# Playground features and physical activity in U.S. neighborhood parks

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ABSTRACT

All people need to engage in routine physical activity and children require it daily. Playgrounds are settings designed for children to be physically active, yet there has been little research assessing which play elements and structures are associated with more moderate-to-vigorous physical activity (MVPA) among both youth and adults. We conducted a national study of neighborhood parks with the goal of identifying factors that promote more MVPA. We selected a nationally representative sample of 162 parks between 3 and 22 acres in 25 U.S. cities with a population > 100,000. We used direct observation to measure MVPA in 147 playgrounds during spring and summer of 2016, documented playground characteristics and assessed hours of use and MVPA by age group and gender. We analyzed data using descriptive statistics and generalized linear models. The most common play elements and structures were slides and ladders (92% of parks) and swings (81%); elements supporting balancing, crawling, spinning, sand and water play were in < 30% of playgrounds. Each additional play element was associated with about 50% more users and 50% more MVPA. Spinning structures and splash pads were associated with more playground use and more MVPA. Playgrounds with signage advertising park programs and on-site restrooms had more person-hours of use, but only half the parks had restrooms and < 30% had signage. To address insufficient physical activity, upgrades to playgrounds should include restrooms, structures that support a wide variety of movements, and elements that also encourage adults to be active.

## 1. Introduction

Playgrounds, the most common feature of U.S. neighborhood parks (Cohen et al., 2016a), are prime attractions that draw families with young children to parks. Playgrounds provide substantial support for a variety of physical activities such as climbing, running, balancing, and spinning and thus exercise major muscle groups to support musculoskeletal development. However, some studies note that both local parks and playgrounds are often sparsely used, especially in low-income neighborhoods (Cohen et al., 2016b; Evenson et al., 2016a). Several barriers contribute to the underuse of playgrounds, including heightened fears about crime (Babey et al., 2005; Babey et al., 2013), and the need for supervision of children.

Another barrier is that play equipment may be uninteresting (Copeland et al., 2012), at least in contrast to the electronic media (television, video and computer games) that occupy the majority of youths' leisure time (Loprinzi and Davis, 2016; AAPCOUNCIL ON COMMUNICATIONS AND MEDIA, 2016). Park design has been tempered by fears of injury and litigation, resulting in much playground equipment being a standard post-and-platform design that is easily mastered and absent of significant physical challenges and risks that may be appealing to users (Copeland et al., 2012). Safety codes have been created to limit injury and they mandate structural design and surface types to reduce the impact of falls (USCPSC, 2015). Such design codes have led to concerns that playgrounds are not sufficiently stimulating for children (Brussoni et al., 2015).

There is increasing recognition that children and adults are not engaging in sufficient physical activity and too few are being exposed to natural, outdoor environments (Louv, n.d.; NPAP, 2016). Active play has been considered essential to child growth, socialization, and brain development (Tremblay et al., 2015; Yogman et al., 2018). Physical activity is also being important to adult health, but many adult caregivers who bring children to parks spend their time there being inactive (Evenson et al., 2016a; Evenson et al., 2016b). Although some new

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"intergenerational" playgrounds are designed to include adults, most are built for only children with their use is often designated by age or body size (e.g., for "children age 6 and under" or under "36 inches tall"). There are currently limited data on how adults use playground areas; observational studies of playgrounds typically report on only children's physical activity (Reimers and Knapp, 2017; Reimers et al., 2018). Previous studies have also been limited to small geographic areas such as a single city or town (Reimers and Knapp, 2017; Farley et al., 2008; Haug et al., 2010; Nielsen et al., 2012; Nielsen et al., 2010; Colabianchi et al., 2011; Floyd et al., 2011).

Multiple studies indicate that physical activity and sedentary behaviors remain consistent over time, and while physical activity is influenced by genetics, personal and cultural preferences, patterns established at young ages are likely to influence physical activity across the life span (Telama, 2009; Biddle et al., 2010; Malina, 2001). Gender differences in park use have been documented in several studies, with males of all ages, compared to their female counterparts, both using parks more often and engaging in more moderate-to-vigorous physical activity (MVPA) while there (Evenson et al., 2016a; Joseph and Maddock, 2016).

