in park access based on race, ethnicity, and income, previous studies primarily focus on objective measures of access such as proximity to parks. Additionally, previous research typically includes single study regions that do not capture differences in distinct places. Relying on survey data from six metropolitan areas of the U.S., we address these gaps by investigating how subjective perceptions of parks vary by race/ethnicity and income (while controlling for other factors). Specifically, we employ linear mixed models to test for interaction effects between race/ethnicity and the six metro regions. We also compare subjective views of parks to ParkScore® rankings and metrics that represent park access. Overall, we found that perceived problems with park availability and quality were highest in the Baltimore area, as well as Los Angeles, Miami, and Boston; they were lowest is Phoenix and Minneapolis–St. Paul. Meanwhile, residents perceived significantly more improvements in park availability and quality in Miami and Minneapolis–St. Paul, followed by the other regions. Compared to objective ParkScore® measures, subjective perceptions of parks do not always follow the relative rankings of metrics for park access and quality. Additionally, Black and Hispanic residents perceived greater park problems than White residents, and Hispanic residents perceived more improvements than White residents. However, distinctions in public perceptions of parks by racial/ethnic groups and regions did not hold up in our mixed, multivariate models. Instead, our results highlight regionally distinct perceptions by race/ethnicity, suggesting that subjective views of park quality are context-dependent. In contrast, income is a more dominant driver of perceived improvements in local parks and open spaces. As a whole, this research underscores the need to consider both objective and subjective measures in particular geographic contexts to fully understand and plan for the equitable distribution of high-quality parks across diverse people and places.

## 1. Introduction

Parks provide a variety of societal, economic, and environmental benefits to urban residents and ecosystems (Bedimo-Rung et al., 2005; Konijnendijk et al., 2013). Urban parks directly promote physical activities and serve as an important public health resource for residents (Schipperijn et al., 2017; Twohig-Bennett and Jones, 2018). They also function as democratic spaces that promote convivial social interactions, a sense of community, and subjective wellbeing (Jennings and Bamkole, 2019; Larson et al., 2016; Schnell et al., 2019). Additionally, parks provide economic benefits such as increased property values for nearby housing (Crompton, 2007; Poudyal et al., 2009). Furthermore, parks offer a multitude of environmental services such as providing wildlife habitat, mitigating stormwater runoff, and functioning as a buffer against air pollution and the urban heat island effect (Yin et al., 2011; Lin et al., 2017; Vieira et al., 2018; Algretawee et al., 2019). Given these multiple benefits, providing equitable access to public parks is one of the most important responsibilities of city officials and planners.

Park access is a multidimensional construct, and previous park studies have mainly incorporated objective metrics on availability, such as proximity, size, and number of parks (Wang et al., 2013,2015,2015; Chen et al., 2020). Objective measures of park quality have also been examined, though to a lesser extent since measuring quality is more resource-intensive in requiring field observations or social surveys

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(Tester and Baker, 2009; Evenson et al., 2016; Chen et al., 2020). Studies based on objective measures consistently show that low-income residents and communities of color in the U.S. have limited access to parks relative to White and upper-class individuals, who disproportionally enjoy park benefits (Boone et al., 2009; Sister et al., 2010; Duncan et al., 2013; Arroyo-Johnson et al., 2016; Rigolon, 2016; Rigolon et al., 2018; Nesbitt et al., 2019; Locke et al., 2021). These inequities are rooted in historic urban planning practices including zoning and redlining that have segregated communities by race and ethnicity; as such, current inequities in park access reflect the persisting legacies of past decisions (Boone et al., 2009; Locke et al., 2021; Lee et al., 2022; Rigolon and Németh 2016).

Many cities are actively seeking to remedy the legacies of racism and discrimination by improving park access among systematically marginalized communities. In these pursuits, objective measures of park access have become influential for equitable park planning (Kaczynski et al., 2016). For instance, the National Recreation and Park Association, the Trust for Public Land, the Urban Land Institute, and the Center for Disease Control and Prevention have mobilized around the concept of the "10-minute walk" campaign, which aims to provide a high-quality park within a half-mile walk of all residents (Oliphant et al., 2019). However, objective metrics alone provide an incomplete assessment of park access. In particular, several studies have highlighted that park users' subjective perceptions are an equally important—if not more critical determinant—of actual park use compared to objective metrics of park access (Chen et al., 2020; Scott et al., 2007; Wang et al., 2015).

The importance of residents' subjective views regarding park availability and quality lies in the fact that parks vary significantly in their design, amenities, vegetation, and community context, among other factors (Cranz and Boland, 2004; Larson, 2018; Thompson, 1998). Furthermore, different individuals and social groups may have varying perceptions of and experiences with the same local park or park system. For instance, some African Americans perceive certain parks as "White Space" and do not visit them despite a park's close proximity and good quality (Lee and Scott, 2016). Researchers have commonly documented that individuals of lower socioeconomic statuses, as well as older women, are more likely to perceive lower levels of park access (Ball et al., 2008; Wang et al., 2015). In addition, studies have found that dense vegetation and natural areas intimidate some park users, especially women and children (Sreetheran and Van Den Bosch, 2014; Sonti et al., 2020), while others regard these park features as an attractive component of green space design (Kuo et al., 1998). Similarly, park features that appeal to residents of one city or area, such as biking paths or the presence of police officers, may be negatively perceived in a different context (Zwierzchowska et al., 2018; Sonti et al., 2020).

Despite the distinct contributions of previous studies on equitable park planning, greater incorporation of residents' subjective views are needed in both research and practice. Additionally, studies including subjective perceptions tend to focus on only one or a few cities, rendering the generalizability of findings limited. Moreover, previous research on park equity has not compared objective metrics to residents' subjective views about park access, nor has research focused on changes or improvements in the availability and quality of parks over time. This study addresses these research gaps by analyzing survey data on residents' perceptions of local parks across six diverse cities of the U.S.: Boston, Massachusetts; Baltimore, Maryland; Minneapolis–St. Paul, Minnesota; Phoenix, Arizona; Los Angeles, California; and Miami, Florida. Specifically, we examine residents' perceptions regarding problems with local park access and recent changes in parks, both in terms of their availability and quality.

With an equity lens, we consider how public perceptions of parks vary across diverse people based on race and ethnicity while controlling for income and other demographic factors. Our large sample allows us to test for random effects associated with the geographic context of each of the six metropolitan regions, particularly to examine how perceptions differ based on race and ethnicity across diverse geographies, as opposed to assuming uniform effects across regions. Lastly, we compare residents' subjective views to objectives metrics of park access. Overall, our aim is to underscore how evaluating subjective views reveals important insights for equitably planning and investments in urban parks for diverse people and places.

