Published in final edited form as:

Am J Prev Med. 2013 November ; 45(5): 590–597. doi:10.1016/j.amepre.2013.06.015.

Increasing Physical Activity in Parks: Results of a Randomized Controlled Intervention Trial Using Community-Based Participatory Research

Deborah A. Cohen, MD, MPH,

Rand Corporation

Bing Han, PhD,

Rand Corporation

Kathryn Pitkin Derose, PhD, MPH,

Rand Corporation

Stephanie Williamson, BA,

Rand Corporation

Terry Marsh, MPH, and

Rand Corporation

Thomas L. McKenzie, PhD

San Diego State University

Abstract

Background—Physical inactivity is an important health risk factor that could be addressed at the community level.

Purpose—To determine whether using a community-based participatory approach with park directors and park advisory boards (PABs) could increase physical activity in local parks. We also tested whether involving PABs would be more effective than working with park directors alone.

Design—Randomized controlled intervention trial from 10/2007–4/2012 with partial blinding of observers to the condition.

Setting/Participants—Of 183 eligible parks in the City of Los Angeles, 50 neighborhood park/recreation centers serving diverse populations participated. Parks were randomized to three study arms, 1) Park-director intervention (PD-only), 2) Park Advisory Board intervention (PAB/PD), and 3) a control arm. We systematically observed physical activity in each park and interviewed park users and residents living within one mile of the park.

Intervention(s)—The intervention including assessing park use, obtaining feedback from park users and community residents, offering training on outreach and marketing, and giving each

Corresponding author: Deborah A. Cohen, MD, MPH, RAND Corporation, 1776 Main St, Santa Monica, CA 90407, 310 393-0411 ext 6023, fax 310 260-8175.

Conflict of interest: None of the authors have conflicts of interest to disclose. The work was supported by NHLBI # R01HL083869

intervention park \$4000 to increase park-based physical activity. The PAB/PD arm required participation and concurrence on all purchases by the PAB.

Main Outcome Measure(s)—Change in the number of park users and change in the level of physical activity, expressed as MET-hours.

Results—Relative to control parks where physical activity declined, in both the PD-only and PAB/PD parks physical activity increased, generating an estimated average of 600 more person visits/week/park, and 1830 MET-hours more physical activity/week/park. Both residents and park users reported increased frequency of exercise. No differences were noted between the PD-only and PAB/PD study arms.

Conclusions—Overall, providing feedback on park use and community perspectives and offering park directors training on outreach and marketing with modest discretionary funding increased the amount of physical activity observed in parks. Parks have an important role in supporting community level physical activity.

Introduction

Although most Americans live in communities with a network of parks and recreational facilities suited for moderate-to-vigorous physical activity (MVPA), the majority of Americans do not meet the national physical activity guidelines of 150 minutes/week for adults and 60 minutes/day for youth.¹ Observations of many public parks indicate they are underutilized, particularly by adults and seniors^{2–4} and most individuals using the park are sedentary there.^{5,6} Given that parks are intended to serve local communities, successfully addressing the underutilization of parks may require community input and participation.

Community-based participatory research (CBPR) is an approach involving community members and/or stakeholders with a continuum of engagement in participation in all stages of the research process^{7,8} and could be useful for designing interventions to reduce physical inactivity. However, previous studies using CBPR have often been limited to a single community, because of the substantial effort required to develop partnerships.^{7,9,10} Nevertheless, physical inactivity is a widespread problem; solutions should be scalable and effective across various types of parks and populations.

Public parks often already have infrastructure designed to provide community input in the form of park advisory boards (PABs), which play a role in planning and programming. Because both staff and community members may lack a broad perspective on park use, and understand it only through their own limited experience, this project was designed to bring objective research measurement methods into the community-based decision making process^{7,9,10} to inform efforts to increase park use and park-based physical activity. Given that previous research suggested that park use was declining,¹¹ the main study question was whether, with limited resources, parks could adjust their programming and outreach efforts to increase use if they had some benchmarks and better information about park use and local preferences. Given limited resources, however, the question of whether low-cost interventions could increase park-based PA remains unanswered. A secondary goal was to determine whether the involvement of PABs in making decisions on how to increase park

use and physical activity would be superior to those decisions made by park directors alone, given access to the same measurement tool and data.

