Published in final edited form as:

Am J Prev Med. 2016 October ; 51(4): 419–426. doi:10.1016/j.amepre.2016.03.021.

The First National Study of Neighborhood Parks:

Implications for Physical Activity

Deborah A. Cohen, MD[1], **Bing Han, PhD**[1], **Catherine Nagel, MLA**[2], **Peter Harnik, BA**[3], **Thomas L. McKenzie, PhD**[4], **Kelly R. Evenson, PhD**[5], **Terry Marsh, MPH**[1], **Stephanie Williamson, BA**[1], **Christine Vaughan, PhD**[1], and **Sweatha Katta, MPH**[2]

[1]RAND Corporation, Santa Monica, California

[2]City Parks Alliance, Washington, District of Columbia

[3]Trust for Public Land, Washington, District of Columbia

[4]School of Exercise and Nutritional Sciences, San Diego State University, San Diego, California

[5]University of North Carolina- Chapel Hill, Gillings School of Global Public Health, Department of Epidemiology

Abstract

Introduction—An extensive infrastructure of neighborhood parks supports leisure time physical activity in most U.S. cities; yet, most Americans do not meet national guidelines for physical activity. Neighborhood parks have never been assessed nationally to identify their role in physical activity.

Methods—Using a stratified multistage sampling strategy, a representative sample of 174 neighborhood parks in 25 major cities (population >100,000) across the U.S. was selected. Park use, park-based physical activity, and park conditions were observed during a typical week using systematic direct observation during spring/summer of 2014. Park administrators were interviewed to assess policies and practices. Data were analyzed in 2014–2015 using repeated-measure negative binomial regressions to estimate weekly park use and park-based physical activity.

Results—Nationwide, the average neighborhood park of 8.8 acres averaged 23 users/hour or an estimated 1,533 person hours of weekly use. Walking loops and gymnasia each generated 221 hours/week of moderate to vigorous physical activity. Seniors represented 4% of park users, but 20% of the general population. Parks were used less in low-income than in high-income neighborhoods, largely explained by fewer supervised activities and marketing/outreach efforts.

Address correspondence to: Deborah A. Cohen, MD, RAND Corporation, 1776 Main Street Santa Monica CA 90407. dcohen@rand.org.

No financial disclosures were reported by the authors of this paper.

Supplementary Information

Design-based estimators

The point estimates were based on the Horvitz-Thompson estimator, where the final weights were the product of sampling inclusion weight of parks and the day weights. The sampling inclusion weights of parks were the inverse of the probability of a park being sampled, where the inclusion probability was calculated according to stratification and two stage clustering. The day weight was 2.5 for week days and 1 for weekend days to reflect the observation schedule (2 week days and 2 weekend days in a park). Standard errors were calculated using the formulas for stratified two-stage complex survey.[28] All analyses were implemented by the Survey package in Stata version 13.1 and SAS version 9.4.

Programming and marketing were associated with 37% and 63% more hours of moderate to vigorous physical activity/week in parks, respectively.

Conclusions—The findings establish national benchmarks for park use, which can guide future park investments and management practices to improve population health. Offering more programming, using marketing tools like banners and posters, and installing facilities like walking loops may help currently underutilized parks increase population physical activity.

Introduction

Neighborhood parks with large open spaces constitute infrastructure to support adherence to national recommendations for moderate-to-vigorous physical activity (MVPA)—at least 60 minutes/day for youth and 150 minutes/week for adults.[1] Because fewer than half of Americans meet these guidelines,[2] physicians are being encouraged to routinely counsel patients about physical activity and to offer “park prescriptions”, identifying nearby parks and recommending regular visits.[3,4] Yet, the degree to which parks are designed or managed to optimize physical activity for all age groups and genders has not been examined at the national level.[5,6] Many urban parks were created before climate-controlled indoor spaces and electronic visual media existed, when work required more physical activity and labor-saving devices were less available. Parks were originally designed for leisure, recreation, and a chance to make contact with nature, not to specifically promote physical activity.[7] Given high levels of inactivity and associated chronic diseases, like heart disease, diabetes, and cancer,[1] it is timely to reconsider parks and their potential to improve the nation's health.

Across the US, more than 9,000 local park and recreation departments and organizations manage more than 108,000 public park facilities and 65,000 indoor facilities.[8] Parks have been categorized by size and facilities into different types, including very small parks (under 2 acres, also called mini-parks, pocket parks, or parklets), neighborhood parks, community and large urban parks, sports complexes, and natural resource areas.[9] Neighborhood parks are considered the backbone of park systems. They often contain multiple diverse facilities —playgrounds, picnic tables, basketball courts, green spaces, and shade trees-- allowing residents of all ages to recreate there on a routine basis. Neighborhood parks are usually between 2 and 20 acres, have more facilities than mini-parks, and are intended to serve local residents living within a 1-mile radius around parks.[9]

Funding for park programming, maintenance, and capital improvements is typically allocated from city budgets, which also vary across jurisdictions. Many cities employ staff to develop, monitor, and market programs for parks, including classes and special events. It is plausible that local park management practices and policies could influence population-level physical activity.