## 2. Methods

### 2.1. Surveyed cities and ParkScore® metrics

Our analysis relies on data collected from a 2011 telephone survey across six metropolitan regions within the United States—specifically, Boston; Baltimore; Minneapolis–St. Paul; Los Angeles; Phoenix; and Miami (Table 1). These cities were chosen due to the original research team's familiarity with and ongoing research in these regions. Located in the fast-growing Sunbelt, our three study regions in California, Arizona, and Florida have largely developed since the mid-1900 s. Accordingly, they have experienced significant urban sprawl and lower density development. Because of their car-centric development, walkable access to parks is lower compared to the older study cities in Massachusetts, Maryland, and Minnesota. While these northerly study regions have more walkable access to parks, their parks tend to be more congested and receive lower levels of funding (Boone et al., 2009, Rigolon, 2016). Across the U.S., however, park funding has declined in recent years, exacerbating park inequities within and across cities and their surrounding suburbs (Joassart-Marcelli, 2010).

To characterize parks in each region, we present ParkScore® rankings and specific metrics from 2013 (Table 1), which is the closest year to the 2011 survey time period for which objective measures are available (Trust for Public Land 2013). Since ParkScore® data are provided at the municipal scale, we focus on the metrics for the central cities of each metro region (Table 1). Among the 50 cities covered in the 2013 ParkScore® data, Minneapolis (1st) and Boston (3rd) ranked highest in terms of overall park availability and quality, although Boston scored slightly higher on park access and acreage. Baltimore (25th) and Phoenix (28th) ranked in the middle tier, with Baltimore providing substantially more walkable park access compared to Phoenix. In the bottom tier, Miami (38th) and Los Angeles (45th) ranked the lowest, with Miami having the lowest park coverage among the study cities.

To understand how much park availability and quality change over a short time period, we plotted the ParkScore® metrics for 2013–2020 (Fig. 1). While the overall rankings have changed, likely due to the addition of new cities after 2013 (the Trust for Public Land now provides metrics for 100 cities), the relative ranking of our study cities is similar across 2013-to-2020 (Fig. 1). The park area and access metrics have also remained fairly stable over the time period. Meanwhile, park investments (dollars spent per resident) have changed in noteworthy ways, especially since 2017; specifically, while increases can be seen in Minneapolis, Boston, and Los Angeles, declines are evident in Miami.

### 2.2. Survey sample

The stratified, purposeful survey sample reflects the goals of the original research project for which the survey was conducted. The previous project sought to understand landscape heterogeneity in relation to population density, socioeconomic status, and life stage (citations removed for anonymous review). Accordingly, the first stage of sampling involved identifying segments that varied by density, socioeconomics, and life stage (e.g., young adults without children, middle-aged adults with children, and older adults living alone) across the study areas.

Claritas Inc's PRIZM database (2013) defines segments as U.S. Census Block Groups that share similar characters. The database captures lifestyle factors inclusive of household demographics, shopping behaviors, and media and technology use, specifically by measuring: *population density*, characterized as urban (within large and medium city

**Table 1**
Objective Measures of Park Availability and Quality from ParkScore® (2013). The total number of cities ranked is 50. Population data are also included for context based on the U.S. Census (2015).

| Overall Rank | Central City, State | Population (Density) 2015 | Acreage: *Park Acres as % of City Area* | Access: *% of Residents within 1/2 Mile of Park* | Investment: *Spending per Resident* |
|---|---|---|---|---|---|
| 1 | **Minneapolis–St. Paul**, Minnesota | 3.5 million (165/km$^2$) | 15% | 94% | $214 |
| 3 | **Boston**, Massachusetts | 4.7 million (402/km$^2$) | 17% | 97% | $112 |
| 25 | **Baltimore**, Maryland | 2.8 million (345/km$^2$) | 10% | 85% | $62 |
| 28 | **Phoenix**, Arizona | 4.4 million (117/km$^2$) | 15% | 45% | $96 |
| 38 | **Miami**, Florida | 5.9 million (369/km$^2$) | 5% | 75% | $79 |
| 45 | **Los Angeles**, California | 13.2 million (892/km$^2$) | 8% | 60% | $68 |

*Source*:Source: The Trust for Public Land.

