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Improved Street Walkability, Incivilities, and Esthetics Are Associated with Greater Park Use in Two Low-Income Neighborhoods

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Abstract Parks may provide opportunities for people to increase their physical activity and improve health. Yet, parks are generally less plentiful and underutilized in low-income urban neighborhoods compared with more advantaged neighborhoods. Renovations within and around parks may improve park utilization but the empirical evidence supporting this relationship is scarce. This study assessed the impact of greenspace, housing, and commercial investments on street characteristics (walkability, amenities, incivilities/poor esthetics) and park use by examining park use over time in two low-income neighborhoods in Pittsburgh, PA ($n = 17$ parks), before and after neighborhood-based renovations that were primarily centered in one neighborhood. We used systematic observation of parks, park use, and street blocks surrounding parks to examine the impact of neighborhood changes on park use. We used difference-in-differences to test whether park use and street characteristics surrounding the parks improved more in the intervention neighborhood than in the comparison neighborhood. We also used zero-inflated negative binomial regression with interactions by time to test whether changes in street characteristics were associated with changes in park use over time. We found that improved walkability, incivilities, and esthetics surrounding parks in socioeconomically disadvantaged neighborhoods were associated with greater park use and may help increase visits to underutilized parks.

Keywords Parks · Physical activity · Neighborhood

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Introduction

Physical activity is considered critical for health and can reduce the risk of disease, including cardiometabolic disease, diabetes, depression, certain cancers, and obesity [1–3]. Based on the most recent 2016 National Health Interview, only about half of US adults reported meeting the recommended [4] amount of leisure time aerobic activity. Furthermore, low-income and racial/ethnic minority populations are the least likely to achieve recommended levels of activity [5, 6], which may contribute to well-documented and pervasive disparities in obesity-related morbidity (e.g., cardiovascular disease and diabetes) as well as other health disparities.

The socioecological perspective recognizes multiple levels of interrelationships between individuals, and social, physical, and policy environments that impact people's physical activity [7–11]. In particular, the built features of where one lives (e.g., sidewalk conditions, traffic calming measures) may limit or promote physical activity and so the neighborhood environment is a potential policy target to improve population-level health behaviors. Parks, in particular, are an important part of the public landscape that provide opportunities to experience nature and for recreation. However, parks located in low-income neighborhoods tend to be underutilized [12, 13] which may be due to lack of park programming, facilities, and amenities, as well as concerns about safety [12, 14–16]. Yet, the association between objectively measured neighborhood characteristics and physical activity behaviors is not well understood (see reviews [17, 18]), especially in minority populations, such as low-income African Americans [19, 20].

Recent advances in longitudinal research capitalizing on natural experiments and randomized control trials suggest that park renovations and marketing/outreach may attract park users and increase the physical intensity of the activities that take place on park grounds [21–27]. For example, one study in Los Angeles, CA, showed that urban parks with new outdoor exercise equipment had greater increases in new park users and higher estimated energy expenditure than comparison parks without new equipment [26]. In Victoria, Australia, introducing a walking track and amenities (e.g., fenced leash-free area for dogs and an all-abilities playground) in a neighborhood park increased park use overall and, in particular, increased the number of walkers and vigorously active park users [21]. In addition, a free exercise program in San Leandro, CA, attracted a large number of people to engage in moderate-to-vigorous physical activity during the class time [27].

While programming and facilities seem to be important to whether and how people use parks, the surrounding neighborhood context has been less studied. It is important to examine because people in urban areas typically access parks by walking to them. Among Latino Los Angeles residents living within 1 mile of 50 parks who reported visiting a park, half reported walking to get there [28]. Research has supported links between built and social environmental factors and physical activity [17, 29], and the area surrounding parks has been recognized as one of the four geographic areas that should be considered when assessing parks for their relationship to physical activity [30].

