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Quantifying the Contribution of Neighborhood Parks to Physical Activity

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Abstract

Objective—To quantify the contribution of U.S. neighborhood parks to the time spent in moderate-to-vigorous physical activity (MVPA) by the local population.

Methods—Observational data on the use of 10 parks in five US cities collected during summer and fall 2008 were analyzed by a model-averaging approach. Estimated MVPA time accrued in parks was compared to estimated total MVPA time accrued by the local population, based upon national estimates.

Results—On average, parks provided roughly 4,000 hours of use and 1,500 MVPA hours per week. Park use accounted for approximately 50% of the vigorous physical activity (VPA) time ofthose living within 0.5 miles of the park and 16% of those living within 1.0 miles of the park. Parks accounted for a modest proportion of moderate physical activity (MPA) time, about 14% and 4% for those living within 0.5 miles and 1.0 miles of the park, respectively.

Conclusion—Parks have significant roles in supporting vigorous physical activity of the local population. Because they are underutilized and vigorous activity is critical to child development and adult physical fitness, efforts should be made to promote vigorous activity within local parks.

INTRODUCTION

Physical inactivity increases the risk and severity of multiple chronic diseases and is the underlying cause of over 10% of deaths in the United States (Lee et al., 2012). National guidelines call for children to accrue at least 60 minutes of moderate-to-vigorous physical activity (MVPA) daily and for adults to accrue at least 150 minutes per week (USDHHS, 2008). Moderate physical activity (MPA) is generally achieved in utilitarian daily routines (e.g. walking briskly). Vigorous physical activity (VPA), such as running, jogging, and playing soccer or tennis, is typically obtained during leisure time. VPA is especially important to the growth and development of children's bones and muscles, and is also

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important for development and maintenance of physical fitness and cardiovascular health in adults (USDHHS, 2008).

Neighborhood parks are a recreational and social focus of communities (Mertes and Hall, 1996). Parks can support MVPA for their users in a variety of ways including: (a) providing attractive facilities (e.g., tennis courts, basketball courts, walking paths) where people can be active on their own, (b) sponsoring physical activity events, sports competitions, and exercise classes, and (c) serving as a gathering place for social groups and clubs.

The existing literature on MVPA in parks focuses on the differences among parks, but little is known about the absolute amount of physical activity they facilitate among the populations they serve (Cohen et al., 2007). Understanding how much parks currently contribute to population MVPA helps provide a baseline for future interventions and surveillance efforts. This information is particularly important in light of the limited number of Americans who currently meet the MVPA guidelines (i.e., fewer than 5% of adults, 9% of teens and 42% of children) according to the 2003-2004 NHANES accelerometer data (Troiano et al., 2008).

Studies to document park use and park-based energy expenditure have relied on systematic momentary assessment, which is a snapshot of park use taken at a single moment [e.g., Cohen et al. (2007), Cohen et al. (2012), Parra et al. (2010), Shores and West (2010), Suau et al. (2012), Tester and Baker (2009)]. Multiple snapshots of representative times and days can provide a general picture of park use. The total use time of a park comprises the absolute amount of sedentary, moderate, and vigorous activity occurring in a park. Until now, park use time has not been accurately assessed. This paper fills this gap in the literature by studying the roles of 10 neighborhood parks in supporting their local population's MVPA using a unique data set, which comprised hourly observations of park use over two weeks, mostly during summer and fall of 2008.

METHODS

Data collection protocol

Trained assessors used the System of Observing Play and Recreation in Communities (SOPARC) to measure the physical activity levels and other characteristics of park users and park contextual information (McKenzie et al., 2006). With SOPARC, parks are divided into target areas, each of which usually has a unique functionality (e.g., playground, tennis court). During a scan (i.e., an observation sweep moving from left to right) of a target area, the physical activity of each individual present is coded using momentary time sampling as sedentary (i.e., lying down, sitting), walking, or vigorous (e.g., jogging, running). The physical activity levels are observed separately for males and females. However, due to the difficulty in observing people in motion, we could not disaggregate the activity levels of individuals by age group or race. The activity codes used have been validated using heart rate monitoring and by accelerometry in physical education classes and leisure time with children and youths in kindergarten through twelfth grade (McKenzie et al., 1991, Sallis et al., 2003), and they are consistent with published energy expenditures for adults (Ainsworth et al., 2000). Scanning all target areas in a park consecutively yields a transient measurement for the how much sedentary, moderate, and vigorous activity occurs within a park's boundaries.