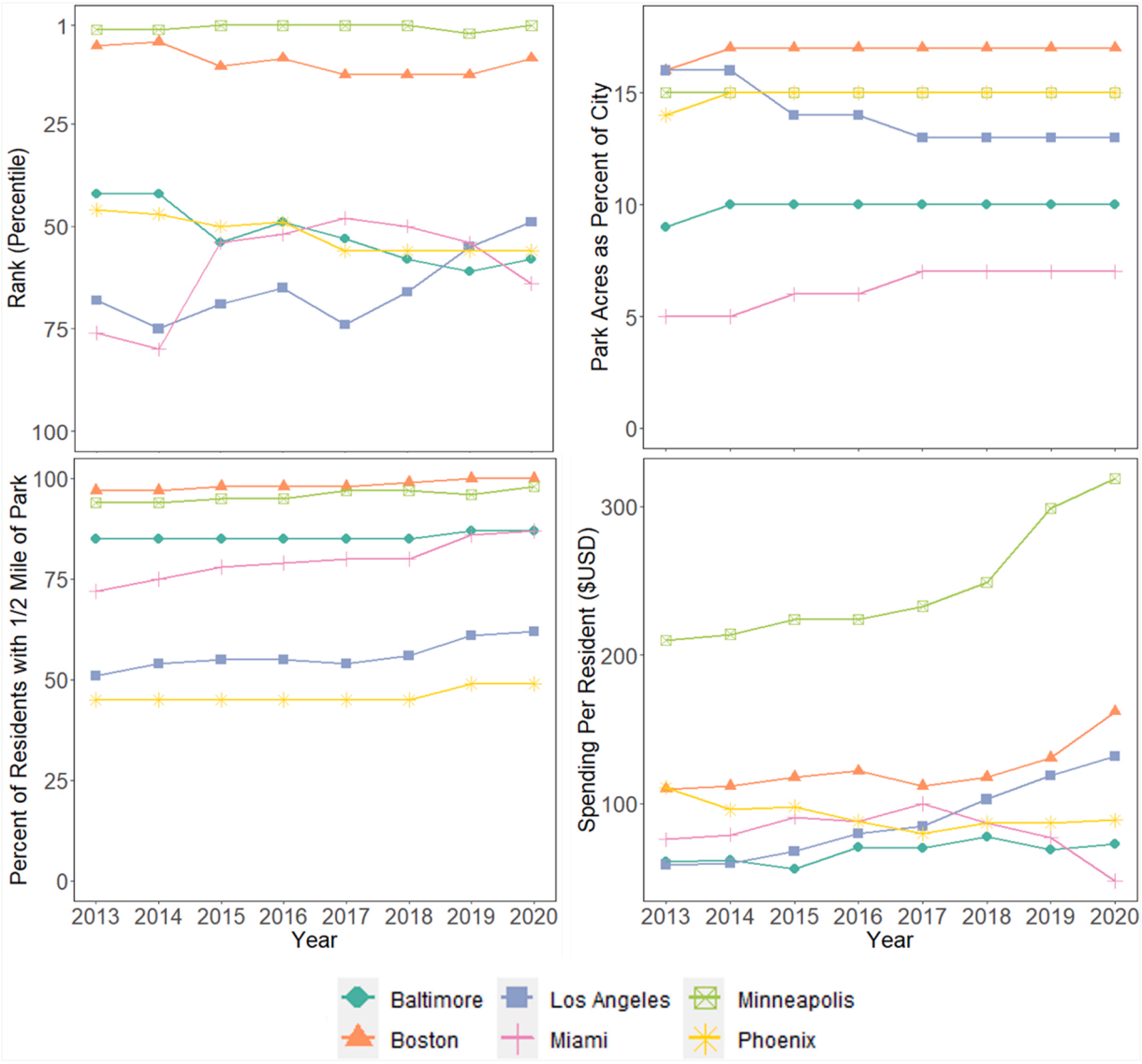


**Fig. 1.** Changes in ParkScore® Metrics over Time for the Central Cities in our Study Regions (2013–2020). Since the number of cities evaluated by ParkScore has changed over time, the rankings are presented as percentiles based on the number of cities evaluated in each time period.

centers), suburban (communities located on the outskirts of cities or in the core neighborhoods of smaller cities and large towns), and rural (in areas that are smaller than towns and include very small towns, villages, hamlets, and rural farms); the *life stages* of residents (e.g., young singles or couples, families with children that are younger than thirty, and older individuals or those with children over the age of thirty); and *low-to-high*

*income levels* (Claritas, Inc. 2013). Based on these three criteria, the final segments (and their identifying numbers) used to stratify the survey include the following: "Urban White Picket Fences" (34) and "Multi--Culti Mosaic" (54) as low-middle income, urban, family groups; "Upward Bound" (13), "American Dreams" (29), and "City Roots" (61) as low-middle income, urban, family-mature; "New Empty Nests" (14) and "Pools and Patios" (15) as middle-income, suburban, mature; "Fast-Track Families" (20) as middle-upper income, town and country, family; "Money and Brains" (07) and "Second City Elite" (10) as upper-income, urban, mature; "Blue Blood Estates" (02) and "Winner's Circle" (06) as upper-income, suburban, family; and, "God's Country" (11) and "Country Casuals" (25) as upper-income relatively exurban or rural and younger communities (Nielsen, 2011).

Residential neighborhoods that reflect the above stratified segments were surveyed through a computer-assisted telephone process implemented by a marketing research firm. Phone numbers within the neighborhoods were obtained from the Nielsen Company. More than 100,000 households across the study cities were contacted to participate in November-December of 2011. Of 13,590 households who answered the phone and qualified (i.e., adults living in single-family homes), the response rate for was 70% with a final sample size was 9480. The regional response rates ranged from 66% to 73%, with samples sizes for regions ranging from a low of 1449 (Los Angeles) to a high of 1646 (Minneapolis–St. Paul; see Supplementary Table 1 for additional details). Responses were fairly even across segments within cities, with an average of 226 responses per neighborhood (standard deviation = 40). While the sample size is large, it is limited to only single-family residents and is not a generalizable random sample. Since the original survey was focused on residential land management, respondents may have been particularly interested in landscaping and gardening.

Despite the limitations of the sample, its large size (n = 9480) across six surveys is valuable in demonstrating how differences in perceptions of park availability and quality play into their unjust distribution, especially considering the local experiences and perspectives of geographically and racially/ethnically diverse residents. In particular, this dataset allows us to investigate how residents' perceptions of local parks—specifically their evaluation of problems and investments in park availability and quality—reflect inequities across race and ethnicity in distinct metropolitan contexts controlling for income and other demographic factors.

### 2.3. Survey variables

Using three-point ordinal response scales, the survey asked the following questions about the "availability" and "quality" of "parks and open spaces" to evaluate residents' subjective views of local parks. First, tell me if you consider [the availability/quality of parks] to be a major problem (3), somewhat of a problem (2), or not a problem (1) in your neighborhood. Second, tell me if you feel [the availability/quality of parks] has improved (3), declined (1), or remained the same (2) "in the past few years." Following standard survey analysis methods (Larson et al., 2021), we created two composite scales—one for perceived problems with parks and a second for perceived park improvements—by averaging individuals' responses to each for availability and quality (Table 2). This is justified given the high correlations (for survey data) between the two sets of variables: Spearman's rho = 0.56, $p < 0.00$, for the two variables in the perceived problems scale, and Spearman's rho = 0.53, $p < 0.00$ for the two variables in the perceived park improvements scale.

The survey question about race and ethnicity asked respondents to self-identify with the following racial and ethnic groups: African American or Black, Hispanic, Asian, or some other group (see Table 3 for descriptive statistics of the sample, in addition to Supplementary Table 1 for the frequencies of respondents by region for each racial/ethnic group). People also self-identified as male or female. An eight-point scale measured income in relation to "the total annual income of all members of your household", ranging from under $15,000 to over $150,000. A five-point scale gauged education for the highest level of schooling completed, including less than high school, high school, some college, college graduate, and post-graduate work. We also measured employment status and included whether respondents were employed full time or not. Five categories classified age ranges: under 35, 35–44, 45–54, 55–64, 65 or over. Finally, for household size, participants were asked: including yourself, how many people live in your household?

**Table 2**
Descriptive Statistics for Perceptions of Local Parks and Open Spaces.

| Dependent Variables | Response Frequencies | Mean | Standard Deviation | Valid N |
|---|---|---|---|---|
| ***Park Problems Scale*** | ***N.A.*** | ***1.16*** | ***0.387*** | ***9421*** |
| *Availability* | 87.7% not<br>9.4% somewhat<br>2.9% major | 1.15 | 0.431 | 9357 |
| *Quality* | 86.9% not<br>10.5% somewhat<br>2.6% major | 1.16 | 0.428 | 9315 |
| ***Park Improvements Scale*** | ***N.A.*** | ***2.17*** | ***0.447*** | ***9399*** |
| *Availability* | 21.2% improved<br>73.2% same<br>5.6% declined | 2.16 | 0.493 | 9337 |
| *Quality* | 24.2% improved<br>69.2% same<br>6.6% declined | 2.18 | 0.526 | 9279 |

**Table 3**
Descriptive Statistics for Socio-Demographic Variables (n = 9480).

| Socio-Demographic Variables | Percentages* | Mean | Standard Deviation |
|---|---|---|---|
| Race/ethnicity | | | |
| White | 82.9% | n.a | n.a |
| Hispanic | 8.5% | n.a | n.a |
| Black | 5.9% | n.a | n.a |
| Asian | 2.2% | n.a | n.a |
| Other | 0.5% | n.a | n.a |
| Income | | | |
| Education: *College Graduate* | 35.3% | 4.6 | 1.11 |
| Gender: *Female* | 58.1% | n.a | n.a |
| Age: *45–54 years* | 27.2% | 3.4 | 1.24 |
| Employment: *Full-Time* | 50.2% | n.a | n.a. |
| Household size: *2 residents* | 36.5% | 3.03 | 1.54 |

*For ordinal variables, the *most frequent response* (mode) is noted.