Prior studies indicate that sociodemographics, size, facilities, aesthetics, and proximity are all important factors contributing to park use,[10-19] but most studies are local and have limited generalizability.[20] To that end the authors conducted a national observational study of 174 parks from 25 cities in the US with a population greater than 100,000.[28] The goals were to determine, at the national level, how neighborhood park systems support population-level physical activity and to identify factors associated with park use and park activities,

including facilities, management practices, and disparities between parks in high and low income neighborhoods, and to understand how park administrators currently measure park use and the potential usefulness of such measures.[21]

Methods

Study design

A two-stage stratified sampling strategy was used to select a representative sample of neighborhood parks in the US cities with a population of ≥ 100,000 according to the 2010 Census.[28] The total 289 cities were divided into nine strata, with eight strata based on population (200,000-1,000,000, and 100,000-200,000) and region (West, Northeast, Midwest, and South), and the ninth stratum comprising cities with more than 1 million population. In the first sampling stage 25 cities were randomly drawn from the nine strata (Appendix Figure 1 and Tables 1,2). All states were in the sampling frame, and by chance all sampled cities were in the 48 continental states. In each of the 25 selected cities a list of public parks was retrieved, either directly supplied by the city's Department of Recreation and Parks or from their website. The selection was restricted to avoid parks in close proximity (< 1 mile from each other) and to ensure distributions of chosen parks were similar with regard to sizes and local poverty rates for all neighborhood parks within each city. Parks between 3 and 20 acres were initially targeted,[9] but in nearly half the cities large numbers of neighborhood parks were slightly below 3 acres or just above 20 acres. As a result, the selection criteria were relaxed to include ten parks below 3 acres (between 2.2 and 2.9 acres) in eight cities and five parks above 20 acres (between 20.1 and 23.0 acres) in five cities.

One hundred seventy-four parks were included representing approximately a 10% sample of all eligible neighborhood parks in the sampled cities. Parks located in a census tract with no or very few residents (airport, prison, military base, hospital, industry facility, etc.), pocket parks (< 2 or 3 acres), regional parks (> 20 or 23 acres in some cities), parks used as school fields during business hours, and parks serving special purposes only (e.g. parkways, boxing gyms, etc.) were excluded. Two parks were replaced because police said they were unsafe for staff to visit.

Measurement protocol

Data collection was conducted on clement days between April and August, 2014 using the System of Observing Play and Recreation in Communities (SOPARC), a validated observational tool.[22] The tool uses momentary time sampling and direct observation methods to assess aggregated physical activity levels, demographic characteristics of park users, and contextual information. From each of the selected cities two to four local field staff were recruited and trained.

Each park was mapped and divided into subareas called target areas that could be observed in one scan and typically included one type of facility (e.g., play equipment, basketball court, lawn) or supported only one type of activity (e.g., tennis). All the target areas were numbered so that every single observation occurred in exactly the same order. Observations

generally took less than one hour to cover the entire park. Based upon a previous study indicating that 12 observations selected on different days and different times of day were sufficient for reliably estimating weekly park use,[23,24] each park was observed according to the following schedule: Tuesday, 8AM, 11AM, and 2PM; Thursday, 12PM, 3PM, and 6PM; Saturday, 9AM, 12PM, and 3PM; and Sunday, 11AM, 2PM, and 5PM. During each hourly observation, all target areas were assessed for specific characteristics, including whether they were accessible, usable, or supervised (i.e., a person was in charge to manage and direct activities like a lifeguard, park staff or coach). Parks were observed during a single week, except when the weather was inclement; on those occasions the observation was rescheduled for the next available day (same time of day and day of week) that was not raining.

Each park user in a target area was categorized into one of 24 groups defined 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]). At the end of each day, staff completed an assessment of the park conditions, including weather, noise, marketing materials (e.g. banners, posters), the amount of litter and graffiti, and presence of apparently homeless individuals, people appearing threatening or engaged in altercations, and park staff, food vendors, or special events.

During visits, field staff also documented park features and amenities, including signage and marketing for park activities, adapted from previously validated park assessment tools.[25-27] To better understand management practices, park administrative staff were surveyed.

Data Analysis

Data were analyzed in 2014-15. Estimates of total weekly park use are based on the assumption that, a park was, on average, usable at least 11 hours a day (between 8AM and 7PM), 7 days a week. Because field staff missed roughly 1% of scheduled target area observations by scan hour level, the mean imputation method was used to impute missing data.[28] To adjust for the complex sampling strategy, design-based estimators were applied to estimate average weekly park use in person-hours/week (Appendix).

Moderate and vigorous activity were combined into one category to match with the national recommendations for physical activity. To identify factors associated with hourly park use and park activities, repeated-measure generalized linear models were fit. The negative binomial distribution was used for the outcome due to variance inflation. Binary indicators were used for different days of a week and different hours of a day to allow for a flexible temporal trend and also included daily weather variables (maximum, minimum, and mean temperature), park size, population density, park facilities, accessibility of facilities, presence of supervised activities, and the observed park conditions described above.

Associations with predictors were tested by the robust generalized estimation equation (GEE) method,[29] which accounted for temporal correlations within a park and spatial correlations within a city. Neighborhood demographics and socio-economic data were drawn from the US Census 2010 and the American Community Survey 2012.[30,31] All analyses were done in SAS version 9.4 and Stata version 13.1.

Results

Considering all 174 study parks, the median local population within a 1-mile radius of a park was 12,400 people and the median percentage of households in poverty was 17.8%. The mean park size was 8.8 acres (range = 2.2-23.0 acres) and parks had a median of 17 (range = 3-101) target areas and 5 (range = 1 - 11) different facility types (Table 1). Although staff observed a mean of 5 supervised activities in park target areas over the 12 observation periods, the median was zero--more than half the parks had no supervised programming at all.