In this paper, we examine these issues using data collected as part of a natural experiment. In Pittsburgh, a plan (known as Greenprint) for greenspace improvement in the Hill District neighborhood, a low-income, predominantly African American urban neighborhood, presented an opportunity to examine the role of neighborhood investments in greenspace and surrounds on park use. The City of Pittsburgh Department of Urban Planning, the Pittsburgh Parks Conservancy, the Hill District Consensus Group, and a nonprofit group called Find the Rivers! came together to form a plan which included proposed creation and renovation of current greenspace, including multiple parks, six outdoor stairwells, and three trails connecting parks. This formed the basis for the design of a natural experiment to examine whether improvements in the Hill District (intervention) influenced park use or resident physical activity. Homewood, a sociodemographically similar Pittsburgh neighborhood, was selected to serve as a comparison neighborhood to control for secular changes that may have been occurring regardless of neighborhood investments. While developments were also planned for Homewood, the scale of the investments was much lower than it was in Hill District.

Despite the methodological strengths of natural experiments, in reality they can present practical challenges. The intervention neighborhood faced delays in expansive greenspace renovations that were scheduled to occur during the study period (2012–2015), including the opening of multiple new parks (which ultimately happened following the study period). The Cliffside/August Wilson park was fully renovated and opened to the public in August 2016. Nonetheless, there were other major investments that directly changed the landscape of Hill District, including major public housing development construction and renovations that changed the surrounding neighborhood characteristics. The Pittsburgh Hill/Homewood Research on Neighborhoods, Exercise and Health (also known as PHRESH Plus) was designed to collect resident physical activity among a randomly selected cohort of participants, as well as objective data on the built and greenspace environment in Hill District and Homewood prior to and after changes in the physical environment.

We used a variety of measures that describe each park or the area surrounding it to test hypotheses about how changes in park use relate to renovations and the changing environment surrounding the parks. We hypothesized that park use, park-based physical activity, and neighborhood conditions (e.g., walkability) would all improve more in the intervention neighborhood than in the comparison neighborhood.

Methods

We collected objective measures of park use for all publicly accessible parks and playgrounds in Pittsburgh's Hill District and Homewood neighborhoods, as well as audits of street characteristics surrounding the parks. At baseline, we collected data on 19 parks but at follow-up, two parks were inaccessible due to construction so we did not include them in the analytic sample ($n = 17$). Baseline park observations and street audit collection occurred in 2012, prior to any renovations. At that time, local parks across both neighborhoods, although accessible, were largely underutilized [12]. In 2015, following completion of planned improvements to Hill District (intervention), we completed follow-up data collection.

Park Use and User Characteristics

We used the System for Observing Play and Recreation in Communities (SOPARC) [31] which is a validated method using momentary time sampling to assess the characteristics of parks and their users, including their physical activity levels. The details regarding use of SOPARC in PHRESH Plus are described elsewhere [12]. Briefly, each park was mapped and divided into distinct target areas. Field staff systematically rotated through all target areas in each of the parks and playgrounds on Tuesdays, Thursdays, Saturdays, and Sundays. The data collectors performed 4 scans per day at different times of day (morning, afternoon, midday, evening) resulting in 16 scans per park. Larger parks required scanning of more target areas than smaller parks. Park users in target areas were categorized by gender (male, female), age group, (child, teen, adult, senior), and physical activity level (sedentary [e.g., seated, standing], moderate [e.g., walking], vigorous [e.g., running, climbing]). We included senior park users (users who appeared to be ~60 years or older) in the adult group because, on average, fewer than 1 senior was observed per hour across parks at baseline and follow-up, respectively. We combined moderate and vigorous physical activity into one moderate-to-vigorous category (MVPA). Since each scan lasted roughly 1 h, we estimated hourly park use as the number of users per scan. We collected park use data at baseline (August to October 2012) and at follow-up (August to October 2015). However, in October 2016, we observed park use for the Cliffside/August Wilson park after its renovation was completed.