### 2.4. Analysis

To understand patterns in park perceptions, we first review descriptive statistics for the variables, both overall and by region and racial/ethnic groups (see Tables 2, 4 and 5). We also report ANOVA results with Tukey's post-hoc comparisons to test for significant differences in park perceptions across regions and race/ethnicity (Tables 4–5).

To investigate the extent to which race/ethnicity and other demographic factors explain perceptions, we conducted two linear mixed models (LMM) with the variables for perceived problems with park access and perceived changes in local parks (see Table 6). Our models treat the six cities as a random effect (intercept; variance for random effect for park problems and improvements is 0.15 and 0.20 respectively), which is appropriate since varying characteristics of each region (e.g., land use, social or historical contexts) may explain variability in park perceptions that is not captured by the fixed variables in the models. For our fixed effects, we included race/ethnicity, income, education, gender, age, employment status, and household size. We also included region as a fixed effect via an interaction effect between race/ethnicity and the metropolitan areas to capture regionally specific racial and ethnic dynamics, since park planning and investments in US cities are tied to

**Table 4**
Statistics and ANOVA Results for Park Perceptions by Region.

| Metropolitan Region | *Perceived Problems*[1] Mean (St. Dev.) | *Perceived Improvements*[2] Mean (St. Dev.) | ParkScore® Overall Ranking | ParkScore® Investment Ranking[3] |
|---|---|---|---|---|
| Baltimore | 1.20[a](0.44) | 2.12[c](0.44) | 25 | 6 |
| Los Angeles | 1.17[a](0.41) | 2.17[b](0.46) | 45 | 5 |
| Miami | 1.17[a](0.44) | 2.23[a](0.49) | 38 | 4 |
| Boston | 1.17[a](0.38) | 2.16[bc](0.45) | 3 | 2 |
| Phoenix | 1.12[b](0.33) | 2.12[c](0.41) | 28 | 3 |
| Minneapolis–St. Paul | 1.11[b](0.31) | 2.20[ab](0.44) | 1 | 1 |
| *ANOVA Statistics* | *F= 12.9, p < 0.01* | *F= 14.0, p < 0.01* | *N.A.* | *N.A.* |

Survey responses ranged from 1 to 3, with 3 signaling [1]problems and [2]improvements with local park access. Different superscripted letters indicate statistically significant pair-wise differences at the $p < 0.05$ level. [3]The ParkScore® rankings for investments are for the study cities only (see Table 1 for details and additional park metrics).

**Table 5**
Descriptive Statistics and ANOVA results for Park Perceptions by Race and Ethnicity.

| Race & Ethnicity | *Perceived Problems*[1] | | *Perceived Improvements*[2] | |
|---|---|---|---|---|
| | Mean (St. Dev.) | N | Mean (St. Dev.) | N |
| Black | 1.24[a](0.50) | 538 | 2.18 (0.48) | 534 |
| Hispanic | 1.23[a](0.48) | 761 | 2.21[a](0.49) | 762 |
| Asian | 1.19 (0.45) | 197 | 2.13 (0.42) | 196 |
| White | 1.14[b](0.36) | 7476 | 2.16[b](0.44) | 7457 |
| Native | 1.13 (0.37) | 35 | 2.21 (0.39) | 35 |
| *ANOVA Statistics* | F= 15.79, p < 0.001 | | F= 2.71, p = 0.028 | |

Survey responses ranged from 1 to 3, with 3 signaling [1]problems and [2]improvements with local park access. Statistically significant pair-wise differences are denoted by different superscripted letters ($p < 0.05$ level).

regional histories and sociopolitical circumstances in particular places (Boone et al., 2009; Locke et al., 2021; Lee et al., 2022). By extension, people of varying races or ethnicities may view park availability and quality differently due their own racialized experiences with parks where they live (Moore et al., 2008; Byrne and Wolch, 2009; Engelberg et al., 2016; Rigolon and Németh 2018).

We ran the mixed models using R version 4.0.4 (R Core Team 2021) and package lme4 (Bates et al., 2015). After running the models, we checked the fit using both $R^2$ and residual diagnostics tests for hierarchical modeling in the Dharma package (Hartig, 2021). Specifically, we used a nonparametric dispersion test of standard deviation to compare residuals of our model relative to simulated residuals generated using our model (Le Cessie and Van Houwelingen, 1995; Gelman and Hill, 2006; Hartig, 2021).

To further explore the potential influence of our predictor variables, we then conducted an analysis of variance test (ANOVA) on variables that were significant at the $p < 0.05$ level in our models. We also conducted Tukey's Honest Significant Difference Test (HSD) to examine the influence of race/ethnicity, as well as region, on the dependent variables capturing perceptions of local parks (Miller, 1981; Yandell, 1997; Scheffe, 1999).

Finally, we qualitatively compared residents' subjective views of parks to objective measures from ParkScore® metrics, specifically considering the relative rankings for park availability and quality. In doing so, we identified consistencies and discrepancies between the objective and subjective measures for parks in our study regions.

## 3. Results

### 3.1. Patterns in park perceptions

Overall, approximately one-tenth of our survey respondents perceived the availability (9%) and quality (10%) of their local parks as somewhat problematic, whereas the vast majority (87% and 85%, respectively) perceived local park access as unproblematic (Table 2). Meanwhile, less than 3% of survey respondents viewed the availability and quality of parks as major problems. Across regions, residents of Minneapolis–St. Paul and metropolitan Phoenix perceived local park access more positively than Baltimore, Miami, Boston, and Los Angeles, where perceived problems were significantly greater based on the ANOVA (Table 4).

Regarding changes in local parks, a majority of our sample reported that the availability (72% respondents) and quality (68%) of local parks had remained the same, while 21% and 24% respectively said parks had improved (Table 2). Only 5–6% perceived their local parks as declining in either their availability or quality. Comparing these perceptions across regions, residents of Miami and Minneapolis–St. Paul perceived the greatest park improvements, followed by Los Angeles and Boston, and then Phoenix and Baltimore (Table 4). Considering both dependent variables, residents of Minneapolis–St. Paul are most consistently satisfied with their local parks and those in Baltimore are least satisfied.

Comparing park perceptions by race and ethnic groups, we found that Black and Hispanic/Latinx residents perceive the availability and quality of local parks as significantly more problematic than White residents (Table 5). Meanwhile, the only significant difference in perceived park improvements is that Hispanic/Latinx residents are more positive than White residents (Table 5).