Data source and measurements

We selected two neighborhood parks from each of five cities that provided for geographic, meteorological, demographic, and socio-economic diversity, including Los Angeles, CA (West), Albuquerque, NM (Southwest), Durham, NC (Southeast), Columbus, OH

(Midwest), and Philadelphia, PA (Northeast). Table 1 describes the diverse characteristics of the 10 parks which ranged from 4.7 to 13 acres and had between 8 and 20 physical activity facilities. Socio-demographic characteristics of the 1-mile area surrounding the park (US Census, 2000) showed that there was a 10-fold difference across parks in the population living within a 0.5 mile or 1.0-mile radius of the park. The percentage of households in poverty within the 1.0-mile radius varied between 6.2% and 32.5%.

The 10 study parks were mapped according to an established protocol (McKenzie et al., 2006) into 274 discrete target areas. Each target area was observed hourly 14 times per day and for 14 days during clement weather (e.g., no precipitation). Since a full scan of a park required approximately 25 to 50 minutes depending on its size and use, the smallest feasible interval between two adjacent observation times was approximately one hour. To investigate week-to-week variability, we conducted observations in the first park of Los Angeles for two consecutive weeks during the summer. After finding a similar pattern of use across the two weeks in that one season, we opted to observe the remaining 9 parks in two different seasons, summer and fall. For that reason, only one Los Angeles park was observed during summer and fall.

A systematic sample of park users (75-150 per park) was recruited for interviews, and they reported the intersection nearest their house, how often they visited, how long they stayed, and whether they usually exercised in the park during their leisure time. Recruitment was based upon park target areas, with users both in the busiest and least busy areas invited for participation.

Statistical analysis (conducted in September 2012)

Estimating the total MVPA time in parks—The mean cumulative park-based MVPA time, denoted by $E(M)$, was first estimated by a linear quadrature method, i.e. $M = \int_1^{14} Y(t)\,dt \approx \frac{1}{2}Y(1) + \frac{1}{2}Y(14) + \Sigma_{t=2}^{13} Y(t) = S$, where $Y(t)$ is the real-time count of park users engaging in MVPA at time t, and S is a weighted sum of all snapshot observations $Y(t)$, t=1,2,…,14. The first observation began at 6:30am (t=1) and the last one began at 7:30pm (t=14). The simple one-sample estimation for $E(S)$ provided an approximation for $E(M)$.

Next, a cubic Poisson regression model was fitted to estimate the mean function $E[Y(t)]$ over time t, i.e., $\mathbf{\log(E[Y(t)]) = \beta_0 + \beta_1 t + \beta_2 t^2 + \beta_3 t^3}$. We chose the cubic function because the trajectory of park use had a sophisticated shape and 14 time points cannot safely support higher-order fitting. After fitting the regression, $E(M)$ was estimated by numeric integration of $\mathbf{E[Y(t)]}$.

Finally, the two estimates above were aggregated by the model-averaging approach using the precision weight (Buckland et al., 1997). Estimates were further extrapolated from the last observed time point at 7:30pm by a linear decreasing rate (dropping 33% at 8:30pm and 66% at 9:30pm), since parks often had users until the close time at 10pm. Hours earlier than 6:30am were not extrapolated, since few park users were ever present at 6:30am. The extrapolation increased the estimates of total MVPA time in parks only slightly (<10%). Because weekends had different use patterns than weekdays (Cohen et al., 2011), they were analyzed separately and aggregated.

Estimating the total MVPA time accrued by the local population—The total MVPA time accrued by the local population was estimated by strata formed by gender and age groups. Within each stratum, we used the national average MVPA time reported in Troiano et al. (2008) which is based on the 2003-2004 NHANES accelerometer data with

6,239 participants. Local population data within 0.5- and 1.0-mile radius of the registered address of each park by gender and age strata were obtained from the 2010 U.S. census. The product of the average MVPA time and the population count is the estimated total accrued MVPA in a stratum. Aggregating across all age by gender strata yielded the total MVPA time accrued by the local population.