Because park use varies by day of the week and time of day, we attempted to complete scans at the same day/time at follow-up as at baseline. In a few cases, that was not possible. To address this, we dropped any scan of a day of the week/time of day combination ($n = 10$) that was not collected at both years, resulting in a total of 525 scans. In the event of rain, data collectors made up the observation at the same day of the week and time of day at a different week.

Street Characteristics

Using geographic shapefiles provided by ESRI and the city of Pittsburgh, we located 2027 street segments in 2012 located within the study neighborhoods. We randomly selected 511 or 25% of these segments (both sides of a street between two cross streets) (25%), with an additional oversampling of 85 segments where there was anticipated investment or change. For this analysis, we examined only the subset of street segments that were within a half-mile radius of each park. We chose a one-half radius because, conceptually, this made sense to our team when looking and examining each of the parks and surrounds. In addition, we chose this distance based on prior research on a nationally representative survey which reported that people will walk about up to a half mile for recreation [32]. In both neighborhoods, trained data collectors conducted audits on a total of 502 (intervention $n = 305$, comparison $n = 197$) street segments. Each street segment was audited by a team of two data collectors, which is shown to improve reliability of ratings [33]. The data–collector pair walked both sides of the street segment to complete a single set of ratings. The data–collector pair walked the length of each segment in 2012 (October to November) and again in 2015 (August to November) to complete the audits: adapted from the Bridging the Gap Street Segment Tool [34–36]. A field coordinator oversaw data collection, reviewed, and resolved any remaining disagreements in ratings. We also assessed inter-rater reliability testing using a random 10% sample of street segments. Across all items, we had about 90% agreement in 2012 and 94% in 2015. Examples of items with poor agreement included amount of litter present which can vary over time and buildings which were not easily identified as vacant or inhabited. We constructed variables describing the characteristics of segments surrounding the parks that we hypothesized would predict park use. Specifically, we created three street characteristic variables that capture incivilities/poor esthetics, amenities, and walkability.

The walkability index was designed based on evidence that sidewalks in good condition and other characteristics such as good lighting and pedestrian crossings are associated with increased physical activity/walking [29, 37, 38]. Specifically, we used a walkability index used by others [35] composed of the sum of the following scores: traffic signs at the intersection (4 points), pedestrian crossings (2 points), sidewalks (10 points), lighting (2 points), transit (2 points), and mixed use (e.g., commercial versus residential) (2 points). The scale ranges from 0 to 22, with higher scores indicating greater walkability.

We summed the following items present in the street: lack of art, lack of garden, litter, vacant housing, bars on windows, broken windows, and the data collector reporting that they did not feel safe walking on the segment to form the incivilities/poor esthetics variable. Higher scores indicate greater incivilities and poorer quality esthetics.

We created an amenities score (with a range of 0–5) as the sum of the following items present in the street: public trash can, street dispenser/vending machine, benches or other seating, drinking fountain, bicycle parking.

To convert the street-level variables to park-level variables, we then took all sampled street segments within a half-mile radial distance surrounding parks ($n = 502$) and created an average of the street-level measures, by multiplying by the length of the segment and dividing by the total length of all sampled street segments surrounding each park (within the half-mile radial-distance buffer). Then, we summed the values across each park buffer. In addition, we normalized the street characteristic variables to facilitate interpretations of change of variables with different scales by subtracting the pooled sample mean and dividing by the standard deviation.

Statistical Analyses

We performed descriptive analyses and multivariable models using Stata 14.0 (StataCorp, College Station, TX). We calculated adjusted means and standard deviations of park use and street characteristic variables.

To test our hypothesis that park use, overall and by type of user (e.g., child) and activity (e.g., MVPA), would increase more in the intervention neighborhood than in the comparison neighborhood. We performed difference-in-difference (DID) tests. We maximized variability across the 17 parks by analyzing the data at the park scan level ($n = 559$) but included clustering by park. For each park user and activity-level outcome, we calculated the (i) average difference between baseline and follow-up values in the Hill District parks (intervention), (ii) average difference between baseline and follow-up values in Homewood parks (comparison), and (iii) a difference-in-difference estimator indicating changes over time in the intervention group compared with those in the comparison group. Because use of parks was low, the park use (e.g., observed number of users) variables contained many zeros (ranging from 57 to 95%). That is, often no one was observed using the park during the scan. Therefore, we used zero-inflated negative binomial (ZINB) regression. ZINB models simultaneously estimate the associations between the independent variables and park use counts and the odds of no park use.