Methods

Study Design

The study grew out of a previous collaborative research between RAND and the LA City Department of Recreation and Parks (LARAP)³ to address the underutilization of local neighborhood parks. LARAP provided a letter of support for a proposal responding to a call for health-related CBPR projects and was involved throughout all stages of the study. All study methods were approved by the RAND Human Subjects Protection Committee.

We randomized 51 parks in the City of Los Angeles to 3 study arms: a park director-led arm (PD-only), a combined Park Advisory Board-Park Director arm (PAB/PD), and a measurement-only or control arm. In the PD and PAB/PD arms, we worked closely with the PDs and PABs in all phases of the research; first, in design, implementation, and interpretation of baseline data collection and results, and, mostly importantly, in using the baseline results to design park-specific interventions aimed at increasing park use and physical activity. Of 183 neighborhood parks with recreation centers and full-time staff, we initially selected 51 based upon population racial and ethnic diversity in the 1-mile radius surrounding the park. These included 10 parks in neighborhoods with the highest percentage of Hispanics, 10 with the highest percentage of African Americans, 10 with the highest percentage of Asians, and 11 in neighborhoods where the distribution of any one racial and ethnic group did not exceed 50 percent of the population and had not been included in the prior 4 lists. After selecting the parks, we replaced two sites that were misclassified as neighborhood parks and checked for geographic diversity to make sure that all parts of the city were represented. We visited all 51 parks to check for comparability and safety issues. Among those visited, five were replaced because they were either under a gang injunction which limited park hours, or were located within a housing project with limited accessibility. To ensure relative equivalence among the three study arms, eligible parks were then randomized based upon park size, number of facilities and programs offered by the park, and the socio-demographic characteristics of the population in a 1-mile radius. One park randomized to the PAB/PD condition voted not to participate based upon concerns that the study findings might be used to change the current park conditions (See Figure 1). We calculated that this sample size ($n=17$ parks per study arm and 28 observations in each park) allowed for detecting a moderately small to medium effect size (.35~.55 SD) under the standard setting of $p\text{-value}<.05$ and $\text{power}>.80$ in two-sided tests, and if the intra-class correlation within a park was between 0 and .20.

Systematic Observations of Parks

We mapped each park and divided it into distinct target areas. We assessed each of the 50 parks during each of the seven days of a week at baseline between 04/28/2008 and 03/20/2010 and in the same season at follow-up 4/27/2010 and 04/02/2012 using methods consistent with the System for Observing Play and Recreation in Communities (SOPARC),¹² a validated method using momentary time sampling to assess the

characteristics of parks and their users, including their physical activity levels. All field staff were certified based upon their measurement accuracy and reliability. Park users were counted by gender, age group, apparent race/ethnicity, and physical activity level (sedentary, walking, vigorous) during systematic rotations through all target areas four times each day (early morning, mid-day, afternoon, and early evening) for each day of the week (28 observations per park at baseline and at follow-up). Additionally, during each observation, target areas were coded as to whether or not they provided direct supervision and organized activities. Generally, a rotation around target areas took no more than one hour, but if it took less than 30 minutes, the rotation was repeated and the counts were averaged for the two observations. Because it was not possible to tell if the same or different people visited the park during the different days and hours that were observed, we summarized park use in person-hour visits. In addition, we translated the levels of physical activity into MET-hours, a measure of energy expenditure with 1 MET-hour equivalent to the amount of energy spent to maintain the body at rest. We used 1.5 METs for sedentary activity (sitting or standing), 3.0 METs for walking or moderate activity, and 6 METs for vigorous activity.