Estimating the contribution of parks to the local population's MVPA time— Because not all park users were from the local area, a direct comparison between the park-based MVPA time and the total MVPA time in the local population would overestimate the contribution of parks to local population. Thus, the park-based MVPA time was adjusted by a factor that reflected the proportion of local users in parks (see Table 3). These adjustment factors were based on the surveys conducted in the parks. Specifically, for MPA the factor was the proportion of respondents whose residential addresses (as the closest street intersection) were within the local boundaries (0.5 miles or 1.0 miles from the park address). The adjustment factor for VPA was the same proportion, but restricted to respondents who reported engaging in exercise during their leisure time.

RESULTS

Figure 1 presents the estimated total sedentary and MVPA time by gender in the 10 study parks. On average, a park had approximately 4,000 person-hours of use in a week (mean≈4,090 and median≈3,750), but there was great variation across the parks (SD≈2,100, IQR≈3,740, min≈1,260, max≈7,300). The proportion of park-use time in MVPA varied between 35 to 46% among parks. On average, a park had approximately 1,500 person-hours in MVPA per week (mean≈1,550 and median≈1,530), with between-park variations in MVPA time also being large (SD≈730, IQR≈1,260, min≈580, max≈2,680). Since survey respondents reported their average duration of a park visit to be less than 2 hours and approximately 55% reported no more than one visit to their neighborhood park a week (Cohen et al., 2012), on average a park likely hosted hundreds of unique users and a couple thousand visits per week.

Figure 2 presents the estimated total MVPA time accrued by local populations based on the average MVPA estimates from NHANES accelerometer data. These estimates are essentially weighted sums for the population by age and gender strata, where weights are the mean MVPA time in each gender by age stratum.

Table 2 presents the ratio of adjusted park-based MVPA time (right panel in Figure 1 adjusted by the factors in Table 3) versus the total MVPA time for the local population (Figure 2). These ratios measure the relative contribution of parks to the total MVPA level of the local population. In particular, the high values for park "OH 1" are a reflection of a children's camp held during the summer measurement period when many were there for extended hours throughout the day.

According to the ratios in Table 2, a park's strongest contribution to MVPA is VPA, with MPA facilitated to a much lesser degree. On average, roughly 50% of VPA time of the local population living within a half-mile radius of neighborhood parks may have occurred in it. The parks' contribution to VPA was smaller but still sizeable (approximately 16% on average) for those living within a one-mile radius. Parks may have accounted for only a modest proportion of MPA, about 14% and 4% for those living within 0.5 miles and 1.0 miles of the park, respectively.

The bivariate correlations between park-based physical activity time and the park-level factors, including park size and facilities, staffing and population, and others, were mostly weak to moderately weak (<0.4) but had three exceptions. First, the total VPA time had a moderately strong correlation with the local population size (between .68 and .86; and higher for males than females and higher for those living closer to the park). Second, there are moderate correlations between total use time and the number of part time staff (between .4 and .65, and higher for males than females). Third, larger parks contributed less to MVPA than smaller parks in our study, with moderately negative correlations between park size and MVPA on the order of −.4 to −.6.

DISCUSSION

Although there was substantial variation in park use due to differences in park size, programming and facilities in our sample, we estimated that approximately 50% of all VPA engaged in by residents living within a half mile radius occurs within the boundaries of the local neighborhood park. Parks are typically designed to include facilities and open spaces specifically created for VPA, such as competitive sports or recreational play. The difference between the contributions of parks to the MPA time versus the VPA time is not surprising, since most MPA occurs during work or daily utilitarian activities, rather than in leisure time or exercise sessions. The concentration of VPA in this setting suggests the potentially important role that parks play in individual health and development.

The finding that the population within a 0.5-mile radius may benefit more from a park than those living further away offers some support to the idea that parks are needed within 0.5-mile of everyone’s home. However, this finding is potentially an artifact in this study, due to ecological fallacy. We do not have a way to distinguish whether individuals living within the 0.5-mile radius were in fact those who were engaging in VPA. Other studies have noted that many users travelled more than one mile to visit a park (Cohen et al., 2007), and one study found adolescent girls to visit parks 5 miles from their home more frequently than those within one-half mile of home (Evenson et al., 2012). Finding ways to increase the use of existing parks might be more cost-effective than developing entirely new parks.