Our hypothesis rests on the assumption that street conditions improved more so in the intervention than in the comparison neighborhood. We repeated the DID approach to examine this. Here, the outcomes were street walkability, amenities, and incivilities/poor esthetics.

In addition, regardless of neighborhood, changes in the conditions of the area surrounding the parks might influence changes in park use. We used zero-inflated negative binomial regression to model the street characteristic by year associations with changes in park use, with clustering on the park. We controlled for the Cliffside/August Wilson park because it was renovated. We report the incidence rate ratios (IRR) for all ZINB models.

Covariates

In all models, we controlled for the size of the park (in acres), whether the observation occurred on a weekend (yes/no), and during daytime (morning/midday/afternoon versus evening). In the models where the exposure was change in street characteristics (i.e., non-DID models), we controlled for neighborhood (comparison versus intervention).

Results

The parks varied in size across the two neighborhoods from 0.2 to 23.3 acres in the intervention neighborhood (Hill District) and from 0.2 to 10.8 acres in the comparison neighborhood (Homewood) (Table 1). Park use increased in the renovated Cliffside/August Wilson park. The street characteristics suggest that the areas surrounding the parks were in slightly better condition in the intervention than in the comparison neighborhood (Table 2). While the intervention neighborhood appeared to have greater walkability and fewer incivilities/better esthetics at both years than the comparison, the number of amenities was similar across neighborhoods.

Table 3 presents within-neighborhood changes in total park users and by user demographics and activity level, as well as the DID tests across the two neighborhoods. The number of park users ranged from about 1 to about 8 users per hour. In both neighborhoods, park users were more likely to be children versus adolescents or adults, and males used parks more than females. Park users were typically engaged in sedentary (e.g., sitting) activity with some moderate-to-vigorous activity. While park use appeared to decline in both neighborhoods, we observed no significant DID across neighborhoods. However, we did find a marginally significant DID that suggests the decline in children using parks may have been slightly greater in the comparison than in the intervention neighborhood (DID = + 1.0, $p = 0.10$). While mean changes were negative, they were not significant; therefore, park use appeared to be relatively stable in the intervention neighborhood.

Table 4 presents the changes and DIDs for the street characteristics. Walkability declined slightly in the comparison neighborhood, and remained relatively stable in the intervention neighborhood (DID = + 0.7, $p = 0.01$). Similarly, amenities declined in the comparison neighborhood but remained relatively stable in the intervention neighborhood (DID = + 1.1, $p < 0.01$). In contrast, incivilities/poor esthetics increased in the intervention neighborhood but did not change in the comparison

Table 1 Park in two low-income neighborhoods (Pittsburgh, PA) and estimated weekly park use

Neighborhood parks	Size (acres)	Baseline 2012 Users per week	Follow-up 2015 Users per week
Hill District (intervention)			
Al Graham	0.3	24.9 (58.0)	10.3 (29.8)
Ammons	8.8	150.6 (227.9)	120.3 (312.6)
Cliffside/August Wilson[1]	3.9	6.2 (17.0)	28.2 (64.8)
Granville	0.6	145.1 (263.4)	96.9 (232.9)
Kennard	13.4	884.4 (1716.9)	613.1 (1465.8)
Robert E Williams	12.3	117.3 (366.1)	294.1 (503.7)
Vincennes	1.6	99.0 (123.9)	35.4 (76.7)
West Penn Rec	23.3	460.6 (724.2)	446.9 (465.2)
Homewood (comparison)			
Baxter Park	2.8	74.8 (120.2)	68.2 (102.0)
Chadwick	6.8	901.3 (1632.4)	98.3 (125.3)
Dallas	0.4	170.5 (280.4)	81.1 (127.6)
JuneBug	0.2	110.0 (285.0)	0.0 (0.0)
KaBoom	2.9	110.0 (205.6)	19.3 (57.9)
Larimer	1.1	197.3 (319.6)	58.4 (80.4)
Willie Stargell	2.7	445.5 (1472.6)	200.8 (549.4)
Westinghouse	10.8	266.8 (295.9)	501.9 (591.1)
Wilkinsburg	0.3	51.3 (116.7)	21.3 (68.6)

