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Short-term associations between objective crime, park-use, and park-based physical activity in low-income neighborhoods

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ABSTRACT

Crime and safety perceptions are commonly cited barriers to park use and physical activity (PA). Given the importance of parks as settings for outdoor recreation and physical activity, the presence of crime may have a detrimental effect on public health. This study uses objective police crime reports and observational park use data to assess type of crime and the time when the crime was committed effects on park user behaviors in 20 parks located in low-income neighborhoods in New York City. The System for Observing Play and Recreation in Communities (SOPARC) was used to assess the number of park users and their physical activity during 78 park visits in Spring 2017. The association between crime rates and park use was assessed using two types of crimes (violent and property crimes). The timing of the crime was assessed using the crimes committed within periods of one week, one month, and three months prior to the visit to the park. By including objective measures of crime together with the exact time on which they were committed, we were able to analyze the short and long term effects of crime on park behavior. Overall, there was a consistent negative association between crime and park use. This relationship was stronger at the 1 month and 3 months' period and weaker at the 1-week period. Violent crimes were strongly associated with lower park use, and crimes proved to be associated with child park use to a greater degree. Girls were more affected by crime than boys.

1. Introduction

Fear and worry about becoming a victim of crime are barriers to physical activity and park use among the US population (Lorenc et al., 2012). Exposure to crime is a problem in itself as it contributes to trauma and mental health problems (Finkelhor and Turner, 2014). Beside direct effects, crime and violence also have an indirect negative effect on other factors such as access to parks, outdoor recreation and physical activity (Berman et al., 2000). Given the importance of urban parks as settings for free open access to outdoor recreation and physical activity, especially for children, the presence of crime may have important detrimental effects on public health.

The link between park availability, park use, and physical activity has been well documented (McCormack et al., 2010). Having good accessibility to parks is important for children's physical activity (Costigan et al., 2017; Veitch et al., 2008). The National Survey of Children's Health data indicates that approximately 85% of children 12 years old and younger reside in a neighborhood with at least one park or playground, and studies have found that more than one-third of children's moderate to vigorous physical activity takes place outdoors (Wheeler et al., 2010).

Some have suggested that crime and crime perception might explain why low-income residents tend to use urban parks less often (Han et al., 2018). On one hand, urban parks can objectively become ground for illicit or illegal activities (Groff and McCord, 2012; Iqbal and Ceccato, 2015; Stodolska et al., 2009). On the other, the combination of green-space vegetation and lower visibility can contribute to the perceived insecurity of people around parks by making both criminals and potential victims less visible (Ou et al., 2016; Shinew et al., 2013; Stodolska et al., 2009). The combination of the objective presence of crime and subjective perception of insecurity can create a barrier between a community and a park, leading to an association between the

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fear of crime and lower levels of physical activity (Bogar and Beyer, 2015; Evenson et al., 2012). This association, however, is still a subject of debate. Some studies have found that safety perception interferes with the positive effects of neighborhood greenness on physical activity (Baran et al., 2014; 2012). A recent systematic review, however, found no evidence of a relationship between safety from crime and physical activity among adults (da Silva et al., 2016).

Most studies addressing the link between crime and park use and physical activity have used either self-assessed safety perception and park use, or self-reports of physical activity (Miles, 2008; van Dillen et al., 2012). Using self-reported measures of physical activity is a limitation as it invites over or under-reporting of physical activity among study participants. And while existing research has found that safety perception can be a stronger predictor of physical activity that actual crime rates (Evenson et al., 2012), perceived measures of crime may include antisocial behavior that often biases self-perception of crime (Han et al., 2018). The presence of vandalism, graffiti or some forms of urban decay for example often contribute to worse safety perception despite not constituting actual crimes (Lorenc et al., 2012). Overall, it is still necessary to understand the direct relationship between objective crime rates and park use and energy expenditure within parks (da Silva et al., 2016; Ribeiro et al., 2015).

Few studies have been able to use objective crime data to assess the relationship between crime and physical activity. The link between crime and physical activity has been studied at the neighborhood level with mixed results (Evenson et al., 2012; Foster et al., 2014; Gómez et al., 2004; Mason et al., 2013; McDonald, 2008; Roman and Chalfin, 2008; van Bakergem et al., 2017). Even fewer studies have explored objective crime reports and its relationship with park use (Baran et al., 2014; Groff and McCord, 2012). To the best of our knowledge, only the study by Han et al. (2018) used police-recorded crime measures to explore its associations with physical activity within parks, and to date, the extent to which crime presence modifies the relationship between park use and physical activity remains unclear.