Park advocacy groups are calling for an increase in the number of parks in order to ensure that all people live within a ten-minute walk of a park (TPL, 2017). As land and housing are developed, municipalities are now requiring the creation of parks nearby to serve residents. Additionally, because the life span of equipment is limited, communities need to periodically refresh and refurbish their playgrounds. Thus, given the importance of physical activity across the life course and a commitment by most cities to maintain an infrastructure of parks and recreational facilities, it is imperative to understand how playground design influences park use and physical activity in order to inform future playground creation and renovation efforts. This study of a nationally representative sample of neighborhood parks assessed the characteristics, design, and use of public playgrounds by all age groups.

## 2. Methods

This study was approved by the RAND Corporation Human Subjects Protection Committee. Data were collected in 2016 during the second wave of the National Study of Neighborhood Parks, which included a representative sample of neighborhood parks in cities of over 100,000 residents in the U.S. (Cohen et al., 2016a) Among 289 eligible cities, a stratified sample of 25 cities were randomly selected. The U.S. cities were stratified by region (Northeast, South, West, and Midwest) and size (100,000–200,000, 200,000–1 million), and all cities above 1 million population were combined into a single stratum. We first obtained a complete inventory of all parks from each selected city or from their website if these were published online. Within each city, we stratified parks above or below the median neighborhood poverty level, and selected a random sample of 10–15% of all neighborhood parks from 3 to 20 acres, since this park size has the space for multiple recreational facilities. Parks this size also represent about half of all neighborhood parks (Cohen et al., 2016a). Park neighborhoods were defined as the 1-mile radius around each park. Further details of the sampling strategy can be found elsewhere (Cohen et al., 2016a). We observed 162 parks in 2016 and conducted detailed assessments of playground areas located in 147 (90%) of those parks.

## 3. Observations

We visited all the parks to collect data on clement days between April and August 2016 using the System of Observing Play and Recreation in Communities (SOPARC), a validated observational tool with reliability exceeding 0.9 (McKenzie et al., 2006; Cohen et al., 2011). The tool uses direct observation momentary time sampling to assess aggregated physical activity levels, demographic characteristics of park users, and area contextual information. We recruited two to four field staff from local areas and they traveled from their city to a central location for a two-day training. They were subsequently certified as data collectors after passing practical examinations to demonstrate their observation accuracy.

After mapping the parks, identifying their facilities and activity areas and documenting their conditions and signage, each park was systematically observed according to the following schedule: Tuesday, 8 AM, 11 AM, and 2 PM; Thursday, 12 PM, 3 PM, and 6 PM; Saturday, 9 AM, 12 PM, and 3 PM; and Sunday, 11 AM, 2 PM, and 5 PM. The parks were observed during a single week, except during inclement weather; on those occasions, observations were rescheduled for the same day of week and time of day during the next week.

Two field staff conducted the observations–one observed while the other entered data into a tablet. They systematically rotated through the parks, taking up to an hour to observe and count users in each target area. Each person in a target area was subsequently categorized into one of 24 groups defined by gender (male, female), age grouping (child, teen, adult, senior), and physical activity level (sedentary [e.g., seated, standing], light-to-moderate [e.g. walking] (called moderate hereafter), or vigorous [e.g., running, climbing]). Time-stamped pictures of specific target areas were taken to verify protocol compliance and validate counts during hourly observations.

During initial playground observations, field staff also assessed the presence of different surface types (dirt, grass mulch, concrete pavement, rubber, or sand) and shade structures and recorded the number of distinct playground structures that were physically separated and designed for use by more than one person at a time. Based on their primary function, play elements were identified and categorized as supporting eight different movements and activities: climbing, sliding, spinning, crawling, swinging, balancing, playing with sand, and water play (e.g., splash pads). Pictures of the play structures were taken to corroborate the assessments.

### 3.1. Data analysis

We first calculated descriptive statistics of park users, identifying the number, gender and age group characteristics and physical activity levels in terms of person-hours. We stratified results by gender and also analyzed gender-specific results by age-group.