**Table 6**
Results from Mixed Models for Perceptions of Park Availability and Quality.

| Significant Explanatory Variables | *Perceived Problems* | | | *Perceived Improvements* | | |
|---|---|---|---|---|---|---|
| | Beta | Standard Error | P-Value | Beta | Standard Error | P-Value |
| ***Race:* White** | -0.20 | 0.09 | 0.02 | n.s. | n.s. | n.s. |
| ***Interaction Effects*** | | | | | | |
| **Black * Miami** | 0.323 | 0.131 | 0.01 | n.s. | n.s. | n.s. |
| **Hispanic/Latinx * Miami** | 0.984 | 0.160 | 0.02 | n.s. | n.s. | n.s. |
| **White * Miami** | 0.346 | 0.125 | 0.01 | n.s. | n.s. | n.s. |
| **Hispanic/Latinx * Los Angeles** | 0.279 | 0.146 | 0.05 | n.s. | n.s. | n.s. |
| **White * Boston** | 0.300 | 0.130 | 0.02 | n.s. | n.s. | n.s. |
| ***Other Demographics*** | | | | | | |
| **Income** | -0.014 | 0.00 | < 0.00 | 0.009 | 0.004 | 0.02 |
| **Age** | -0.025 | 0.004 | < 0.00 | 0.016 | 0.005 | < 0.00 |
| **Gender: Male** | -0.002 | 0.001 | 0.03 | n.s. | n.s. | n.s. |
| ***Model $R^2$ Statistics*** | *Fixed Effects Only: 0.023* *Full Model: 0.046* | | | *Fixed Effects Only: 0.012* *Full Model: 0.033* | | |

Only significant variables shown. N.S. indicates non-significant variables in the perceived improvements model. Full model results are in the Supplementary Tables 1 and 2.

### 3.2. Significant explanatory factors for park perceptions

Our first model examining perceived problems with local park access contained nine significant ($p < 0.05$) variables (Table 6). Regarding race/ethnicity, White respondents across cities perceived park availability and quality as less problematic than other racial and ethnic groups. Meanwhile, lower income and younger individuals perceived park access as more problematic than high income and older residents. Women also perceived greater problems with local park access than men. All other significant variables were interaction effects. Specifically, Black, Hispanic/Latinx, and White respondents living in Miami perceived access to local parks as problematic compared to Asian residents, as well as all other residents across study regions. In addition, Hispanic/Latinx residents of Los Angeles and White residents of Boston were more likely to perceive problems with local park access than other groups in each region (Table 6; Supplemental Table 2).

The overall fit of the park problems model was $R^2 = 0.046$. Thus, although the model significantly explained some variation in perceived problems with local park access, other factors that we did not capture explain residents' perceptions. Moreover, our nonparametric dispersion test indicated that the model fit the overall spread of the data, as our simulated values based on the data did not significantly differ from the model fit ($p = 0.21$).

Our analyses of variance for both race/ethnicity alone and race/ethnicity-by-city (interactions) provide a more detailed view of how the different groups perceived parks as a problem (Fig. 2). Broadly, across all cities, Asian, Black, and Hispanic/Latinx perceived park access similarly, and again, as overwhelmingly unproblematic. Asian and White individuals also perceived problems with local park access approximately the same. However, the primary difference seen by race and ethnicity alone was that Black and Hispanic/Latinx residents perceived local park access as more problematic than White residents.

Our second model, which investigated residents' perceptions of park improvements, contained only two significant variables: income and age (Table 6; Supplemental Table 3). Perceptions of park improvements both increased with age and income, showing the inverse pattern seen with park problems. Neither race/ethnicity, region, nor the interaction effects significantly explained perceptions of park improvements. We therefore did not delve deeper into comparing perceptions by race/ethnic groups. The model fit was $R^2 = 0.033$ (Table 6). The nonparametric dispersion test indicated that the model fit the overall spread of the data ($p = 0.304$).

### 3.3. Comparing subjective views to objective park metrics

In relation to ParkScore® indices for the six study regions, the trends in public perceptions of park quality and availability are somewhat consistent and somewhat divergent (Tables 1 and 4). Among the study regions, the Minneapolis–St. Paul area ranks the highest both in terms of objective and subjective measures. The rankings for objective and subjective measures of parks for Los Angeles are also relatively consistent as well, yet both trend negative compared to the other regions in our study.

For other regions, the subjective and objective metrics of park quality are more divergent. Specifically, the ParkScore ranking for Boston is relatively high compared to residents' perceptions of parks, which captured more perceived problems with local access and less investment relative to the other study regions. The opposite trend held true for Phoenix, where parks were moderately ranked on objective measures compared to positive perceptions (i.e., minimal park problems). Baltimore-area residents also expressed negative perceptions of local parks compared to their moderate rankings based on objective measures, though this region also had the worst investment ranking among the regions (Table 4). The results for Miami are more complex, as perceived problems with local access to parks were relatively high compared to other cities but residents reported more significant improvements in recent years. Although Miami is among the bottom cities for park quality based on subjective and objective metrics, perhaps park improvements and investments have occurred in the region.

### 3.4. Limitations

Before we discuss our results, we recognize several limitations to our analysis. First, the 2011 survey data analyzed are more than a decade old and may not reflect the present-day perceptions. Our use of this secondary dataset is justified since the funding agency (the U.S. National Science Foundation) explicitly encourages data sharing to enhance the utility of publicly funded research. Second, our sample is predominately (97%) homeowners and may not represent the views of renters, nor is it a generalizable sample broadly. Third, the dependent variables are limited based on the precise wording and response scales, and we did not have other potentially useful data, such as visitation rates, to examine perceptions in relation to park usage. Fourth, our models explained minimal variation in the dependent variables, which were limited in their variability. Lastly, our comparisons of subjective perceptions of parks relative to objective ParkScore® metrics are imperfect given the mismatch in time (i.e., our 2011 survey relative to the oldest available metrics from 2013) and scale (i.e., regional survey data compared to city-level objective metrics). Despite these limitations, our approach and the results are informative in highlighting how subjective views may vary from objective metrics of park access, in addition to underscoring the regionally-specific racial and ethnic effects on residents' perceptions of local park access.

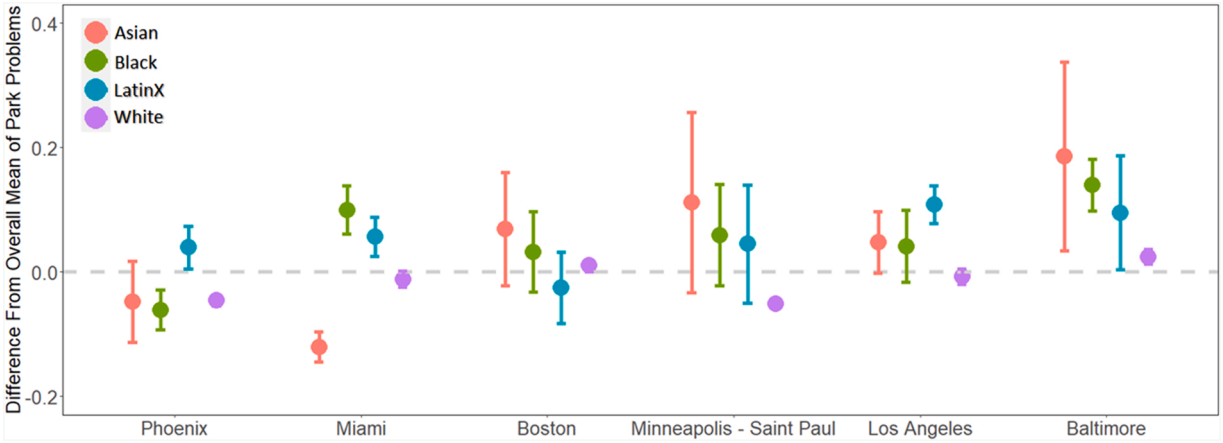


**Fig. 2.** Average Deviations from the Whole Sample's Perception of Park Problems by Race and Ethnicity. Bars represent the standard error around these averages.