Table 2 shows the most common facilities in neighborhood parks and how much each contributed to MVPA for children and teens or adults and seniors. The most common park facilities were lawns (97%) and play areas (89%). Nearly half the parks had outdoor basketball courts (53%) and baseball fields (49%), 31% had tennis courts and 29% had a walking loop. Almost all facilities (97%) were rated usable and 98% were accessible.

On average, the park facility that generated the most MVPA time for adults and seniors was a walking loop, where 9% of users were seniors versus 4% in other park areas (data not shown). Children and teens accrued similar amounts of MVPA on walking loops as they did in a pool or skate park. After walking loops and gymnasiums, fitness zones and exercise areas generated the next highest amounts of MVPA for adults and seniors.

Across the 174 parks staff counted 77,300 people during 2088 hourly observations. Assuming a park is usable at least 77 hours/week (11 hours/day between 8AM and 7PM, 7 days/week), adjusting for survey design, it was estimated that the national average park use was 1,533 person-hours per week (95% CI: 930, 2,140). Weekly park use varied greatly across the parks (range = 0-26,260 person-hours), and the estimated average hourly use was 20 people per park. Seventy-five percent of target area-level observations recorded no users.

Disparities in Park Use

Table 3 shows significant disparities by gender and age group in park use and park-based MVPA. Overall more park users were male (57%) and they accounted for 60% of estimated MVPA person hours. The gender disparity was the greatest for teens. Male teens accounted for 65% of teen visitors and 68% of teen MVPA person hours ($p < .05$). Park visitation by age group was significantly different than that in the general population ($p < .0001$). The distribution of park users included 38% children and 13% teens, but of the total US population, children and teens represent 20% and 7% respectively. Seniors (aged ≥60 years) represented only 4% of observed park visitors but comprise 20% of the general population.

There were significant disparities in park use and park characteristics by socio-economic status (data not shown). Within the same city, parks in high-poverty neighborhoods (identified as above the median of the local poverty levels of all parks in the city) tended to be smaller than those in low-poverty neighborhoods (7.8 vs. 10.0 acres; $p = 0.003$). However, there was no difference in the number of accessible facilities. Parks in high poverty areas were used less than parks in low-poverty neighborhoods: (1380 versus 1690 person hours/week, $p < .0001$) and they had significantly fewer supervised areas (average of

2.1 vs. 4.5; p = 0.012). Litter was observed more often in low-income area parks, but not more graffiti. There was no difference in the presence of homeless people or dogs off leash in high versus low income area parks.

Predictors of park use

None of the weather variables were associated with park use or physical activity in any model, so these were eliminated. Three basic factors associated with the number of observed park users were first examined: park size, local population density, and local neighborhood household poverty levels (Model 1 in Table 4). On average, keeping the other two predictors constant, 1 additional acre was associated with 9% increase in park use (β=0.09, p<.0001); 10,000 additional population living in a 1-mile radius was associated with an 13% increase in park use (β=0.12, p<.0001); and a 10-percentage point increase in the local household poverty level was associated with a 12% decrease in park use (β=−0.01, p=0.04). The pattern of relationships between these factors and the amount of MVPA person hours occurring in the parks was similar to the model predicting the number of park users (bottom of Table 4).

Model 2 includes multiple other observed park characteristics. Park size was not significant after controlling for other related factors in the model. Supervised activities and onsite marketing were significantly related to increased park use and MVPA person hours. Every additional supervised activity increased mean park use by 48% (β= 0.39; p <0.0001) and the mean MVPA time by 37% (β=0.37; p < 0.0001). The presence of marketing materials, such as banners, posters, and signs was associated with a 62% (β=0.48; p=0.003) increase in the number of park users and 63% (β= 0.49; p< 0.001) increase in MVPA person-hours. Each additional accessible target area (e.g., basketball court, tennis court, play area) was associated with 2% more person-hours of park use (β=0.02, p=0.03) and 2% more minutes of MVPA (β=0.02, p=0.006).

Staff interviewed senior administrators from all 25 city park systems in the study. None routinely measured park use, other than by tracking whether people registered for specific programs or sports leagues. Although two park systems reported doing annual resident surveys and using population-level results to inform programming decisions, most provided “user-driven” recreational services by responding to requests of vocal citizens. All administrators said that park measurements would be useful to guide management decisions, targeting and programming, but they currently lacked the necessary skills and resources. Limitations in resources were a major barrier to park improvements; among administrators of 119 parks (68%) who answered survey questions about resources, roughly 50% indicated their parks had budget and staff decreases in the past two years and 40% indicated no changes. Only 10% reported budget increases.

Discussion

Conditions in local neighborhood parks can potentially support or limit physical activity. The mere presence of a park does not guarantee its use, even when many facilities are usable. This study identified multiple disparities in park use, especially low use among adults, seniors, girls, and women and lower use in higher-poverty neighborhoods, suggesting

efforts to improve services for these subpopulations are necessary. Although it is critically important for adults and seniors to engage in routine physical activity, most parks are geared toward serving youths rather than adults. Few programmed activities that specifically targeted adults and seniors were documented. Given that physical activity may have more immediate benefits for adults and seniors as far as preventing or mitigating the impact of chronic diseases, park systems should consider adding enhancements, like walking loops, and more programming that would appeal to older age groups. Neighborhood parks may not be adequately serving low-income groups, even though their parks have similar facilities to those serving higher income groups. These models suggest that disparities in these neighborhoods might be largely overcome by offering more supervised activities, and engaging in greater marketing/outreach efforts.