Surveys of Park Users and Community Residents

We also interviewed a sample of 75 adult park users using a systematic selection method from the busiest and least busy target areas.² As well, we randomly selected households within 1 mile of each park, stratified by distances of 0–1/4 mile, 1/4–1/2 mile, and 1/2 –1 mile to interview about 25 individuals in each stratum, for a total of 75 resident interviews per park at baseline and follow-up. When households were inaccessible due to locked apartment buildings or gates we conducted interviews in front of retail outlets or bus stops, including only people who lived within a mile of the park. We asked about their use of the park and frequency of exercise.

Data Collection

All SOPARC observations and field surveys were conducted by seasoned, trained bilingual field staff (*promotoras*), the title for Spanish-speaking lay health workers.¹³ Except for 7 of the 16 PAB/PD parks where PAB members and/or local residents opted to serve as paid data collectors, and who typically administered surveys only, certified *promotoras* conducted the observations for all study arms. Except for these 7 PAB/PD parks, data collectors were blind to the study arm assignments.

Collaborative Intervention

After baseline assessment, we interpreted park-specific observation and survey results with the PD-only and PAB/PD parks, but not with the control parks, using the data to inform decisions about how to draw more users to the park and increase physical activity. In this way, the baseline results were a key part of the “intervention” in each park. In addition, we gave parks in both intervention arms \$4,000 each to spend in ways they thought appropriate to increasing physical activity in their particular parks. Given needs identified in baseline interviews with park directors, a marketing consultant provided five training sessions for park directors and PAB members on outreach, the importance of visibility and excellent customer service, and how to use special events to promote park programs. Finally, the

marketing consultant made a personal visit to each of the 33 intervention parks and, after touring the facilities, made specific recommendations on improving the park image, making it more user-friendly, building the customer base, and efficiently using the \$4000 to attract more users. The decision as to what specific park-based interventions were developed were left to the park directors and the PABS. Each park's district supervisor was required to sign off on proposed expenditures, and for the PAB/PD study arm, the PAB Board President also had to certify concurrence by the PAB.

To be able to explore whether there might be differences in outcomes due to park expenditures, we categorized park purchases into three groups: 1) signage, which included banners, bulletin boards, floor mats, staff shirts, table covers, water kegs, clipboards, staff aprons and walking path signage; 2) promotional incentives like water bottles, bags, or park-branded key chains or individually targeted email communications; and 3) outreach and support for group activities. This latter category included hiring additional instructors, buying class/activity materials, and purchases of equipment like shades, tents, movie screen/projector, cameras, and PA systems for events or concerts in park. We also documented external factors including changes in staffing as well as modifications or upgrades in facilities during the study period.

Statistical Analysis

Longitudinal park observations were analyzed using the difference-in-differences (DID) method to account for unobserved park and neighborhood characteristics as well as temporal trends. The temporal trends using the 28 observation periods per park per wave were modeled by a flexible mixed-effect approach using a fixed-effect mean temporal trend for each study arm and a park-specific trend by random effects. Both the mean and random trends used indicators for specific time of a day and day of a week and their interactions. The mean trend further includes indicators for seasons, waves, and wave by study arm interactions. This modeling specification was chosen for its superior performance in a 7-fold cross validation (leaving one day out for validation), among several alternatives including both simpler and more complex formulations. The overall treatment effect was examined by comparing the mean temporal trend of the two treatment arms and the control arm. We also calculated the average dollars spent for MET-hours gained. Detailed treatment effects were examined by comparing a single treatment arm with the control arm, and by comparing the observations among subpopulations. The relative effects of three categories of park purchases were also compared. Park-level characteristics (e.g., size) and time-varying covariates (e.g. temperature) were controlled by fixed effects. The mixed-effect model was fitted by PROC MIXED in SAS 9.2 (SAS Institute Inc, Cary, North Carolina).