The counts of users during an hourly observation were averaged to estimate the mean of hourly use, given that the sample hours capture the main characteristics of the temporal usage curve (McKenzie et al., 2006; Cohen et al., 2011). We stratified by gender the number and characteristics of observed park users and compared playground areas to all other park activity areas. Next, we fit a set of generalized linear models to estimate marginal associations between playground characteristics (structures, play elements and surface types) and the number of observed park users and their physical activity on playgrounds. We used the negative binomial distribution and the log link function to account for the overdispersion in the observed counts. We also used the generalized estimation equation and robust standard error to account for the intra-class correlation (clustering) among repeated observations in the same park. Given the small sample size, we did not have sufficient power to include all the playground characteristics into one model. Instead, we studied each characteristic in a separate model, controlling for park size in acres, local population density, and neighborhood poverty level within a 1-mile radius of the park (based on its street address), and adjusting for temporal correlations in the observational data (Cohen et al., 2016a). Neighborhood demographics and socio-economic data were drawn from the US Census 2010 and the American Community Survey 2012 (USCensus, 2011; USCensus, 2012). We estimated population in the mile radius surrounding the parks first by calculating the proportion of the area of every census tract that intersected the 1-mile radius and then multiplied this proportion by the tract population. We then summed the proportional population of each tract to get the total population. The estimated association was a

**Table 1**
Characteristics of Sampled Parks ($N$ = 162 parks).

| | Mean (sd) |
|---|---|
| Park characteristics | |
| Average size (acres) | 9.3 (5.7) |
| Population within 1-mile radius of park | 25,667 (34,497) |
| Population density per square mile | 8179 (10,981) |
| % households in poverty within 1-mile radius of park | 19.0% (11.2) |
| Average number of different types of park facilities | 7.4 (3.2) |
| Park amenities | |
| Lawns | 95.1% |
| Parking lots | 54.9% |
| Many large shade trees | 54.9% |
| Restrooms | 50.6% |
| If restroom, it is accessible | 81.7% |
| Any buildings | 38.3% |
| Bleachers | 39.5% |
| Grills | 28.4% |
| Bulletin boards | 27.8% |
| Banners | 27.2% |
| Signs promoting physical activity | 22.2% |
| Posters | 21.6% |
| Adjacent to highway | 14.2% |
| Park facilities | |
| Playgrounds | 147 [90.7%] |
| #separate play structures for use by multiple people (SE) | 4 (4.9) |
| #different playground features (SE) | 4 (1.3) |
| Basketball courts (outdoor) | 53.7% |
| Baseball fields | 50.6% |
| Picnic areas | 47.5% |
| Other sports fields | 37.7% |
| Walking loops | 32.7% |
| Tennis courts | 32.1% |
| Multipurpose courts | 17.3% |
| Classrooms | 15.4% |
| Single purpose courts | 14.8% |
| Water features | 12.4% |
| Gymnasiums | 10.5% |
| Splash pads | 10.2% |
| Exercise areas | 9.9% |
| Skate parks | 6.2% |
| Dog parks | 6.2% |
| Fitness zone (with equipment) | 3.7% |

Abbreviations: SD, standard deviation; SE, standard error.

marginal relationship between a playground characteristic and an outcome, without adjusting for other possibly confounding playground characteristics. Given the large number of tests, we applied the step-up method to adjust $p$-values to control for the false discovery rate < 0.05, i.e., no more than 5% of the claimed significant findings are type I errors on average (Benjamini and Hochberg, 1995). We also examined the association between playground and park features and use and MVPA by gender and age groups (children/teens vs. adults/seniors).

## 4. Results

### 4.1. Park characteristics

Table 1 shows that the average size of the 162 parks was 9.3 acres. Within a 1-mile radius of the park the average population was 25,667 people (population density = 8170 per sq. mile) and average household poverty level was 19%. Study parks averaged 7.4 distinct types of park facilities, with the top six being playgrounds, basketball courts, baseball fields, picnic area, other sports field, walking paths and tennis courts (Table 1). More than half the parks had a parking lot and about half had restrooms, but about 18% of these were not accessible (i.e., locked) during observation periods. Picnic areas were present in 47.5% of the parks, and fewer than 30% of parks had temporary signage advertising programs like park events, little league or exercise classes. The signs included banners, posters, or flyers on bulletin boards. In addition, about 22% had permanent signs that encouraged physical activity.

Park playgrounds had an average of 4 different independent structures and these often included multiple play elements. Fig. 1 shows the most common elements were slides and ladders (climbing and sliding), (92% of playgrounds) and swings (81%). Other elements included balance equipment (29%), crawling tubes (27%), spinning equipment (21%), sand boxes (14%), and splashpads (10%). Nearly 10% of playgrounds had 2 or fewer play elements, 55.8% had 3–4 elements, 31.3% had 5–6 elements and only 2.0% had 7 elements.

The playgrounds also had a variety of different surface areas, with mulch and rubber the most common (43% and 42% of playgrounds, respectively). This was followed by pavement/concrete (38%), sand (25%), grass (18%), and dirt (17%). (See Fig. 1).