Limitations

This first national observational study of neighborhood parks is cross-sectional so it cannot be concluded that the associations between park features, programming, and physical activity are causal. However, many other longitudinal studies have shown that investments in outreach, programming and park improvements do increase park-based physical activity.[32-36] Because the observations were limited to the spring and early summer, a time when parks may be used more than in other seasons, and all observations for a park were conducted over a short period (usually within one week), it may not be possible to estimate annual use based on these data. Weather did not appear related to park use, in part because these models already controlled for city which is correlated with temperature. These estimates, however, do provide a snapshot of park use by age, gender, and activity level. In addition, given limited resources, park users and local residents were not interviewed about their perspectives on park use and which features they considered more attractive or the degree to which their perceptions on park safety might have influenced use of neighborhood parks. It is likely that some of the lower use of parks in high-poverty neighborhoods might be explained by concerns about personal safety. However, the models suggest that park size, supervised activities, and marketing materials each has a comparable or larger effect size than the local poverty level, which has been correlated with safety concerns.[37] Also, parks were observed only between 8AM and 7PM, precluding estimation of park use occurring before or after these hours. Previous research observing parks 14 hours/day suggest that 8AM-7PM is when parks are typically used most.[23]

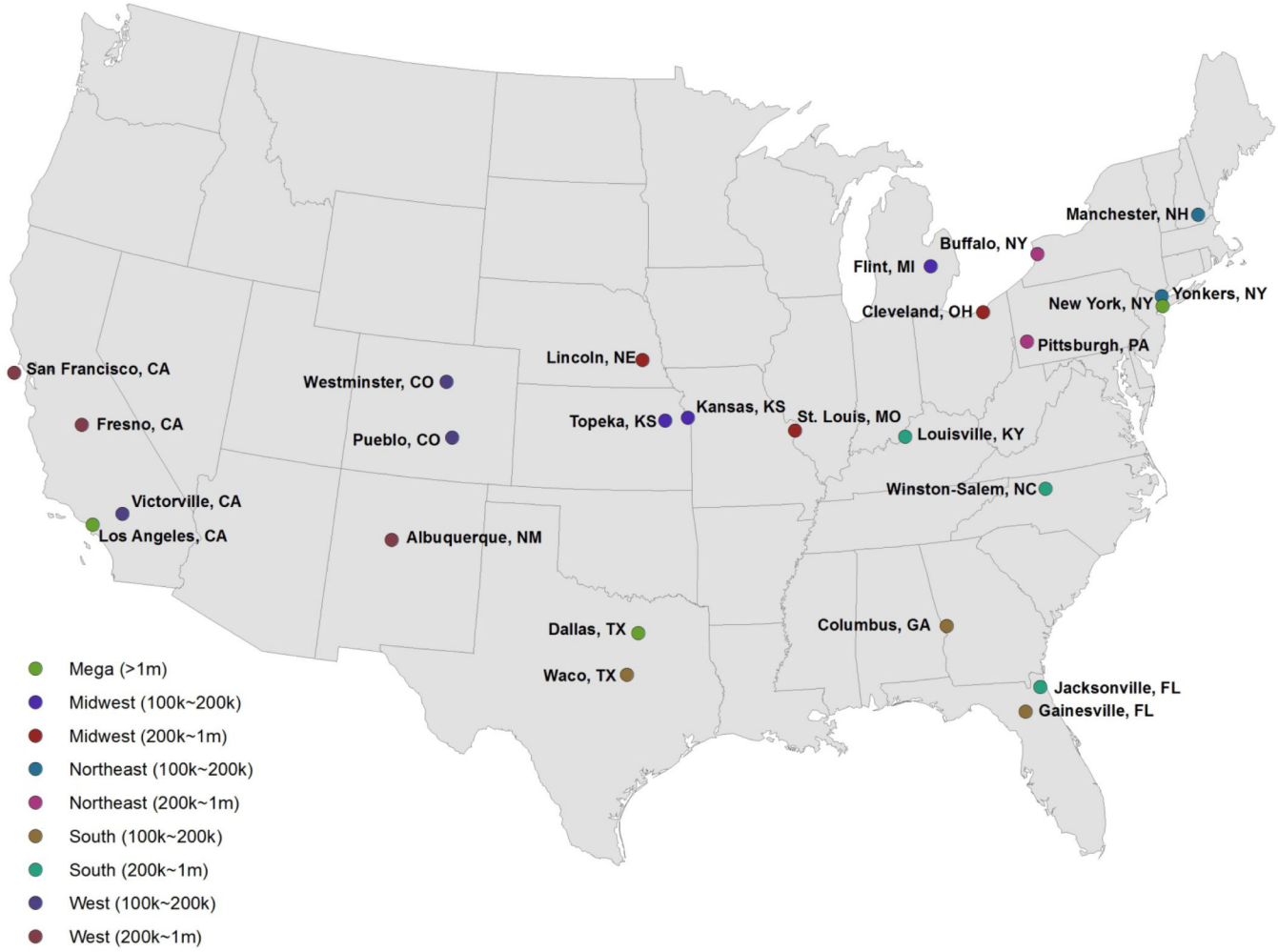
The current investment in urban parks across the US is relatively small, considering the potential benefits they may yield in health. Physical inactivity contributes to a high proportion of chronic diseases and is directly responsible for 11% of all deaths.[38] Yet among the 100 largest US cities, the average annual per capita expenditure for parks in 2013 was $73 (range $9-$247),[39] less than 0.8% of the $9,146 per capita expenditure on health care in the same year.[40] Neighborhood parks are challenged by being financed at the local level, although limited federal dollars are sometimes available through Community Development Block Grants and the Land and Water Conservation Fund. Private philanthropy can help, although it rarely occurs in lower-income neighborhoods. Relatively modest investments may improve neighborhood park conditions to make them conducive to physical activity for everyone, regardless of age, gender, or income-level.