Survey outcomes were also analyzed by the DID approach using the repeated-measure generalized linear models in PROC GENMOD in SAS 9.2 where the generalized estimating equation accounted for within-park correlations. Respondents' characteristics (e.g., gender, race, age) were controlled in these models. Since park users and local residents are different target populations, they were analyzed separately. Multiple comparisons for all intervention effects were adjusted by the step-up method to control for the false discovery rate, i.e., the expected ratio of type I errors among significant findings.¹⁴ Results for park observations

and survey outcomes were adjusted separately. Covariate effects were not adjusted for multiple comparisons since we did not aim to confirm any specific covariate effects. In sensitivity analyses, alternative modeling approaches examined the robustness of our findings. For park observations we examined alternative configurations of both fixed and random effects. For survey outcomes we examined the fixed-effect approach and post-stratification weighting. The main findings did not change.

Results

Park and Survey Participant Characteristics

The study arms were similar at baseline with respect to the factors on which they were randomized, including socio-demographic characteristics of the 1-mile neighborhoods and park characteristics, including size, facilities, and staffing (Table 1).

Table 2 reports the socio-demographic characteristics of respondents from the park user and household surveys (combining baseline and follow-up) by study arm. The response rate in parks was 61% and for households and street surveys 66%. In all cases, more females than males were surveyed. Although the percentage of household surveys from Hispanics was similar to the percentage of Hispanics from the census (data not shown), the park users who reported they were Hispanic were oversampled. However, the average age was similar across the study arms.

Park Purchases Intended to Increase Physical Activity

The majority of parks invested their funds in multiple categories, implementing more than one specific change within each category. However, 51% of funds was spent on signage and 32 of the 33 intervention parks purchased signs and banners inviting the public to participate in a wide variety of park-sponsored activities. Among all the parks, 28% was spent on materials and labor related to increasing group activities (20 parks investing in this category), and 21% on incentives like giveaways (18 parks investing). The investments in the various categories did not differ between the PD-only and PAB/PD study arms.

Changes in Park Use and Observed and Self-Reported Physical Activity

Over the study period, the control parks saw a marginal secular decline of 6–10% in the number of users ($p=.06$) and the energy expended ($p=.07$), at the magnitude of 140 fewer person-hour visits per week in each park, expending an average of 325 fewer MET-hours. In contrast, both the PD-only and PAB/PD treatment arms had increases in the number of person-hour visits and energy expended, but these changes were not significantly different between PD-only and PAB/PD parks. Using a DID analysis and comparing the combined treatment arms to the control arm, we found a relative increase in park use at the magnitude of 7–12%, or 196 person-hour visits/week per park over the 28 observations ($p=.035$, false discovery rate $<.10$). Energy expenditure increased by 610 MET-hours ($p=.006$, false discovery rate $<.05$). Since the 28 observation times represent less than 1/3 of the hours the parks were open, the total increase per park is likely to be three times higher, a gain of about 1830 MET-hours/week. The two intervention arms had very similar changes (Table 3).

Covariates that were significantly associated with increased number of person-hour visits and MET-hours expended included summer season, higher average temperature, greater population density, larger number of park facilities, more accessible areas, and more supervised and organized activities. Park size (acreage) did not appear to affect the change in park use or energy expenditure, nor did the number of full time staff, which did not vary considerably across the parks.

Relative to the control parks, the combined PAB/PD and PD-only arms saw increases in the number of males and their energy expenditure in the parks. The largest increases were among children, non-Hispanic whites with marginally significant increases among African Americans (Table 4).

The primary mediator of the change was the investment in signage, which explained 37% of the change in park users and 39% of the increase in MET-hours (Table 4). Neighborhood poverty had no independent effect on the intervention and was entirely mediated by other covariates, especially the number of organized and supervised activities, park facilities, and population density (data not shown).

The number of reported weekly exercise sessions increased among both park users and residents near the intervention parks, and the reported frequency of intervention park visits increased among park users, but park use duration was down among residents (Table 5).

Economic Analysis

If the effect of the intervention lasted at least 20 weeks, and the cost of the intervention is \$5,000/park (\$1000 for staff training and assessment of park practices and \$4000 for purchases) the cost-effectiveness is approximately \$0.14 per MET-hour gained. If the assessment of park use and surveys of users and residents are included (about \$5000), the cost per MET-hour gained would be \$0.28. Previous benchmarks considered a physical activity intervention as cost-effective if the cost was less than \$0.50-\$1.00/MET-hour.¹⁵ Each MET-hour gained is roughly equivalent to a person engaging in MVPA for about 15 minutes.