This article explores the associations between objective crime measures, park attendance, and park-based physical activity. It does so by exploring effects of the type of crime and crime temporality on objectively measured park use and physical activity of park users and children in New York City.

2. Methods

2.1. Study sample

The primary data for this analysis come from a larger park use study set in 20 parks in low-income neighborhoods in New York City (Botchwey et al., 2018; Marquet et al., 2019). The parent study was a large observational study on the patterns of use and physical activity of children in low-income high-minority communities. The 20 selected parks are all located within low-income neighborhoods in NYC, with a high presence of Latinx or Asian American populations. Low-income areas were defined as those census block groups with < 80% of the median county household income. All parks had a minimum of one playground area and one sports court/field. Using demographic 5-year estimates from the 2014 American Community Survey at the block group level, we selected the 10 parks with a larger estimate of low-income Latinx children living within a 0.5 miles catchment area of the park and the 10 parks with a larger estimate of Asian American child population. Selected parks were located in the boroughs of the Bronx (7), Manhattan (5), Brooklyn (5), and Queens (3). Following the System for Observing Play and Recreation in Communities (SOPARC) protocol, only specific areas of the parks were selected for observation. These target areas included playgrounds, swing sets, sports courts, water features, and other kinds of play areas. On average each park had 8.5 target areas (SD = 2.9), with no park with < 4. The average size of the areas observed per park was 0.6 acres (SD = 0.5) All selected parks were managed by the NYC Department of Parks and Recreation.

2.2. Measures

SOPARC was used to objectively measure the use of parks by different demographic groups. Use of SOPARC has been validated and is employed widely in recreational and health studies (Evenson et al., 2016; Han et al., 2013; Joseph and Maddock, 2016). Observers were trained following SOPARC protocols to count park users and classify them by gender (male-female), age group (0-4y.o., 5–10 y.o., teenagers, adults and older adults), race/ethnicity (Asian-American, Latino, African-American, White, Other), and physical activity level (sedentary, moderate, vigorous). All 20 parks were visited four days (two weekend days, two weekdays) in hour-long periods at 3:00 pm, 4:30 pm and 6:00 pm during Spring 2017. Within each hour, four rounds of observation were conducted, adding up to 12 rounds for each day of observation. Scheduled visits were canceled in the case of inclement weather and rescheduled within the same season. Observers worked in pairs and were randomly assigned to improve reliability. If more than one round of observation was completed in a one-hour time frame, the observations were averaged. Then we added the observations made at 3 pm, 4:30 pm and 6 pm to estimate the total number of people present at the park per day, total number of children (5–10 y.o.) present at the park, total number of female children, and total number of male children. To analyze per-capita physical activity during an observation, we converted the physical activity of each person counted in the park into Metabolic Equivalents (METs). Each activity level was multiplied by the corresponding MET value (sedentary = 1.5 METs, moderate = 3METs, vigorous = 6 METs) (Chow et al., 2016; Ramos et al., 2017). In addition, temperature conditions at the time of each observation (rounded to the closest hour), were obtained using METAR data from National Oceanic and Atmospheric Administration (NOAA) station located in Central Park. METAR data is a standardized weather report used for aviation purposes that provides hourly highly precise weather conditions (Dangel et al., 2013; Wang, 2014). The Area Deprivation Index, ranked from 1 to 100, created by the Health Resources & Services Administration (HRSA) was used to account for socioeconomic status. The population density of the areas around the parks were also used as covariates at the park level.

Crime data for the year 2017 were obtained through the NYC Open Data website (NYPD, 2017). A dataset containing all felonies, misdemeanors and violations reported to the New York City Police Department (NYPD) during 2017 was geocoded in ArcGIS using reported addresses or nearest intersection. We selected all crimes and misdemeanors occurring within a buffer of a half mile around each of the 20 selected parks (street network buffer). Crimes were classified as violent and property crimes, following the Uniform Crime Reporting definitions (U.S. Department of Justice, 2018). Violent crimes included criminal homicide, aggravated assault, forcible rape, and robbery. Property crimes consisted of arson, motor vehicle theft, larceny-theft, and burglary. We also analyzed the total number of crimes reported (violent plus property). In addition to the type of crime, we used the exact date when the crime was committed in relation to the date of each visit to the park to select those crimes committed in the week before the visit to the park, crimes committed within the month previous to the visit to the park, and crimes committed within the previous 3-months. With three types of crimes (violent, property, all) and three temporal periods (1-week, 1-month, 3-months before the park visit), a total of nine crime variables were created. To account for the different catchment area size around the parks and potential differences in population density around the parks, we used American Community Survey (ACS) 5-year population estimates (U.S. Census Bureau, 2018) to convert the nine crime variables into crime rates by dividing the number of crimes per every 10,000 people living within the park catchment area.