Acknowledgements

This study was supported by the National Heart, Lung, and Blood Institute, NHLBI # R01HL114432.

DC is the Principal Investigator and took the lead in designing the study and writing the manuscript. BH is the statistician and also helped design the study and data collection protocol. CN supervised the fieldwork and, along with PH, KE, CV, and TLM, assisted in protocol development, data analysis, and manuscript preparation. TLM also assisted in training field staff. TM was responsible for fieldwork, training, and quality control. SW was the project programmer. SK was responsible for field staff, quality control, and conducting park director surveys. All authors discussed the results and reviewed multiple drafts of the manuscript.

Appendix



Appendix Figure 1.
Study cities in National Study of Neighborhood Parks (NSNP)

Appendix Table 1

U.S. Cities in the National Study of Neighborhood Parks Sample

U.S. Census region	City population (2010 Census)	# total cities available	# cities sampled	Cities sampled
Nationwide	>1 million	9	3	Dallas, TX
				Los Angeles, CA
				New York, NY
West	200,000~1 million	39	3	Albuquerque, NM
				Fresno, CA
				San Francisco, CA
	100,000~200,000	73	3	Pueblo, CO
				Victorville, CA
				Westminster, CO
Northeast	200,000~1 million	6	2	Buffalo, NY
				Pittsburgh, PA
	100,000~200,000	17	2	Manchester, NH
				Yonkers, NY
South	200,000~1 million	40	3	Jacksonville, FL
				Louisville/Jefferson County metro government (balance), KY
				Winston-Salem, NC
	100,000~200,000	57	3	Columbus, GA
				Gainesville, FL
				Waco, TX
Midwest	200,000~1 million	17	3	St. Louis, MO
				Lincoln, NE
				Cleveland, OH
	100,000~200,000	31	3	Flint, MI
				Kansas City, KS
				Topeka, KS
Total		289	25	

Appendix Table 2

Sampling of Neighborhood Parks for the National Study of Neighborhood Parks

Cities sampled in NSNP	# of parks < 20 acres potentially eligible	# eligible neighborhood parks	# sampled
Albuquerque, NM	304	94	10
Buffalo, NY	84	41	6
Cleveland, OH	75	57	8
Columbus, GA	47	23	6
Dallas, TX	379	149	14
Flint, MI	25	25	4

Cities sampled in NSNP	# of parks < 20 acres potentially eligible	# eligible neighborhood parks	# sampled
Fresno, CA	50	46	6
Gainesville, FL	18	8	2
Jacksonville, FL	262	90	10
Kansas City, KS	49	25	4
Lincoln, NE	64	46	6
Los Angeles, CA	548	147	16
Louisville/Jefferson County metro government, KY	122	46	6
Manchester, NH	65	28	4
New York, NY	217	148	16
Pittsburgh, PA	129	62	8
Pueblo, CO	56	32	6
San Francisco, CA	177	73	8
St. Louis, MO	59	47	6
Topeka, KS	96	43	6
Victorville, CA	22	14	4
Waco, TX	25	19	4
Westminster, CO	47	42	6
Winston-Salem, NC	47	29	4
Yonkers, NY	82	28	4
Total	3,049	1,362	174

References

1. U.S. DHHS.. Physical Activity Guidelines for Americans. U.S. DHHS; Washington, DC: 2008.
2. U.S. DHHS. The Surgeon General's Vision for a healthy and Fit Nation. 2010. www.surgeongeneral.gov/priorities/healthy-fit-nation/obesityvision2010.pdf
3. NRPA.. Prescribing Parks for Better Health: SUCCESS STORIES. 2014. www.nrpa.org/uploadedFiles/nrpa.org/Grants_and_Partners/Health_and_Livability/FINAL%20Prescribing%20Parks%20for%20Better%20Health%20Success%20Stories.pdf
4. Puett R, Teas J, Espana-Romero V, et al. Physical activity: does environment make a difference for tension, stress, emotional outlook, and perceptions of health status? J Phys Act Health. 2014; 11(8): 1503–1511. http://dx.doi.org/10.1123/jpah.2012-0375. [PubMed: 24733227]
5. Han B, Cohen DA, Derose KP, Marsh T, Williamson S, Raaen L. How much do neighborhood parks contribute to local residents' MVPA in the City of Los Angeles--a meta-analysis. Prev Med. 2014; 69(Suppl 1):S106–S110. http://dx.doi.org/10.1016/j.ypmed.2014.08.033. [PubMed: 25199733]
6. Han B, Cohen D, McKenzie TL. Quantifying the contribution of neighborhood parks to physical activity. Prev Med. 2013; 57(5):483–487. http://dx.doi.org/10.1016/j.ypmed.2013.06.021. [PubMed: 23827723]
7. Olmstead, F. Public Parks and the Enlargement of Towns.. In: LeGates, RS,F., editor. The City Reader. Second ed.. Routledge; London: 1870. p. 314-320.
8. Godbey, G.; Mowen, A. The Benefits of Physical Activity Provided by Park and Recreation Services: The Scientific Evidence. 2010. www.nrpa.org/uploadedFiles/nrpa.org/Publications_and_Research/Research/Papers/Godbey-Mowen-Research-Paper.pdf
9. Mertes, J.; Hall, J. Park, Recreation, Open Space and Greenway Guidelines. National Recreation and Park Association; Ashburn, VA: 1996.