Discussion

This is the first RCT of a park-based physical activity intervention demonstrating increased physical activity at the population level. We did not follow a cohort of individuals, but instead have serial cross-sectional data from individuals that support our systematic observations of park use. Although individual desire and motivation are often conceptualized as the driving forces for physical activity, there is a large body of evidence indicating that environmental cues influence and change individual behavior, including physical activity.^{16,17} When physical activity opportunities and reminders become more salient, whether they be overt signs or notices for classes, leagues, or new walking paths, they may lead people to consider becoming active, especially if they are already in a park.

An increase in physical activity among the Finnish population over the past few decades has been attributed, in part, to the emphasis on local parks and sports facilities as well as seed

money for promoting physical activity at the municipal level.¹⁸ In contrast, many U.S. municipalities have reduced their support for public physical activity programs and facilities, which was also the case in Los Angeles.¹⁹ During the course of the study, all 50 parks suffered substantial budget cuts, and each park lost staff and had to reduce hours of operation, explaining physical activity declines in comparison parks.

It is perhaps even more notable, then, that within this context of park and recreation budget reductions, we found that working with park directors and PABs in a participatory fashion had a positive impact on levels of park-based physical activity. Yet involving PABs in resource allocation decisions did not appear to be superior to working with the park directors alone. There are several possible reasons: 1) the information provided and the process followed with the two intervention groups (PD-only vs. PAB/PD) was very similar, 2) the investment decisions made by the individual parks were similar, 3) PAB members were invited to participate in the marketing and outreach training, but most did not, 4) some PAB members did not appear to be wholeheartedly supportive of the project goals, and 5) some park directors in the PD-only condition may have consulted PAB members when allocating intervention funds. Further, the role of PABs in park operations is fairly limited, with members typically focused on their own or their children's participation in specific park activities.

Among the interventions implemented, signage was likely effective because of the role it plays in making the park more salient. In a study of desire, Hofmann et al. found that people desired to participate in sports only about 2.6% of their waking hours and that people were sensitive to situational cues that influenced their ability to follow-through or resist these desires.²⁰ Many other studies, albeit with a focus only on stair climbing, have shown that signs are effective cues that can increase physical activity.^{16,21,22} That most of the impact appeared to be concentrated among existing park users, suggests that putting reminders and signs in areas outside the park may be necessary to recruit new users to the park.

During the course of the study, some parks had renovations and many lost staff and changed park directors. Three intervention and two comparison parks had new or improved skate parks, five intervention and five comparison parks had outdoor fitness equipment installed, and 26 parks experienced a director change due to retirement or transfer, with several of them having multiple transfers. These changes occurred in all study arms and hence were not confounded with the intervention arm. We also examined these potential confounders in the sensitivity analysis and did not have notable changes in the main findings.

The higher proportion of Hispanics interviewed than observed in parks may reflect an inadvertent bias of bilingual staff to oversample individuals of their same ethnicity, but also a bias of respondents to participate. This oversampling was taken into account by two methods in the analysis as well as the sensitivity analysis. Furthermore, the reliability of observing apparent race/ethnicity is lower than the observations of other individual characteristics.¹² Nevertheless, documenting race/ethnicity may illuminate issues related to health disparities and meeting population needs.

Limitations

An important limitation of our methods is that observers were not able to record detailed physical activity levels by age and race. Because of this, we cannot precisely determine which subpopulations benefited most as far as increases in MVPA. In addition, our assessment occurred only over a 1 week post-intervention conducted in the same season as at baseline and not timed to precisely follow the intervention implementation. It is possible that we did not capture the full impact of interventions, if the impact was greatest at the time of implementation. In addition, data collectors were not blinded to the condition in seven parks at baseline, which might have inadvertently biased the assessment.