2.3. Statistical analysis

Descriptive statistics were used to observe inter-neighborhood and inter-park variation in crime rates, park attendance and park characteristics. In order to examine associations between crime rates and park attendance while accounting for the nested nature of the data (20 parks; 4 visits per park) we used a Multilevel Poisson regression model, with the number of people counted in the park as the dependent variable, the crime rate as the independent variable and area deprivation, population density, day of the week, park size, and temperature at the time of the observation as covariates. A different model was built for each crime type (violent, property, all) and crime time (1 week, 1 month, 3 months) leading to nine models for each population group. A multiple comparison adjustment for Type 1 error was implemented using the Bonferroni correction. Given that nine hypothesis tests were conducted, the cut-off for a significant *p*-value was set to be 0.0056. We first regressed the counts of total people found in the target areas, counts of children 5–10 years old, counts of female children and counts of male children. The same set of models was used to regress the energy expenditure –measured in METs per capita- of each demographic group. We formally tested the association between crime rates and gender by regressing both park attendance and energy expenditure with the interaction term between the counts of boys and girls at the time of observation. All analyses were run in Stata (version 14).

3. Results

Descriptive statistics are provided in Table 1. A total of 28,397 individuals were observed in the parks of which 8944 were children 5–10 y.o. (31.4%). We observed an average of 811 individuals per acre of park observed. The mean energy expenditure of the individuals observed in the park was 2.9 METs per person, slightly below the moderate physical activity MET equivalent (3 MET). Users of parks located in the Bronx (3.11 METs per person) were more active than users in parks located in Manhattan or Queens (2.72 METs per person). The average crime rate around the parks during the three months of observation, was 25.74 crimes per 10,000 people, with no significant differences between parks located in different boroughs. In the three months before the start of the study, the most common violent crime was robbery ($n = 3125$) followed by murder ($n = 54$). The most common propriety crime was grand larceny ($n = 9780$), followed by burglary ($n = 2845$) and arson ($n = 187$).

The relationship between crime type and when crimes were committed with the counts of park users is modeled in Table 2. A one standard deviation increase in the number of violent crimes measured 1 week, 1 month and 3 months before the park visit was significantly associated with fewer observed park users. Violent crime was associated with 7.2% less park visitors at the 1 week level, 13.1% less at the 1 month, and 12.1% at the 3 months' level. Throughout all time periods, this association was slightly stronger when running the model with children 5–10 exclusively (−7.3%; −14.5%; −21.6%, respectively). Increases in property crimes were also found significantly associated with the number of park users, but only during the previous week.

The effects of crime on the presence of children 5–10 y.o. per gender are displayed in Table 3. The magnitude of the associations was stronger for the number of female children observed in the parks. Despite not finding statistically significant effects, the model estimating the relationship between crime rates and the female-male children presence in the park finds consistent negative coefficients, indicating that increases in crime tend to correspond with fewer female children in the park. The presence of young girls in the park was strongly negatively associated with surges of violent crime (−10.3%; −17.9%; −28%) and property crime at the 1 week (17.4%) and 3 months' level (11.6%). The presence of male children in contrast, was only significantly associated with violent crimes and the coefficients were consistently lower (−5.5%; −11.8%; −16.3%).

Tables 4 and 5 display the effects of crime on the total energy expenditure estimated during the observation period. While all the coefficients at one week and one month before the park observation indicate a negative effect of crime on overall energy expenditure, none of the tests reached statistical significance after the Bonferroni correction.

When the association between crime and children's park-based energy expenditure is analyzed by gender (Table 5) only the total amount of crimes committed during the previous week are significantly associated with lower energy expenditure among girls. With a change in crime rate in the week before, being associated with 36.2 fewer accumulated METs (95% CI: −58.9; −10.1), which is equivalent to a 26.2% decrease in the average energy expenditure.