[1] Park use at follow-up was observed in October 2016 after renovations were complete

Table 2 Park and street characteristics by neighborhood

Street characteristics ($N = 525$)	Intervention (Hill District) ($N = 8$ parks)		Comparison (Homewood) ($N = 9$ parks)	
	2012 Mean (SD)	2015 Mean (SD)	2012 Mean (SD)	2015 Mean (SD)
Walkability	8.1 (0.8)	8.4 (0.5)	7.4 (0.6)	7.2 (0.6)
Amenities (e.g., benches)	0.3 (0.1)	0.4 (0.1)	0.3 (0.1)	0.2 (0.1)
Incivilities/poor esthetics (e.g., broken windows)	4.0 (0.4)	4.5 (0.4)	5.2 (0.1)	5.2 (0.4)

neighborhood (DID = + 0.7, $p = 0.02$). These results indicate that changes in the intervention neighborhood were not as uniformly positive as anticipated, rendering our difference-in-difference approach to testing our hypotheses less informative.

Thus, we conducted regression analyses that tested associations between the street characteristics surrounding each park and park use changes over time using the combined sample of parks across both neighborhoods. Any interaction between time (baseline versus follow-up) and street characteristics would indicate that change in that characteristic is associated with park use. The interaction terms for walkability by time were significant for the outcomes of total, adult, male, and sedentary users. Effects are illustrated in Fig. 1. One specific example shows that increased walkability (by one standard deviation) in the streets surrounding the parks was associated with over a two and a half-fold increase in hourly adult park users between follow-up and baseline (IRR = 2.75, $p < 0.01$). Increased walkability was also associated with increased sedentary (e.g., sitting) park use (IRR = 2.24, $p = 0.02$), and increased park use for males (IRR = 2.12, $p = 0.01$) and users (IRR = 2.09, $p = 0.01$). Lastly, an increase in incivilities/poor esthetics near parks was associated with a decrease in adult park use by a factor of about 0.6 (IRR = 0.61, $p = 0.04$) as well as decreased male (IRR = 0.47, $p < 0.01$) and sedentary (IRR = 0.55, $p = 0.03$) park use. None of the amenities by year associations was significant. The interaction model estimates are presented in the Supplemental file (Table S1).

Discussion

Using objectively measured park use and street characteristics, we found correlational evidence that increases in walkability and improvements in esthetics were associated with increases in park use. However, using our natural experiment design, we did not find that greenspace renovations resulted in greater park use

Table 3 Estimated park users per hour by type and activity level means, standard deviations (SD), and difference-in-difference tests