Conclusion

Parks have a large, untapped potential to increase population physical activity. Community facilities can stimulate users to increase their levels of physical activity, but doing so requires attention to marketing and outreach with modest investments.

Acknowledgments

This study was funded by NHLBI # R01HL083869.

References

1. Troiano RP, Berrigan D, Dodd KW, Mâsse LC, Tilert T, McDowell M. Physical activity in the United States measured by accelerometer. *Med Sci Sports Exerc.* Jan; 2008 40(1):181–188. [PubMed: 18091006]
2. Cohen, D.; Sehgal, A.; Williamson, S., et al. *Park Use and Physical Activity in a Sample of Public Parks in the City of Los Angeles.* Santa Monica: RAND; 2006.
3. Cohen DA, Marsh T, Williamson S, et al. Parks and Physical Activity: Why are Some Parks Used More than Others? *Prev Med.* 2010; 50(Suppl 1):S9–S12. (Epub 2009 Oct 19. PMC2821457):S9–12. [PubMed: 19850067]
4. 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. *Journal of physical activity & health.* Sep.2011 8:S151–S160. [PubMed: 21918228]
5. Floyd MF, Bocarro JN, Smith WR, et al. Park-Based Physical Activity Among Children and Adolescents. *Am J Prev Med.* Sep; 2011 41(3):258–265. [PubMed: 21855739]
6. Floyd MF, Spengler JO, Maddock JE, Gobster PH, Suau LJ. Park-based physical activity in diverse communities of two U.S. cities. An observational study. *Am J Prev Med.* Apr; 2008 34(4):299–305. [PubMed: 18374243]
7. Israel BA, Schulz AJ, Parker EA, et al. Review of community-based research: Assessing partnership approaches to improve public health. *Ann Rev Public Health.* 1998; 19:173–202. 19:173–202. [PubMed: 9611617]
8. Green L. From research to "best practices" in other settings and populations. *Am J Health Behav.* 2001; 25(3):165–178. [PubMed: 11322614]
9. Minkler M, Blackwell AG, Thompson M, Tamir H. Community-based participatory research: implications for public health funding. *Am J Public Health.* Aug; 2003 93(8):1210–1213. [PubMed: 12893597]
10. Wandersman, A.; Chavis, D. P. S. Involving citizens in research. In: Kidd, R.; Saks, M., editors. *Advances in applied social psychology.* Vol. 2. Hillsdale, NJ: Erlbaum; 1983.
11. Cohen, D.; McKenzie, TL.; Sehgal, A.; Marsh, T.; Williamson, S.; Golinelli, D. *Active Living Research.* Washington, DC: 2008. Effects of Park Improvements on Park Use and Physical Activity: Policy and Programming Implications.

12. McKenzie TL, Cohen DA, Sehgal A, Williamson S, Golinelli D. System for Observing Parks and Recreation in Communities (SOPARC): Reliability and feasibility measures. *Jl of Physical Activity and Health*. 2006; 3(Suppl 1):S208–S222.
13. St John JA, Johnson CM, Sharkey JR, Dean WR, Arandia G. Empowerment of Promotoras as Promotora-Researchers in the Comidas Saludables & Gente Sana en las Colonias del Sur de Tejas (Healthy Food and Healthy People in South Texas Colonias) Program. *J Prim Prev*. Feb 13.2013
14. Benjamini H. Controlling the false discovery rate: a practical and powerful approach to multiple testing. *J. Royal Stat.* 1995; B:57.
15. Wu S, Cohen D, Shi Y, Pearson M, Sturm R. Economic analysis of physical activity interventions. *Am J Prev Med*. 2011; 40(2):149–158. [PubMed: 21238863]
16. Andersen RE, Franckowiak SC, Snyder J, Bartlett SJ, Fontaine KR. Can Inexpensive Signs Encourage the Use of Stairs? Results from a Community Intervention. *Ann Intern Med*. 1998 Sep 1; 129(5):363–369. 1998. [PubMed: 9735063]
17. Kahn EB, Ramsey LT, Brownson RC, et al. The effectiveness of interventions to increase physical activity. A systematic review. *Am J Prev Med*. May; 2002 22 Suppl(4):73–107. [PubMed: 11985936]
18. Vuori I, Lankenau B, Pratt M. Physical activity policy and program development: the experience in Finland. *Public health reports*. May-Jun;2004 119(3):331–345. [PubMed: 15158112]
19. NRPA. 2010. Economic Update Survey Report; <http://www.nrpa.org/uploadedFiles/Economic%20Update%20Survey%20Report%20-%20Spring%202010.pdf>
20. Hofmann W, Vohs KD, Baumeister RF. What people desire, feel conflicted about, and try to resist in everyday life. *Psychological Science*. 2012; 23(6):582–588. [PubMed: 22547657]
21. Nocon M, Muller-Riemenschneider F, Nitzschke K, Willich SN. Review Article: Increasing physical activity with point-of-choice prompts--a systematic review. *Scand J Public Health*. Aug; 2010 38(6):633–638. [PubMed: 20601438]
22. Russell WD, Dzewaltowski DA, Ryan GJ. The effectiveness of a point-of-decision prompt in deterring sedentary behavior. *Am J Health Promot*. May-Jun;1999 13(5):257–259. ii. [PubMed: 10538638]