4. Discussion

This study focused on identifying the relationships between crime rates around parks and park-based physical activity among the general population of park users and children in particular. We used NYPD crime reports to assess how crime rates affected park attendance and physical activity in 20 NYC parks located in low-income areas. Crime severity was assessed by distinguishing between violent crime rates and property crime rates. We also accounted for crime temporality by distinguishing when crimes were committed with respect to the time parks were systematically observed and thus we distinguished between crime

Table 1
Characteristics of the 20 study parks and their catchment areas.

		Manhattan Parks = 5 $n = 18$	Brooklyn Parks = 5 $n = 20$	The Bronx Parks = 7 $n = 28$	Queens Parks = 3 $n = 12$	Total Parks = 20 $n = 78$	p[1]
Population density[a]	Mean	56,969	52,809	50,308	63,377	54,559	0.682
	Range	50,267; 63,672	32,089; 73,529	30,084; 70,532	42,871; 83,882	47,245; 61,873	
Area Deprivation Index[b]	Mean	74,3	39.9	92.5	25.6	65.7	< 0.001
	Range	49.2	60.2	24.4	50	95	
Crime rate[c]	Mean	25.6	20.3	28.7	24.8	25.2	0.394
	Range	17; 46	7; 38	10; 97	19; 36	8; 98	
Park user density[d]	Mean	522.8	1209	660.6	962.3	811.9	0.015
	Range	41; 1194	76; 3921	20; 1719	595; 1791	20; 3921	
Energy Expenditure[e]	Mean	2.72	2.86	3.11	2.72	2.9	0.037
	Range	2.08; 3.47	2.42; 3.77	2.01; 4.01	2.19; 3.00	2.01; 4.01	

[a] Population per sq./km inside the 0.5 miles catchment areas around the study parks.
[b] From Health Resources & Services Administration (HRSA). From 0 (less deprived) to 100 (more deprived).
[c] Crimes inside the catchment area of the study parks reported to the NYPD in the 3 months before the study.
[d] Daily park users per acre of park.
[e] METs per person observed in the park.
[1] One way ANOVA.

Table 2
Estimated associations of crime type and crime time in the number of observed park users per age.

Number of crimes per 10,000 population	Observed park users					
	All users			5–10 y.o.		
	Coef.	*p*	95% CI	Coef.	*p*	95% CI
Previous week						
Violent crimes	−0.072	0.000*	−0.08; −0.06	−0.073	0.000*	−0.1; −0.05
Property crimes	−0.093	0.000*	−0.11; −0.08	−0.076	0.000*	−0.1; −0.05
All crimes	−0.105	0.000*	−0.12; −0.09	−0.094	0.000*	−0.12; −0.07
Previous month						
Violent crimes	−0.131	0.000*	−0.15; −0.11	−0.145	0.000*	−0.18; −0.11
Property crimes	−0.009	0.400	−0.03; 0.01	−0.015	0.459	−0.05; 0.02
All crimes	−0.126	0.000*	−0.15; −0.1	−0.149	0.000*	−0.2; −0.1
Previous 3 months						
Violent crimes	−0.121	0.000*	−0.15; −0.09	−0.216	0.000*	−0.27; −0.16
Property crimes	0.035	0.008	0.01; 0.06	−0.08	0.000*	−0.12; −0.04
All crimes	0.007	0.592	−0.02; 0.03	−0.106	0.000*	−0.15; −0.06

All estimates are count changes in the counts of park users per one SD increase in crime rates
Estimates are adjusted by day of the week (weekend; weekday), size of the park (in acres), and temperature at the time of the observation.
* Significant at 0.05 (after adjustment for multiple comparison $p < 0.0056$).

Table 3
Estimated associations of crime type and crime time in the number of children observed park users by gender.

Number of crimes per 10,000inh	Observed park users								
	Female 5–10 y.o.			Male 5–10 y.o.			Female-male interaction		
	Coef.	*p*	95% CI	Coef.	*p*	95% CI	Coef.	*p*	95% CI
Previous week									
Violent crimes	−0.103	0.000*	−0.14; −0.07	−0.055	0.000*	−0.08; −0.03	−0.160	0.159	−0.38; 0.06
Property crimes	−0.174	0.000*	−0.22; −0.13	−0.015	0.391	−0.05; 0.02	−0.159	0.178	−0.39; 0.07
All crimes	−0.184	0.000*	−0.22; −0.14	−0.044	0.006	−0.07; −0.01	−0.209	0.074	−0.44; 0.02
Previous month									
Violent crimes	−0.179	0.000*	−0.23; −0.13	−0.118	0.000*	−0.16; −0.08	−0.118	0.308	−0.35; 0.11
Property crimes	−0.042	0.190	−0.1; 0.02	0.001	0.953	−0.05; 0.05	−0.099	0.441	−0.35; 0.15
All crimes	−0.199	0.000*	−0.27; −0.13	−0.107	0.000*	−0.17; −0.05	−0.140	0.269	−0.39; 0.11
Previous 3 months									
Violent crimes	−0.28	0.000*	−0.36; −0.2	−0.163	0.000*	−0.23; −0.1	−0.022	0.860	−0.27; 0.22
Property crimes	−0.116	0.000*	−0.18; −0.05	−0.056	0.040	−0.11; −0.00	−0.033	0.796	−0.28; 0.21
All crimes	−0.146	0.000*	−0.21; −0.08	−0.077	0.007	−0.13; −0.02	−0.031	0.802	−0.28; 0.21