## 4. Discussion

Overall, our analyses reveal complex patterns in public perceptions of park availability and quality across geographically diverse regions. While we found that Black and Hispanic/Latinx residents of the six U.S. metropolitan regions perceived local park availability and quality as more problematic than White residents, these distinctions did not hold in multivariate mixed models that tested for interaction effects based on race/ethnicity in particular regions. Instead, we found significant interaction effects for particular groups of residents in particular regions. Specifically, Black, Hispanic/Latinx, and White residents in Miami perceived heightened problems with local park access compared to other groups across regions. Furthermore, Miami was among the regions with higher perceived problems compared to others; however, surveyed residents reported more improvements in local parks compared to other areas. Together, these findings underscore the importance of evaluating subjective views of parks in distinct geographic contexts to truly understand equitable access to high-quality parks, which ultimately depends on the subjective realities of local residents (Chen et al., 2020; Scott et al., 2007; Wang et al., 2015).

We also found additional interaction effects for race/ethnicity in specific metropolitan regions. Hispanic/Latinx residents of Los Angeles perceived greater problems with parks compared to other residents within and outside of the region. This finding is similar to a previous study that found Hispanic and Latino individuals in Los Angeles felt "unwelcome" or "out of place" in parks (Byrne, 2012). Meanwhile, residents of metropolitan Los Angeles perceived some improvement to parks overall, although race/ethnicity did not significantly affect perceptions of improvements in Los Angeles or elsewhere in the multivariate models. In contrast to both Los Angeles and Miami, White residents of metropolitan Boston perceived more problems with park access than residents of other racial/ethnic groups within and outside of Boston. Consistent with previous research, our results indicate that the perceptions of parks vary by race/ethnicity and geographic context (Moore et al., 2008; Engelberg et al., 2016). As a whole, our findings suggest the need to account for unique sociohistorical and planning processes in distinct regions and how they have produced different racialized experiences with parks (Boone et al., 2009; Byrne, 2012; Rigolon and Németh 2018).

Meanwhile, the relatively steady pattern of White residents perceiving fewer problems with local park access across the study regions (with the exception of Boston) is noteworthy. This suggests inequitable access to high-quality parks based on subjective perceptions, which is consistent with research that has repeatedly shown inequitable access based on subjective and objectives measures (Boone et al., 2009; Sister et al., 2010; Duncan et al., 2013; Arroyo-Johnson et al., 2016; Rigolon et al., 2018).

Compared to perceived park problems, perceptions of park improvements were more influenced by income than by race and ethnicity or regional effects. This is not surprising since previous research has illustrated how wealthier communities tend to have more resources to invest in their local parks (Joassart-Marcelli, 2010).

Respondents' age was positively associated with both park problems and improvements. This finding is in line with previous research on objective park measures documenting that communities with older adults tend to have more park availability (Cutts et al., 2009; Jones et al., 2015). Given that age positively correlates with household net worth in the U.S. (Ozawa et al., 2006), elderly Americans may be more likely to live in middle- or upper-class communities with higher-quality parks.

Regarding gender, the fact that women perceive park availability and quality as more problematic may reflect their higher expectations for park upkeep and maintenance as well as heightened concerns about personal safety in different park settings, as reported in previous studies (Brownlow, 2006; Sonti et al., 2020). In fact, a meta-analysis showed that, for women, fear or safety concern is the most frequently cited constraint to visit parks (Zanon et al., 2013). Other studies have also documented that fear or safety concerns tend to intensify as people get older so that elderly women are far less likely to visit parks compared to elderly men (Raymore and Scott, 1998).

Overall, inconsistencies in objective metrics and subjective views of park quality may be due to the regional scope of our survey sample relative to the municipal-scale of ParkScore metrics, as well as the mismatch in the time periods with available data. For example, the discrepancies for Boston and Baltimore might suggest that the central cities of these regions may have greater access to parks compared to their surrounding suburbs and exurbs, whereas for Phoenix, the surrounding municipalities may have greater park access than the central city. Regardless, such discrepancies echo previous studies comparing objective and subjective park access (Ball et al., 2008; Wang et al., 2015). The temporal dynamics of changing park quality and access are also worthy of future research, especially considering recent efforts to improve urban parks and their equitable availability to all residents (Oliphant et al., 2019). Miami might prove to be a particularly interesting case given residents' relatively high perceived problems with local park access coupled with relatively positive views regarding recent park improvements.

We recommend additional research on park inequities to more deeply explore a variety of subjective views on local parks in relation to their natural and built features, as well as park usage. Although some efforts have been made in this area (e.g., Wang et al., 2015), deeper investigations could examine local problems and investments in urban parks along with how local residents view and experience them. Distinguishing between measures of park availability and quality is also an avenue for future research. Overall, more robust research on park equity would include a variety of objective metrics and subjective perceptions of park availability, quality, and usage, including both quantitative measures (as used in this research) as well as qualitative narratives about diverse peoples' views and experiences of their local parks.

Additionally, in-depth, qualitative and historical research could reveal the particularities of public perceptions and use based on recreational preferences, racialized experiences, land-use policies, and development legacies, among other potentially influential factors. Studies are also needed to examine how park access has and is changing over time, especially given ongoing perturbations such as the COVID-19 pandemic, economic downturns, and social polarization, which has recently been associated with declines in park use among socially vulnerable groups such as lower-income communities of color (Larson et al., 2021).

Furthermore, we advocate for continued research on perceptions of equitable park access and quality across diverse people and places, especially those who have been historically marginalized in their access to high-quality parks and associated public investments. Among our study regions, the Los Angeles area seems to need the most attention given relatively poor perceptions of park access and investments, coupled with relatively low objective rankings and inequitable park access among Hispanic and Latinx communities. Moreover, studies including renters are important, along with residents of multi-family households since they may have more limited access to outdoor environments near their homes relative to residents of single-family homes. To validate our results and conclusions, we recommend similar studies that incorporate more generalizable samples to further understanding and planning for equitable park access across diverse contexts.

Regarding the policy implications of our study, park planners and advocates for equitable park access need to do more than ensure all residents have access to a park within a half mile of where they live. Public perceptions of parks are critically important to equitable access since such subjective views often determine park visitation and usage more so than objective metrics such as distance to the nearest park (Chen et al., 2020; Scott et al., 2007; Wang et al., 2015). Accordingly, identifying the geographic areas where residents tend to negatively view their local parks is of particular importance to achieving the goal of

equitable park access.