Figure 1.
Profile of Randomized Controlled Trial

Table 1Characteristics of Parks at Baseline (N=50)^a

	PAB/PD parks (n=16)	PD-Only Parks (n=17)	Control Parks (n=17)
Park Neighborhoods			
% households in poverty	22.9 (12.6)	23.7 (12.9)	24.2 (12.6)
% African American	12.7 (16.8)	11.6 (16.0)	14.5 (19.1)
% White	45.4 (25.9)	43.2 (23.0)	40.4 (24.7)
% Hispanic	44.7 (18.5)	47.8 (24.7)	50.6 (28.7)
Population in 1 mile (in thousands)	35 (17)	41 (26)	41 (28)
Park Characteristics			
Acres	12.1 (15.5)	13.6 (16.8)	13.2 (11.3)
# of areas	33.7 (15.0)	33.2 (15.1)	35.2 (16.5)
# of sports fields	2.1 (1.9)	2.4 (1.7)	2.2 (1.4)
# facilities	8.9 (3.8)	10.8 (3.8)	10.7 (3.8)
# full time staff	2.4 (0.8)	2.4 (0.6)	2.2 (0.5)
# part-time staff	14.8 (9.2)	13.6 (16.8)	15.1 (10.3)
# PAB members	7 (5.1)	6 (2.9)	6 (5.2)
# unique programs	10.4 (3.3)	9.9 (2.8)	9.5 (3.4)
# of participants	2663 (917)	1302 (776)	936 (745)
% with after school program	30.8	20.0	37.5
% in residential areas	37.5	47.1	52.9
Park Observations (7 days)			
# park users observed (in thousands)	1.93 (1.20)	1.97 (1.21)	2.34 (1.18)
# observed per acre (in thousands)	0.32 (0.27)	0.24 (0.15)	0.23 (0.14)
% male users	60.6	62.7	62.8
% Hispanic users	50.0	62.0	58.6
% White users	30.3	22.2	21.9
% African American users	9.6	9.1	14.9
% Asian/other users	10.1	6.7	4.6
# of organized activity sessions ^b	23.5 (20.0)	25.7 (14.9)	22.4 (17.5)
# of supervised activity sessions ^b	14.8 (11.0)	14.1 (9.2)	16.0 (13.6)
% areas accessible	88.5 (6.6)	90.5 (4.8)	89.7 (7.6)
% common areas empty ^c	62.0 (14.8)	63.0 (10.3)	57.8 (10.8)

^aValues are reported as mean (SD) or sample proportion for binary park-level characteristics. There is no significant mean difference across the study arms in any observed characteristics (tested by 1-way ANOVA).

^bEach observation time counts as a session.

^cCommon areas include sports fields, playgrounds, gym, basketball courts and sport-specific areas.