The positive correlation between park-based VPA and population density suggests that park use is proportional to the number of potential users. The number of part-time park staff is likely to be associated with the number of activities in the park, and this could explain the positive correlation between the number of part-time staff and total park use time. The negative association between park size and its contribution to MVPA is very likely an artifact caused by the two large NC parks (11 acres) which had relatively few users and low local population densities. In general, the generally low bivariate correlations are likely due to the small number of parks and cities in the dataset, as well as a lack of variation in some park-level characteristics (e.g., 8 of the 10 parks had 13 to 15 facilities).

This study has several limitations. First, the observations focused on MVPA that occurred only within the parks. Evenson et al. (2012) suggested that some park users may expended 50-100% more energy getting to and from parks than they do in them. Second, the park use adjustment factors were based upon only a small sample of users for each park and thus had limited accuracy. Third, the NHANES data did not account for seasonal or geographical differences, and so may not accurately fit the populations of the five cities in this study. Our observations were only taken during clement weather and during two seasons, potentially inflating the estimates of parks’ contribution to MVPA. Last, observers did not record physical activity levels by age, precluding estimates for parks’ contribution to MVPA by age group.

CONCLUSION

Parks play a notable role in contributing to the VPA time accrued by the local population. Since many parks are underutilized (Cohen et al., 2010), there is great potential for them to augment current physical activity levels. Because VPA is critical to people of all ages, the results suggest that more attention should be paid to expanding opportunities for VPA in park settings.

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Highlights

- Among the first few to investigate the contribution of US parks to MVPA
- Found parks' significant role in supporting local residents' vigorous activity
- Providing a strong evidence for park-based efforts to promote community health

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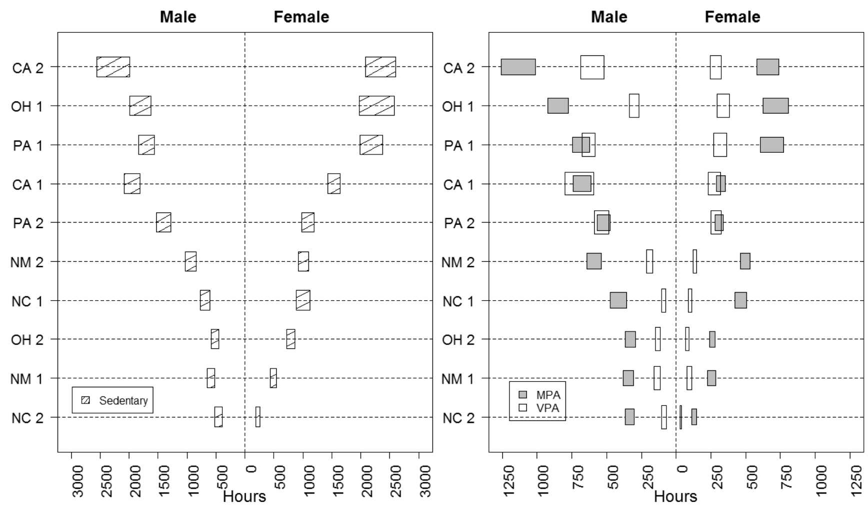

Figure 1.

Estimated total park use time during one week (confidence intervals). Left panel shows sedentary time and right panel shows MVPA time.

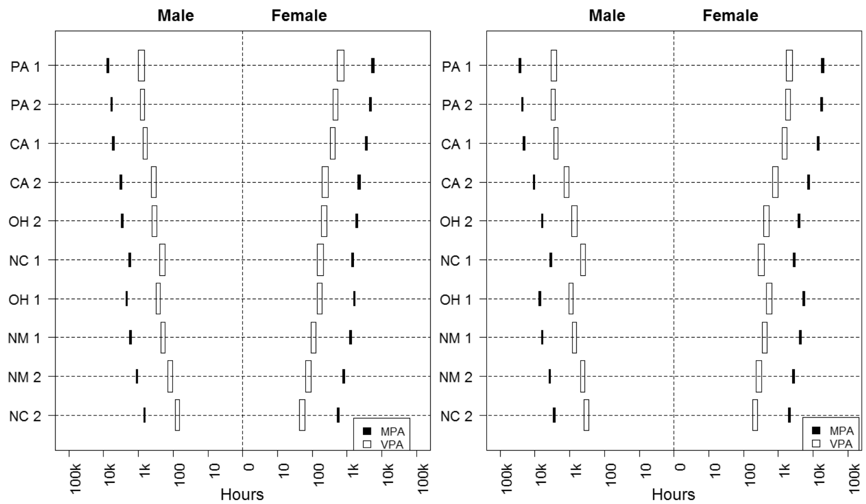

Figure 2.