## 5. Conclusion

Our study utilized telephone survey data and ParkScore® indices to demonstrate the importance of considering subjective views of parks and open spaces in the context of park equity. Our findings reveal complexities wherein race and ethnicity affect perceptions of parks differently across six metropolitan contexts of the U.S. Additionally, objective and subjective measures of park quality may not always align with each other, and since subjective views affect park use and associated outcomes for human wellbeing, they should be the focus of future research. As a whole, we call for more research that carefully considers equitable access to public parks with measures beyond proximity and other objective metrics. In particular, future research should consider the implications of subjective and objective measures of park quality to fully understand how fairly park benefits are distributed among diverse people in different geographic areas, as well as how parks are changing over time to be more equitably distributed among diverse people and places.

## Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

## Data Availability

Data will be made available on request.

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## Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.ufug.2022.127733.

## References

Algretawee, H., Rayburg, S., Neave, M., 2019. Estimating the effect of park proximity to the central of Melbourne city on Urban Heat Island (UHI) relative to Land Surface Temperature (LST). Ecol. Eng. 138, 374–390.

Arroyo-Johnson, C., Woodward, K., Milam, L., Ackermann, N., Komaie, G., Goodman, M. S., Hipp, J.A., 2016. Still Separate, Still Unequal: Social determinants of playground safety and proximity disparities in St. Louis. J. Urban Health 93 (4), 627–638.

Ball, K., Jeffery, R.W., Crawford, D.A., Roberts, R.J., Salmon, J., Timperio, A.F., 2008. Mismatch between perceived and objective measures of physical activity environments. Prev. Med. 47 (3), 294–298.

Bates, D.M.M., Bolker, B., Walker, S., 2015. Fitting linear mixed-effects models using lme4. J. Stat. Softw. 67 (1), 1–48.

Bedimo-Rung, A.L., Mowen, A.J., Cohen, D.A., 2005. The significance of parks to physical activity and public health: a conceptual model. Am. J. Prev. Med. 28 (2), 159–168.

Boone, C.G., Buckley, G.L., Grove, J.M., Sister, C., 2009. Parks and people: an environmental justice inquiry in Baltimore, Maryland. *Ann. Assoc. Am. Geographers* 99 (4), 767–787.

Brownlow, A., 2006. An archaeology of fear and environmental change in Philadelphia. Geoforum 37 (2), 227–245.

Byrne, J., 2012. When green is White: the cultural politics of race, nature and social exclusion in a Los Angeles urban national park. Geoforum 43 (3), 595–611.

Byrne, J., Wolch, J., 2009. Nature, race, and parks: past research and future directions for geographic research. Prog. Hum. Geogr. 33 (6), 743–765.

Chen, S., Sleipness, O., Xu, Y., Park, K., Christensen, K., 2020. A systematic review of alternative protocols for evaluating non-spatial dimensions of urban parks. Urban For. Urban Green. *53*.

Claritas, Inc. (2013). CLARITAS PRIZM Market Segmentation. ⟨www.claritas.com/MyBestSegments/Default.jsp⟩.

Cranz, G., Boland, M., 2004. Defining the sustainable park: a fifth model for urban parks. Landsc. J. 23 (2), 102–120.

Crompton, J.L., 2007. The role of the proximate principle in the emergence of urban parks in the United Kingdom and in the United States. Leis. Stud. 26 (2), 213–234.

Cutts, B.B., Darby, K.J., Boone, C.G., Brewis, A., 2009. City structure, obesity, and environmental justice: an integrated analysis of physical and social barriers to walkable streets and park access. Soc. Sci. Med. 69 (9), 1314–1322.

Duncan, D.T., Kawachi, I., White, K., Williams, D.R., 2013. The geography of recreational open space: Influence of neighborhood racial composition and neighborhood poverty. J. Urban Health 90 (4), 618–631.

Engelberg, J.K., Conway, T.L., Geremia, C., Cain, K.L., Saelens, B.E., Glanz, K., Frank, L. D., Sallis, J.F., 2016. Socioeconomic and race/ethnic disparities in observed park quality. BMC Public Health 16 (1). https://doi.org/10.1186/s12889-016-3055-4.

Evenson, K.R., Jones, S.A., Holliday, K.M., Cohen, D.A., McKenzie, T.L., 2016. Park characteristics, use, and physical activity: a review of studies using SOPARC (System for Observing Play and Recreation in Communities). Prev. Med. 86, 153–166.

Gelman, A. & Hill, J. (2006). Data Analysis Using Regression and Multilevel/Hierarchical Models. Cambridge University Press.

Hartig, F. (2021). DHARMa: Residual diagnostics for hierarchical (multi-level/mixed) regression models. R package version 0.4.3. ⟨https://CRAN.R-project.org/package=DHARMa⟩.

Jennings, V., Bamkole, O., 2019. The relationship between social cohesion and urban green space: an avenue for health promotion. Int. J. Environ. Res. Public Health 16 (3), 452.

Joassart-Marcelli, P., 2010. Leveling the playing field? Urban disparities in funding for local parks and recreation in the Los Angeles region. Environ. Plan. A 42 (5), 1174–1192.

Jones, S.A., Moore, L.V., Moore, K., Zagorski, M., Brines, S.J., Diez Roux, A.V., Evenson, K.R., 2015. Disparities in physical activity resource availability in six US regions. Prev. Med. 78, 17–22.

Kaczynski, A.T., Schipperijn, J., Hipp, J.A., Besenyi, G.M., Wilhelm Stanis, S.A., Hughey, S.M., Wilcox, S., 2016. ParkIndex: development of a standardized metric of park access for research and planning. Prev. Med. 87, 110–114.

Konijnendijk, C.C., Annerstedt, M., Nielsen, A.B., Maruthaveeran, S. (2013). Benefits of Urban Parks: A Systematic Review. A Report for IFPRA, Copenhagen & Alnarp.

Kuo, F.E., Bacaicoa, M., Sullivan, W.C., 1998. Transforming inner-city landscapes: trees, sense of safety, and preference. Environ. Behav. 30 (1), 28–59.

Larson, L.R., Jennings, V., Cloutier, S.A., 2016. Public parks and wellbeing in urban areas of the United States. PLoS One 11 (4), e0153211.

Larson, L.R., Zhang, Z., Oh, J.I., Beam, W., Ogletree, S.S., Bocarro, J.N., Wells, M. (2021). Urban park use during the COVID-19 pandemic: Are socially vulnerable communities disproportionately impacted? Frontiers in Sustainable Cities, 3.

Larson, S.M., 2018. Imagining social justice and the false promise of urban park design. Environ. Plan. A Econ. Space 50 (2), 391–406.

Le Cessie, S., Van Houwelingen, H.C., 1995. Testing the fit of a regression model via score tests in random effects models. Biometrics 600–614.