All estimates are count changes in the number of park users per one standard deviation increase in crime rates.
Estimates are adjusted by day of the week (weekend; weekday), size of the park (in acres), and temperature at the time of the observation.
* Significant at 0.05 (after adjustment for multiple comparison p < 0.0056).

Table 4
Estimated associations of crime type and time of crime and energy expenditure of park users.

Number of crimes per 10,000 population	Observed park users					
	All users			5–10 y.o.		
	Coef.	*p*	95% CI	Coef.	*p*	95% CI
Previous week						
Violent crimes	−48.292	0.328	−144.99; 48.41*	−23.068	0.307	−67.29; 21.15
Property crimes	−140.343	0.007	−243.44; −38.32	−35.953	0.136	−83.22; 11.31
All crimes	−142.993	0.007	−246.02; −39.97	−42.144	0.08	−89.29; 5.00
Previous month						
Violent crimes	6.391	0.916	−112.94; 125.72	−12.52	0.622	−62.23; 37.26
Property crimes	−47.215	0.458	−171.91; 77.48	−22.126	0.416	−75.43; 31.18
All crimes	−52.243	0.475	−195.56; 91.08	−28.39	0.327	−85.13; 28.35
Previous 3 months						
Violent crimes	46.146	0.541	−101.95; 194.25	−0.85	0.977	−57.53; 55.84
Property crimes	79.987	0.233	−51.58; 211.56	1.766	0.949	−52.68; 56.21
All crimes	76.136	0.266	−58.03; 210.3	1.247	0.964	−53.53; 56.02

All estimates are changes in the estimate of total METs gained by park users per one standard deviation increase in crime rates.
Estimates are adjusted by day of the week (weekend; weekday), size of the park (in acres), and temperature at the time of the observation.
* Significant at 0.05 (after adjustment for multiple comparison p < 0.0056).

Table 5
Estimated associations of crime type and crime time in the Energy Expenditure (MET) per Gender of park users.

Number of crimes per 10,000inh	Observed park users								
	Female 5–10 y.o.			Male 5–10 y.o.			Female-male interaction		
	Coef.	*p*	95% CI	Coef.	*p*	95% CI	Coef.	*p*	95% CI
Previous week									
Violent crimes	−17.611	0.128	−40.26; 5.04	−4.858	0.705	−30; 20.28	−0.172	0.126	−0.39; 0.05
Property crimes	−33.119	0.006	−56.92; −9.32	−2.556	0.851	−29.2; 24.09	−0.206	0.076	−0.43; 0.02
All crimes	−36.984	0.002*	−60.59; −3.38	−4.71	0.729	−31.34; 21.93	−0.25	0.028	−0.47; −0.03
Previous month									
Violent crimes	−14.645	0.271	−40.69; 1.40	3.929	0.774	−22.87; 30.73	−0.131	0.250	−0.35; 0.09
Property crimes	−13.523	0.341	−41.36; 4.31	−7.259	0.627	−36.55; 22.04	−0.101	0.425	−0.35; 0.15
All crimes	−21.489	0.159	−51.38; 8.4	−4.494	0.77	−34.57; 25.59	−0.145	0.238	−0.39; 0.1
Previous 3 months									
Violent crimes	−6.442	0.678	−36.83;23.94	5.756	0.702	−23.67; 35.19	−0.03	0.781	−0.27; 0.2
Property crimes	−2.91	0.843	−31.68;25.86	5.321	0.72	−23.73; 34.37	−0.043	0.724	−0.28; 0.2
All crimes	−3.839	0.795	−32.86;25.17	5.682	0.702	−23.37; 34.73	−0.042	0.726	−0.28; 0.19

All estimates are changes in the estimate of total METs gained by park users per one standard deviation increase in crime rates. Estimates are adjusted by day of the week (weekend; weekday), size of the park (in acres), and temperature at the time of the observation.