	Intervention (Hill District)				Comparison (Homewood)					
	2012 Mean (SD)	2015 Mean (SD)	Mean change	*p* value	2012 Mean (SD)	2015 Mean (SD)	Mean change	*p* value	Difference-in-difference (Hill District − Homewood)	*p* value
Park users by type of person										
Total users	8.8 (4.9)	6.3 (2.2)	− 2.5	0.41	7.8 (3.0)	3.2 (0.6)	− 4.88	0.17	2.4	0.30
Children	5.2 (5.5)	3.6 (3.1)	− 1.6	0.58	*3.7 (0.9)*	*1.3 (0.2)*	*− 2.6*	*0.02*	1.0	0.10
Teenagers	1.6 (0.4)	0.8 (0.3)	− 0.89	0.22	1.7 (0.9)	1.2 (0.7)	− 0.47	0.63	− 0.4	0.69
Adults	3.2 (1.5)	2.6 (0.6)	− 0.57	0.68	3.6 (2.2)	0.8 (0.1)	− 3.37	0.26	2.8	0.19
Female	2.4 (1.1)	2.4 (0.7)	0.01	0.99	2.3 (0.8)	1.0 (0.2)	− 1.4	0.23	1.4	0.18
Male	6.4 (3.8)	4.1 (1.8)	− 2.38	0.29	5.5 (2.2)	2.2 (0.6)	− 3.51	0.15	1.1	0.36
Park users by type of activity										
Sedentary	5.4 (4.2)	3.9 (1.8)	− 1.51	0.58	4.9 (2.0)	1.7 (0.3)	− 3.57	0.14	2.1	0.22
Moderate to vigorous	3.3 (1.0)	1.6 (0.4)	− 1.83	0.15	*3.5 (0.9)*	*2.2 (0.5)*	*− 1.33*	*0.04*	− 0.5	0.54

Italics indicates $p < 0.05$

Table 4 Street characteristics: means, standard deviations (SD), and difference-in-difference tests

Street characteristic	Intervention (Hill District)				Comparison (Homewood)				Difference-in-difference (intervention − comparison)	*p* value
	2012 Mean (SD)	2015 Mean (SD)	Mean change	*p* value	2012 Mean (SD)	2015 Mean (SD)	Mean change	*p* value		
Walkability	0.4 (0.4)	0.8 (0.3)	0.4	0.16	*− 0.4 (0.3)*	*− 0.7 (0.3)*	*− 0.3*	*< 0.01*	0.7	*0.01*
Amenities	0.2 (0.3)	0.5 (0.3)	0.3	0.05	*0.1 (0.4)*	*− 0.7 (0.3)*	*− 0.8*	*< 0.01*	1.1	*< 0.01*
Incivilities/poor esthetics	*− 1.2 (0.2)*	*− 0.4 (0.3)*	*0.8*	*< 0.01*	0.7 (0.1)	0.8 (0.2)	0.1	0.73	0.7	*0.02*

Italics indicates $p < 0.05$

Variables were normalized by subtracting the pooled sample mean and dividing by the standard deviation

and physical activity in the intervention neighborhood. This may be because changes were not uniformly more positive in the intervention than the control. Walkability and amenities improved, but incivilities/poor esthetics actually increased. Given that walkability was associated with increased use and incivilities with decreased use in our analysis across neighborhoods, this may explain why the neighborhood-based DID analysis of park use outcomes was not significant. Nevertheless, improving the walkability and reducing incivilities/poor esthetics in the areas around parks in socioeconomically disadvantaged neighborhoods may help increase use of underutilized parks.

Improving neighborhood walkability around parks may make park use more appealing. Contrary to our hypothesis, sedentary activity appeared to increase with greater walkability more than MVPA. However, these findings are consistent with another study that reported that, in city parks (Ghent, Belgium; and San Diego, CA) neighborhood walkability was positively associated with in-park user count, sedentary activity, and walking but not vigorous activity [39]. However, even sedentary park users may have expended more physical activity than they otherwise would have if they had not visited the park. About half of park users in low-income neighborhoods reported walking as their means of transportation to parks [40]. Promoting more intense physical activity in parks may require constructing new/refurbishing park facilities or developing attractive park activity programs. For example, offering free exercise classes in a low-income, predominantly Latino neighborhood park increased moderate-to-vigorous physical activities, especially among women users [27]. Social factors (e.g., safety concerns) that can impede park