Lee, K.J., Scott, D., 2016. Bourdieu and African Americans' park visitation: The Case of Cedar Hill State Park in Texas. Leis. Sci. 38 (5), 424–440.

Lee, K.J., Fernandez, M., Scott, D., Floyd, M. (2022). Slow violence in public parks in the U.S.: Can we escape our troubling past? Social & Cultural Geography.

Lin, P., Lau, S.S.Y., Qin, H., Gou, Z., 2017. Effects of urban planning indicators on urban heat island: a case study of pocket parks in high-rise high-density environment. Landsc. Urban Plan. 168, 48–60.

Locke, D.H., Hall, B., Grove, J.M., Pickett, S.T.A., Ogden, L.A., Aoki, C., Boone, C.G., O'Neil-Dunne, J.P.M., 2021. Residential housing segregation and urban tree canopy in 37 US Cities. *Urban*. Sustainability 1 (1), 1–9.

Miller, R.G., 1981. Simultaneous Statistical Inference. Springer.

Moore, L.V., Diez Roux, A.V., Evenson, K.R., McGinn, A.P., Brines, S.J., 2008. Availability of recreational resources in minority and low socioeconomic status areas. Am. J. Prev. Med. 34 (1), 16–22. https://doi.org/10.1016/j.amepre.2007.09.021.

Nesbitt, L., Meitner, M.J., Girling, C., Sheppard, S.R.J., Lu, Y., 2019. Who has access to urban vegetation? A spatial analysis of distributional green equity in 10 US cities. Landsc. Urban Plan. 181, 51–79.

Oliphant, E.L., Hughey, S.M., Stowe, E.W., Kaczynski, A.T., Schipperijn, J., Hipp, J.A., 2019. ParkIndex: using key informant interviews to inform the development of a new park access evaluation tool. J. Park Recreat. Adm. 37, 1.

Ozawa, M.N., Kim, J., Joo, M., 2006. Income class and the accumulation of net worth in the United States. Soc. Work Res. 30 (4), 211–222.

Poudyal, N.C., Hodges, D.G., Merrett, C.D., 2009. A hedonic analysis of the demand for and benefits of urban recreation parks. Land Use Policy 26 (4), 975–983.

Raymore, L., Scott, D., 1998. The characteristics and activities of older adult visitors to a metropolitan park district. J. Park Recreat. Adm. 16 (4), 1–21.

Rigolon, A., 2016. A complex landscape of inequity in access to urban parks: a literature review. Landsc. Urban Plan. 153, 160–169.

Rigolon, A., Németh, J., 2016. A Quality Index of Parks for Youth (QUINPY): evaluating urban parks through geographic information systems. Environ. Plan. B Urban Anal. City Sci. 45 (2), 275–294.

Rigolon, A., Németh, J., 2018. What shapes uneven access to urban amenities? Thick injustice and the legacy of racial discrimination in Denver's parks. J. Plan. Educ. Res. 41 (3), 312–325.

Rigolon, A., Browning, M., Jennings, V., 2018. Inequities in the quality of urban park systems: an environmental justice investigation of cities in the United States. Landsc. Urban Plan. 178, 156–169.
Scheffe, H., 1999. The Analysis of Variance, Vol. 72. John Wiley & Sons.
Schipperijn, J., Cerin, E., Adams, M.A., Reis, R., Smith, G., Cain, K., Frank, L.D., 2017. Access to parks and physical activity: an eight-country comparison. Urban For. Urban Green. 27, 253–263.
Schnell, I., Harel, N., Mishori, D., 2019. The benefits of discrete visits in urban parks. Urban For. Urban Green. 41, 179–184.
Scott, M.M., Evenson, K.R., Cohen, D.A., Cox, C.E., 2007. Comparing perceived and objectively measured access to recreational facilities as predictors of physical activity in adolescent girls. J. Urban Health 84 (3), 346–359.
Sister, C., Wolch, J., Wilson, J., 2010. Got green? Addressing environmental justice in park provision. GeoJournal 75 (3), 229–248.
Sonti, N.F., Campbell, L.K., Svendsen, E.S., Johnson, M.L., Auyeung, D.N., 2020. Fear and fascination: use and perceptions of New York City's forests, wetlands, and landscaped park areas. Urban For. Urban Green. 49, 126601.
Sreetheran, M., Van Den Bosch, C.C.K., 2014. A socio-ecological exploration of fear of crime in urban green spaces–a systematic review. Urban For. Urban Green. 13 (1), 1–18.
Tester, J., Baker, R., 2009. Making the playfields even: evaluating the impact of an environmental intervention on park use and physical activity. Prev. Med. 48 (4), 316–320.
Thompson, C.W., 1998. Historic American parks and contemporary needs. Landsc. J. 17 (1), 1–25.
Twohig-Bennett, C., Jones, A., 2018. The health benefits of the great outdoors: a systematic review and meta-analysis of greenspace exposure and health outcomes. Environ. Res. 166, 628–637.
Vieira, J., Matos, P., Mexia, T., Silva, P., Lopes, N., Freitas, C., Correia, O., Santos-Reis, M., Branquinho, C., Pinho, P., 2018. Green spaces are not all the same for the provision of air purification and climate regulation services: the case of urban parks. Environ. Res. 160, 306–313.
Wang, D., Brown, G., Mateo-Babiano, I., 2013. Beyond proximity: an integrated model of accessibility for public parks. Asian J. Soc. Sci. Humanit. 2 (3), 486–498.
Wang, D., Brown, G., Liu, Y., 2015. The physical and non-physical factors that influence perceived access to urban parks. Landsc. Urban Plan. 133, 53–66.
Wang, D., Brown, G., Liu, Y., Mateo-Babiano, I., 2015. A comparison of perceived and geographic access to predict urban park use. Cities 42, 85–96. https://doi.org/10.1016/j.cities.2014.10.003.
Wang, D., Brown, G., Zhong, G., Liu, Y., Mateo-Babiano, I., 2015. Factors influencing perceived access to urban parks: a comparative study of Brisbane (Australia) and Zhongshan (China). Habitat Int. 50, 335–346.
Yandell, B.S. (1997) Practical Data Analysis for Designed Experiments. Chapman & Hall.
Yin, S., Shen, Z., Zhou, P., Zou, X., Che, S., Wang, W., 2011. Quantifying air pollution attenuation within urban parks: an experimental approach in Shanghai, China. Environ. Pollut. 159 (8–9), 2155–2163.
Zanon, D., Doucouliagos, C., Hall, J., Lockstone-Binney, L., 2013. Constraints to Park visitation: a meta-analysis of North American studies. Leis. Sci. 35 (5), 475–493.
Zwierzchowska, I., Hof, A., Iojă, I.-C., Mueller, C., Poniży, L., Breuste, J., Mizgajski, A., 2018. Multi-scale assessment of cultural ecosystem services of parks in Central European cities. Urban For. Urban Green. 30, 84–97.