* Significant at 0.05 (after adjustment for multiple comparison $p < 0.0056$).

rates calculated for the week previous to the observation, crime rates for the previous month, and crime rates calculated for the three months prior to the park observation.

Our analyses found a consistent negative relationship between violent crime rates around the park and park use. Higher crime rates on the week previous to park visit were associated with 7% less park users observed in the park. Both the general population and children in particular seem to be consistently affected by crime at all three time frames (1 week, 1 month, 3 months). At each time, violent crimes were always associated more strongly with lower park attendance than property crimes. Similarly, children appeared to always be more susceptible to crime than the general park population, with the exception of crimes committed during the week before the park visit.

While both property crimes and violent crimes were negatively associated with park use, violent crimes had a stronger effect. The effect of property crimes over park attendance seems to fade rapidly, as they are only found to impact park attendance when committed during the week previous to the park visit. This could reflect recency bias on the part of park users, and indicate that property crimes might be affecting only immediate behavior. Violent crimes, in contrast, prove to have longer lasting effects on park attendance.

Distinguishing between types of crime is important because aggregated measures of crime can mask significant associations between crime and physical activity (Foster and Giles-Corti, 2008). The relationship between violent crime and less park use was also found by Baran et al. (2014) who used a 3-year average crime rate around the parks and recently by Han et al. (2018) who used a 6 month period to calculate crime rates around the parks. None of them, however, had been able to at the same time distinguish between violent and property crimes while also incorporating when the crimes were committed.

Children's park use was also negatively associated with violent crime rates for the three studied time frames with an increase in the 3-month crime rate being associated with 21.6% less children observed in parks. This is likely a result of parents engaging in avoidance behavior, altering habits and activities in an attempt to reduce perceived risks (Baran et al., 2014; Carver et al., 2010). As suggested by Gómez et al. (2004), parents and guardians may be more aware of the dangers around the park than their children are, and may restrict visits to parks accordingly. The fact that children's park attendance was affected more by crime rates than the adults' presence in the park also suggests that adults are more likely to engage in avoidance behavior when it comes to their children in comparison with their own set of activities. This finding, however, contradicts Han et al. (2018) who found the park use of children in Los Angeles to be unaffected by crime rates.

The park behavior of girls also appeared to be more impacted by crime than that of boys. For example, violent crimes were negatively associated with the counts of both male and female children, but property crimes were only significantly associated with fewer female children in the parks. This specific relationship between crime rates and lower girl physical activity was also reported by van Bakergem et al. (2017) and Gómez et al. (2004) among low income Hispanic children. However, Han et al. (2018) reported no gender differences in the relationship between crimes and objective park use. It must be noted that while the interaction model found consistent negative coefficients indicating that female park attendance was more affected by crime rates, no significant association was found.

In terms of energy expenditure, our results indicate that only recent crime rates (1-week) were associated with a decrease in girl's energy expenditure. This reinforces the idea that young girls and their parents are more likely to change their park-going behavior –both attendance and physical activity while they are in the park– because of crime than young boys.

By using objective crime reports and systematic park level observational data, we have been able to visualize how the presence of crime, particularly of the violent kind, has a significant negative role on park attendance and energy expenditure in parks. This study provides evidence that the decision to go to parks is negatively associated with increases of crime rates and illustrates how crime may affect park use measured at 1 week, 1 month and 3 months' periods. Given the importance of park use and physical activity gained within parks for both children and all populations, crime rates around urban parks can create important negative effects on public health. Finding solutions to soften short-term effects in park use after an increase in crime rates might help moderate the negative effects of crime. Our findings suggest that policies and programs to address park safety should give particular attention to girls and their parents and families.

4.1. Limitations

This study is subject to several limitations. The use of observational data and objective crime reports does improve the available existing methods but it is still not possible to establish causation. Because the focus of our study was set on low-income areas, with typically higher crime rates, the variability between parks was limited. In the future, adding different geographic areas with different crime rates might add valuable insight. Using SOPARC we were able to systematically assess park use, by observing park use a total of twelve times a day on each park visit. Each park, however, was only visited during two weekend

days and two weekdays. Similarly, in this paper we intended to apply the SOPARC protocol to measure some pre-defined target areas such as playgrounds and sports courts, and not the park on its entirety.

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