10. Cohen D, Han B, Derose K, et al. Neighborhood poverty, park use, and park-based physical activity in a Southern California city. Soc Sci Med. 2012; 75(12):2317–2325. http://dx.doi.org/10.1016/j.socscimed.2012.08.036. [PubMed: 23010338]
11. Floyd MF, Spengler JO, Maddock JE, Gobster PH, Suau L. Environmental and social correlates of physical activity in neighborhood parks: An observational study in Tampa and Chicago. Leis Sci. 2008; 30(4):360–375. http://dx.doi.org/10.1080/01490400802165156.
12. Kaczynski AT, Potwarka LR, Saelens BE. Association of park size, distance, and features with physical activity in neighborhood parks. Am J Public Health. 2008; 98(8):1451–1456. http://dx.doi.org/10.2105/AJPH.2007.129064. [PubMed: 18556600]
13. Kaczynski AT, Stanis SAW, Hastmann TJ, Besenyi GM. Variations in Observed Park Physical Activity Intensity Level by Gender, Race, and Age: Individual and Joint Effects. J Phys Act Health. 2011; 8:S151–S160. [PubMed: 21918228]
14. Lounsbery, MAF.; McKenzie, TL.; Funk, B.; Holt, K. Park use and physical activity in Southern Nevada.. Med Sci Sports Exerc; American College of Sports Medicine Annual Meeting; San Francisco. 2012. p. S368
15. Mowen A, Orsega-Smith E, Payne L, Ainsworth B, Godbey G. The role of park proximity and social support in shaping park visitation, physical activity, and perceived health among older adults. J Phys Act Health. 2007; 4(2):167–179. [PubMed: 17570886]
16. Rung AL, Mowen AJ, Broyles ST, Gustat J. The role of park conditions and features on park visitation and physical activity. J Phys Act Health. 2011; 8(Suppl 2):S178–187. [PubMed: 21918231]
17. Shores, KA.; West, ST.; Evans, AW.; Evans, D. Parks, Recreation, and Public Health: Collaborative Frameworks for Promoting Physical Activity. Cooper Institute Conference Series; Dallas, TX: 2006. The relative importance of social and environmental attributes for active park use.; p. 18-19.
18. Weigand, L. Can park design and facilities promote park use and physical activity?. Active Living Research Annual Conference; Coronado, CA.. 2007;
19. Giles-Corti B, Broomhall MH, Knuiman M, et al. Increasing walking: how important is distance to, attractiveness, and size of public open space? Am J Prev Med. 2005; 28(Suppl 2):169–176. http://dx.doi.org/10.1016/j.amepre.2004.10.018. [PubMed: 15694525]
20. Godbey GC, Caldwell LL, Floyd M, Payne LL. Contributions of leisure studies and recreation and park management research to the active living agenda. Am J Prev Med. 2005; 28(Suppl 2):150–158. http://dx.doi.org/10.1016/j.amepre.2004.10.027. [PubMed: 15694523]
21. Floyd MF, Taylor WC, Whitt-Glover M. Measurement of park and recreation environments that support physical activity in low-income communities of color: highlights of challenges and recommendations. Am J Prev Med. 2009; 36(4 Suppl):S156–160. http://dx.doi.org/10.1016/j.amepre.2009.01.009. [PubMed: 19285207]
22. McKenzie TL, Cohen DA, Sehgal A, Williamson S, Golinelli D. System for Observing Parks and Recreation in Communities (SOPARC): Reliability and feasibility measures. J Phys Act Health. 2006; 3(Suppl 1):S208–S222. [PubMed: 20976027]
23. Cohen DA, Setodji C, Evenson KR, et al. How much observation is enough? Refining the administration of SOPARC. J Phys Act Health. 2011; 8(8):1117–1123. [PubMed: 22039130]
24. Han, B.; Cohen, DA.; Derose, KP.; Marsh, T.; Williamson, S.; Raaen, L. Validation of a New Counter for Direct Observation of Physical Activity in Parks.. J Phys Act Health. In press. Online June 15, 2015. http://dx.doi.org/10.1123/jpah.2014-0592
25. Bedimo-Rung, A. BRAT-DO Instrument. 2009. http://publichealth.lsuhsc.edu/Faculty_Pages/rung/Documents/BRAT-DO%20-%20General%20Use%20-%20All.pdf
26. Saelens B, Frank L, Auffrey C, Whitaker R, Burdette H,NC. Measuring physical environments of parks and playgrounds: EAPRS instrument development and inter-rater reliability. J Phys Act Health. 2006; 3(Supplement 1):S109–S207.
27. Kaczynski AT, Stanis SA, Besenyi GM. Development and testing of a community stakeholder park audit tool. Am J Prev Med. 2012; 42(3):242–249. http://dx.doi.org/10.1016/j.amepre.2011.10.018. [PubMed: 22341161]
28. Sharon, Lohr. Sampling: design and analysis. 2nd ed.. Cengage Learning; Boston, MA: 2009.