Table 2

Characteristics of the survey respondents (combined, baseline and follow-up)^a

	Park Users			Local Residents		
	PAB/PD	PD-only	Control	PAB/PD	PD-only	Control
Sample size	2,539	2,441	2,771	2,240	2,552	2,719
Gender (% male) ^a	37.7	38.3	36.0	40.3	39.9	37.1
Mean age (SD)	38.5 (12.4)	38.7 (12.4)	38.8 (11.8)	43.5 (13.9)	42.6 (13.6)	42.6 (13.2)
Self-Reported Race/Ethnicity						
% Hispanic ^a	64.9	74.8	76.8	56.4	62.6	63.9
% White	20.9	16.1	13.9	25.1	20.7	18.5
% African American	6.9	5.3	6.0	10.8	10.5	11.0
% Asian/Other	7.3	3.8	3.3	7.7	6.2	6.6

^aThere are more females and Hispanics in the respondents partly due to their relatively higher accessibility for interview than other subgroups.

Table 3

Estimated overall and subgroup DID intervention impacts on park observations (28 times per week)

	# users (SE)	#MET-hours (SE)
Overall	196 (92)*	610 (224)**
Study arms		
PAB/PD	212 (109)	644 (263)*
PD-only	182 (106)	582 (258)*
Genders		
Females	53 (45)	171 (104)
Males	143 (56)**	442 (146)**
Age groups		
Children	120 (39)**	— ^a
Teens	8 (28)	— ^a
Adults	56 (50)	— ^a
Seniors	8 (11)	— ^a
Races		
White	146 (48)**	— ^a
Black	53 (25)*	— ^a
Hispanic	−22 (67)	— ^a
Other races	−17 (14)	— ^a
Expenditure types (per \$1000) ^b		
Signage	73 (31)*	235 (76)**
Incentives	8 (47)	42 (112)
Group activities	56 (39)	148 (92)

* Significant at false discovery rate <.10

** Significant at false discovery rate < .05

^aPhysical activity levels by these groups not observed^bAll interventions parks had a total expenditure of approximately \$4k. Results cannot be extrapolated out of this range.

Table 4

Controlled covariates in estimating the overall intervention effects in 28 observation times per week

	# users (SE)	#MET-hours (SE)
Land use type (commercial vs residential)	179 (188)	532 (465)
Average temperature (F)	50 (39)	78 (94)
Average temperature squared	−0.3 (0.3)	−0.4 (0.7)
Acres	8 (8)	36 (22)
Population within 1-mile radius (10k)	101 (39) **	277 (92) **
# facilities	45 (20) *	179 (48) ***
# accessible areas	33 (8) ***	64 (22) **
# inaccessible areas	14 (14)	17 (34)
Fall	196 (154)	647 (372)
Spring	196 (171)	243 (414)
Summer	759 (188) ***	1940 (456) ***
Winter	-	-
Supervised activities ^a	85 (8) ***	238 (19) ***
Organized activities ^a	84 (10) ***	154 (24) ***

^a Assume only one target area has activities in one observation time of a day.

*** Raw p-value<.001

** raw p-value<.01

* raw p-value<.05

Table 5

Estimated overall DID intervention impacts on self-reported physical activity and park use

Survey outcome	Estimates (SE) ^a	
	Residents	Park users
Frequency of park use	-0.12 (0.06)	0.14 (0.04) **
# days doing exercise in a week	0.18 (0.05) **	0.29 (0.04) **
Perception of safety (safe=1)	0.23 (0.25)	0.48 (0.27)
Knowing park staff (knowing =1)	-0.15 (0.11)	0.06 (0.11)
Visit duration among those who report using parks	-0.14 (0.05) **	0.00 (0.04)
Child program participation (participate =1)	0.35 (0.28)	0.12 (0.12)
Program participation (participate=1)	-0.17 (0.22)	0.23 (0.17)

^a Most effects are in the logit scale except for self-reported visit duration.

^b Effects are in hours.

* Significant at false discovery rate <.10

** Significant at false discovery rate < 0.05