Estimated total MVPA time accrued by the local residents during one week (confidence intervals). Left panel is for ½ mile radius, and right panel is for 1 mile radius. Note the x-axis is in $\log_{10}$ scale.

Table 1

Characteristics of the 10 study parks

Park ID	Size (acres)	# facilities	Staffing: Full time	Staffing: Part time	Population: ½-mile radius	Population: 1-mile radius	% Households in poverty[a]
OH 1	5.8	16	3	4	4857	16362	14.4
OH 2	13	13	4	20	6363	12970	6.8
NM 1	7	14	0	0	4179	14193	9.9
NM 2	8	8	0	0	2638	8907	24.9
PA 1	6.7	13	2	35	17979	62665	16.8
PA 2	7	13	3	15	13727	51140	32.5
NC 1	11	13	6	0	4307	8569	7.0
NC 2	11	14	0	0	1732	6463	7.0
CA 1	4.7	15	2	11	11325	44336	21.8
CA 2	9.8	20	2	15	7302	24170	6.2
Average (range)	8.4 (4.7-13)	13.9 (8-20)	2.2 (0-6)	10 (0-35)	7441 (1732-17979)	24978 (6463-62665)	14.7 (6.2-32.5)

[a] within 1 mile radius of the park's registered address

Table 2

Ratios between park-based MVPA time and total MVPA time accrued by local residents, after adjusting for estimated park use.

Park	½-mile resident				1-mile resident			
	Female		Male		Female		Male	
	Moderate	Vigorous	Moderate	Vigorous	Moderate	Vigorous	Moderate	Vigorous
OH 1	0.29	1.48[a]	0.35	0.92	0.09	0.44	0.10	0.27
OH 2	0.08	0.20	0.09	0.27	0.04	0.10	0.04	0.13
NM 1	0.11	0.61	0.14	0.56	0.03	0.16	0.04	0.15
NM 2	0.36	1.14 [a]	0.34	1.07 [a]	0.02	0.10	0.02	0.18
PA 1	0.08	0.32	0.07	0.62	0.01	0.11	0.02	0.17
PA 2	0.04	0.46	0.07	0.66	0.02	0.02	0.05	0.07
NC 1	0.04	0.04	0.11	0.14	0.01	0.11	0.02	0.21
NC 2	0.05	0.13	0.13	0.34	0.03	0.11	0.06	0.28
CA 1	0.05	0.42	0.10	0.81	0.01	0.03	0.03	0.08
CA 2	0.09	0.38	0.21	0.93	0.11	0.31	0.10	0.31
Average[b] (range)	0.12 (0.04-0.36)	0.46[b] (0.04-1.48)	0.16 (0.07-0.35)	0.59[b] (0.14-1.07)	0.04 (0.01-0.11)	0.15 (0.02-0.44)	0.05 (0.02-0.10)	0.17 (0.07-0.31)

[a]A ratio bigger than 1 may be due to one or more of the following: estimation errors in the adjustment factors or MVPA times; physical activity levels of the local population may be higher than national average; special events during observation periods may have boosted park-based use, and others.

[b]Truncated means (values larger than 1.0 truncated at 1.0).

Table 3

Estimated proportions of park users from local neighborhoods by physical activity level.

Park	½-mile resident		1-mile resident	
	Moderate	Vigorous	Moderate	Vigorous
OH 1	0.65	0.72	0.89	0.83
OH 2	0.60	0.56	0.77	0.72
NM 1	0.55	0.71	0.71	0.81
NM 2	0.60	0.66	0.64	0.69
PA 1	0.68	0.68	0.82	0.82
PA 2	0.66	0.76	0.81	0.94
NC 1	0.14	0.06	0.46	0.31
NC 2	0.21	0.21	0.26	0.30
CA 1	0.53	0.59	0.76	0.75
CA 2	0.32	0.32	0.60	0.57