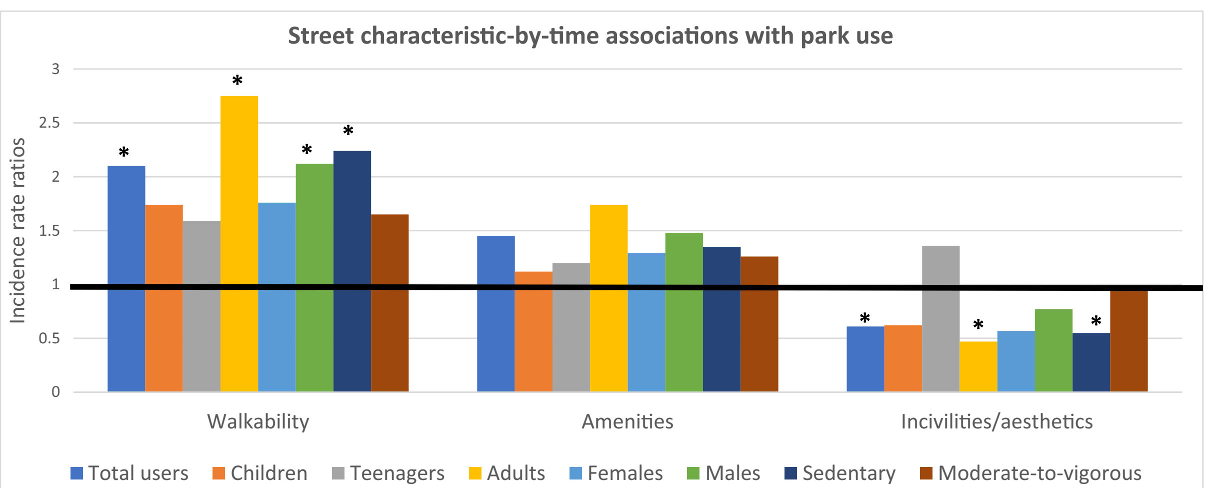

Fig. 1 Interaction between time (baseline versus follow-up) and street characteristics

programing in disadvantaged neighborhoods should also be considered [24].

This study highlights the challenges and opportunities associated with natural experiments that investigate health outcomes as a consequence of policy changes. Natural experiments are needed to rigorously test how environmental changes can impact health behaviors. Yet, this study was challenged by the fact that the originally planned changes did not happen according to schedule or of the predicted magnitude that was originally anticipated. Despite enthusiasm, the comprehensive Greenprint goals were not fully realized by 2015. However, during our study period, we found evidence that some street features surrounding the parks did improve substantially more in the intervention neighborhood than in the comparison neighborhood. However, studying the impact of these with a natural experiment proved difficult, given that there were concomitant negative changes in the intervention neighborhood.

Our study has limitations. Even in light of the rigorous longitudinal study design, our findings should not be interpreted as causal influences on park use. Our set of 17 parks is relatively small and may have limited our power to detect effects. Moreover, our study is set in one city so our findings may not generalize to other settings. Given the natural experimental design of our study, it is possible that construction that we were not aware of occurred and could have impacted our street measures and park use. The street audits occurred in slightly different time frames. Although we do not expect most of the street characteristics that we assessed would systematically vary between August and October, we tested multiple models so some significant findings may be due to chance. Yet, the consistent pattern of results with walkability across several types of park users reduces the possibility these are spurious findings. Moreover, we relied on field staff perceptions to categorize park users which could introduce a measurement error. Our study lacked information about park management practices (e.g., marketing/outreach) or programming that have been shown to influence park use [13, 14]. Our study has other notable strengths. We used a quasi-experimental approach to capitalize on a natural experiment assessing changes within and around parks in relation to changes in park use in low-income urban neighborhoods. We collected repeated measures of park use and street characteristics objectively using validated tools.

Conclusions

Parks are underutilized yet they hold the potential to provide people opportunities to be physically active and improve health. Improving the public park landscape may be even more important for low-income populations who are at high risk of inactivity and activity-related disease than higher income populations. In addition to improving the quality of parks and greenspace, policy-makers should consider how the areas surrounding neighborhoods can attract park users. Notably, increasing walkability and safety from crime may increase park use and the intensity of park-based physical activity.

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