29. Zeger SL, Liang KY, Albert PS. Models for longitudinal data: a generalized estimating equation approach. Biometrics. 1988; 44(4):1049–1060. http://dx.doi.org/10.2307/2531734.
30. U.S. Census. 2010 Census Summary File 1—United States/ prepared by the U.S. Census Bureau, 2011. 2011
31. U.S. Census. 2007-2011 American Community Survey, Table B17017. 2012
32. Cohen D, Golinelli D, Williamson S, Sehgal A, Marsh T, McKenzie TL. Effects of Park Improvements on Park Use and Physical Activity: Policy and Programming Implications. Am J Prev Med. 2009; 37(6):475–480. http://dx.doi.org/10.1016/j.amepre.2009.07.017. [PubMed: 19944911]
33. Cohen DA, Han B, Derose KP, Williamson S, Marsh T, McKenzie T. Physical Activity in Parks: A randomized controlled trial using community engagement. Am J Prev Med. 2013; 45(5):590–597. http://dx.doi.org/10.1016/j.amepre.2013.06.015. [PubMed: 24139772]
34. Cohen DA, Han B, Isacoff J, et al. Impact of Park Renovations on Park Use and Park-Based Physical Activity. J Phys Act Health. 2015; 12(2):289–295. http://dx.doi.org/10.1123/jpah.2013-0165. [PubMed: 24956608]
35. Cohen DA, Marsh T, Williamson S, Golinelli D, McKenzie TL. Impact and cost-effectiveness of family Fitness Zones: a natural experiment in urban public parks. Health Place. 2012; 18(1):39–45. http://dx.doi.org/10.1016/j.healthplace.2011.09.008. [PubMed: 22243905]
36. Cohen DA, Marsh T, Williamson S, et al. The potential for pocket parks to increase physical activity. Am J Health Promot. 2014; 28(3 Suppl):S19–26. http://dx.doi.org/10.4278/ajhp.130430-QUAN-213. [PubMed: 24380461]
37. Cohen DA, Han B, Derose KP, et al. Neighborhood poverty, park use, and park-based physical activity in a Southern California city. Soc Sci Med. 2012; 75(12):2317–2325. http://dx.doi.org/10.1016/j.socscimed.2012.08.036. [PubMed: 23010338]
38. Lee IM, Shiroma EJ, Lobelo F, Puska P, Blair SN, Katzmarzyk PT. Effect of physical inactivity on major non-communicable diseases worldwide: an analysis of burden of disease and life expectancy. Lancet. 2012; 380(9838):219–229. http://dx.doi.org/10.1016/S0140-6736(12)61031-9. [PubMed: 22818936]
39. TPL.. City Park Facts. 2014. 2014. www.tpl.org/2014-city-park-facts
40. WHO.. Health expenditure per capita (current US$). 2014. http://data.worldbank.org/indicator/SH.XPD.PCAP

Table 1

Descriptive Characteristics of the 174 Study Parks

	Mean (SD)	Median (IQR)
Park size (acres)	8.8 (5.5)	7.7 (8.5)
Population (1-mile radius)	24,200 (33,500)	12,400 (16,000)
Households in poverty (1-mile radius) (%)	19.8 (11.2)	17.8 (16.5)
Activity facilities (#)	9.6 (8.4)	7 (8)
Accessible target areas (#) [a]	20.4 (13.9)	16 (12)
Accessible target areas (%)	96.8 (6.2)	99.5 (4.6)
Target areas with supervised activities (#) [b]	5.2 (10.0)	0 (5)
Onsite marketing materials such as banners, signage, posters (% parks)	28% (0.45)	-
Moderate or more litter in parks observed at least once (% parks)	38% (0.49)	-
Homeless people observed at least once (% parks)	28% (0.45)	-
Food vendor observed at least once (% parks)	27% (0.45)	-
Dogs off leash observed at least once (% parks)	60% (0.49)	-
Moderate or more graffiti observed at least once (% parks)	9% (0.29)	-
Maximum temperature (F) [b]	78.7 (10.3)	80 (15)
Minimum temperature (F) [b]	56.4 (10.4)	57 (14)
Mean temperature (F) [b]	67.6 (9.6)	69 (14)

IQR, interquartile range

[a] During an hourly measurement.

[b] During 12 hourly measurements.

Table 2

Estimated Average Weekly Use and Average MVPA Time (Person-Hours) Among Target Area Facility Types [a,b]

Target area facility type	Parks with the facility (%)	Total weekly use (person-hours) [b]	Weekly MVPA person-hours among children and teens [b]	Weekly MVPA person-hours among adults and seniors [b]
Lawn	96.6	**55** ***	6	7
Play area	88.5	139	**41** ***	9
Basketball court (outdoor)	52.9	138	**45** ***	**24** ***
Picnic area	43.1	164	11	**12** **
Baseball field	49.4	**183** ***	**36** ***	**24** ***
Sports fields	35.1	158	**30** ***	**28** ***
Bleachers	40.2	113	6	5
Tennis	31.0	**58** **	8	**20** ***
Walking loop	28.7	**345** ***	**72** ***	**149** ***
Seating area	20.0	68	7	6
Pool	12.1	**301** ***	**72** ***	**39** ***
Dog park	4.6	139	4	**36** **
Skate park	5.2	**282** **	**72** ***	13
Exercise area	7.5	150	6	**51** ***
Gymnasium	9.2	**688** ***	**137** ***	**84** ***
Fitness zone	2.3	**193** **	**28** ***	**61** ***

Note: Boldface indicates statistical significance

*$p<0.05$.

MVPA, moderate-to-vigorous physical activity

[a] Assumes that a park is usable 7 days a week and 11 hours a day. All estimates have adjusted for the multi-stage survey sampling design. Estimates for bleachers were the marginal means across all parks. Estimates for other facility types controlled for park size, local population, poverty, observation time, and temporal correlation and were based on the comparisons with respect to bleachers.

[b] Significance level based on comparisons with bleachers.

*** $p<0.001$

** $p<0.01$

Table 3

Estimated Average Weekly Park Use and Time Spent in Moderate-to-Vigorous Physical Activity (MVPA) by Age Group and Gender in Person-Hours[a]

Weekly person-hours in park use				
	Percentage male person-hours in parks Total=867 (SE=153)	**Percentage males by age group in US population (2010)**	**Percentage female person-hours in parks Total=664 (SE=135)**	**Percentage females by age group in US population (2010)**
Children	**40.4%**	17.9%	**35.8%**	16.3%
Teens	**15.2%**	10.0%	**10.8%**	9.2%
Adults	**40.2%**	54.5%	**49.2%**	53.9%
Seniors	**4.2%**	17.7%	**4.2%**	20.4%

Weekly person-hours of MVPA in parks				
	Males (SE)	**Gender percentage within age group**	**Females (SE)**	**Gender percentage within age group**
All	361 (60)	**59.9%**	242 (55)	**40.1%**
Children	170 (34)	**59.2%**	117 (31)	**40.8%**
Teens	65 (11)	**68.4%**	30 (5)	**31.6%**
Adults	114 (18)	**56.7%**	87 (18)	**43.3%**
Seniors	12 (2)	**60.0%**	8 (2)	**40.0%**

Note: Boldface indicates statistical significance ($p<0.0001$); p-values are based on Chi-square tests (df=3)

MVPA, moderate-to-vigorous physical activity

[a]Assumes that a park is usable 7 days a week and 11 hours a day. All estimates have adjusted for the multi-stage survey sampling design.

Table 4

Negative Binomial Regression Models Predicting Total Park Use and MVPA Time in Parks[a]

	Total park use (person-hours)			
	Model 1		Model 2	
Factors	**β (SE)**	**exp (β)**	**β (SE)**	**exp (β)**
Park size in acres	**0.09 (0.01)*** **	1.09	0.01 (0.01)	1.01
Population density (per 10,000 in 1-mile radius)	**0.12 (0.02)*** **	1.13	**0.06 (0.03)***	1.07
% Households in poverty	**−0.01 (0.01)***	0.99	−0.01 (0.01)	0.99
Litters in parks			**0.25 (0.12)***	1.29
Homeless people in parks			0.20 (0.16)	1.22
Vendors in parks			**0.57 (0.12)*** **	1.77
Dogs unleashed in parks			0.09 (0.13)	1.09
Graffiti in parks			−0.08 (0.24)	0.92
# accessible target areas			**0.02 (0.01)** **	1.02
# target areas with supervised activities			**0.39 (0.03)*** **	1.48
Onsite marketing (banners, signage, posters)			**0.48 (0.16)** **	1.62

	MVPA time in parks (person-hours of MVPA)			
	Model 1		Model 2	
Factors	**β (SE)**	**exp (β)**	**β (SE)**	**exp (β)**
Park size in acres	**0.08 (0.01)*** **	1.08	0.00 (0.01)	1.00
Population density (1-mile radius)	**0.11 (0.02)*** **	1.11	**0.05 (0.02)***	1.05
% Households in poverty	−0.01 (0.01)	0.99	−0.01 (0.01)	0.99
Litters in parks			0.15 (0.12)	1.16
Homeless people in parks			0.08 (0.15)	1.08
Vendors in parks			**0.52 (0.11)*** **	1.68
Dogs unleashed in parks			0.12 (0.13)	1.13

Am J Prev Med. Author manuscript; available in PMC 2017 October 01.

	MVPA time in parks (person-hours of MVPA)			
	Model 1		Model 2	
Factors	**β (SE)**	**exp (β)**	**β (SE)**	**exp (β)**
Graffiti in parks			0.12 (0.24)	1.12
# accessible target areas			**0.02 (0.01)****	1.02
# target areas with supervised activities			**0.31 (0.03)*****	1.37
Onsite marketing (banners, signage, posters)			**0.49 (0.14)*****	1.63

Note: Boldface indicates statistical significance

MVPA, moderate-to-vigorous physical activity

*** $p<0.001$

** $p<0.01$

* $p<0.05$.

[a] Other variables controlled in the models included indicators for cities, days of a week, and hours in a day. Within-park correlations were adjusted by generalized estimation equation.