### 4.2. Observations of playground use and MVPA

Table 2 indicates an estimated average of 403 person-hours of use in a playground during a week with clement weather. This represents 24.8% of the entire park activity area use by children and 13.4% of area use by all visitors (total = 3007 person-hours).

At 13.4%, playgrounds were the second most used activity area in the parks, second only to lawns which accommodated 20.4% of all users and more than baseball fields (10.9%) and sidewalks (10.7%) (see supplement for ranking of use of park facilities.) More females used playgrounds than males, with the difference particularly marked among adults (84% more adult females than adult males) but also 56% more

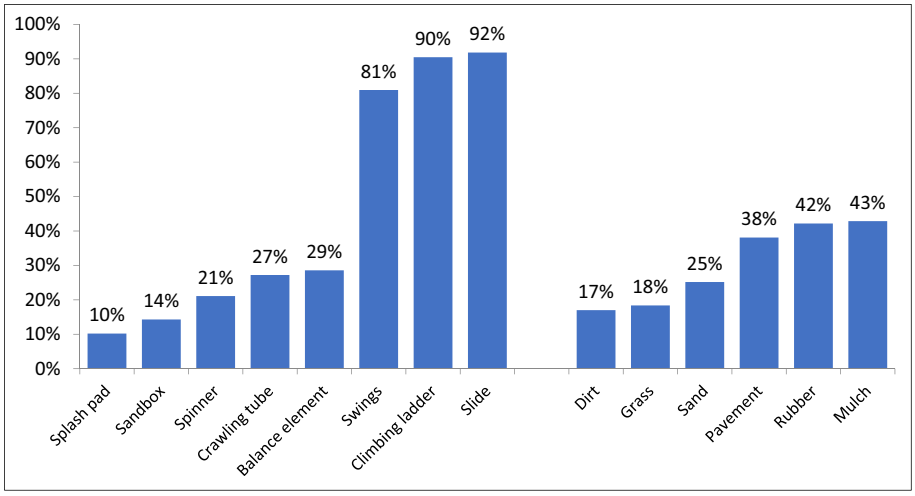


**Fig. 1.** Proportion of playgrounds containing different structure types and surface materials. ($n$ = 147 playgrounds).

**Table 2**
Observed visitors/users in playgrounds vs. those in other park activity areas with estimated mean weekly use as a % of all person-hours (N = 162 parks).

| User characteristics | Playground areas only Person-hours (%) | All other park activity areas Person-hours (%) | *p*-Value |
|---|---|---|---|
| All | 403 | 2604 | |
| Males (% of all users) | 176 (43.6%) | 1592 (61.1%) | < 0.0001 |
| Age group- males | | | |
| Children (% of males) | 121 (68.8%) | 484 (30.4%) | < 0.0001 |
| Teens (% of males) | 9 (5.1%) | 253 (15.9%) | 0.0002 |
| Adults (% of males) | 44 (25.0%) | 790 (49.6%) | 0.0002 |
| Seniors (% of males) | 2 (1.1%) | 65 (4.1%) | 0.08 |
| Males in MVPA (% of all males) | 95 (54.0%) | 667 (41.9%) | 0.003 |
| Children in MVPA (% of age-gender group) | 77 (63.6%) | 239 (49.4%) | 0.007 |
| Teens in MVPA (% of age-gender group) | 5 (55.6%) | 133 (52.6%) | & |
| Adults in MVPA (% of age-gender group) | 12 (27.3%) | 277 (35.1%) | 0.37 |
| Seniors in MVPA (% of age-gender group) | 1 (50.0%) | 18 (27.7%) | & |
| Females (% of all users) | 227 (56.3%) | 1012 (38.9%) | < 0.0001 |
| Age group-females | | | |
| Children (% of females) | 129 (56.8%) | 274 (27.1%) | < 0.0001 |
| Teens (% of females) | 14 (6.2%) | 130 (12.8%) | 0.013 |
| Adults (% of females) | 81 (35.7%) | 563 (55.6%) | < 0.0001 |
| Seniors (% of females) | 3 (1.3%) | 45 (4.4%) | 0.06 |
| Females in MVPA (% of all females) | 104 (45.8%) | 322 (38.8%) | < 0.0001 |
| Children in MVPA (% of age-gender group) | 77 (59.7%) | 118 (43.1%) | 0.003 |
| Teens in MVPA (% of age-gender group) | 7 (50.0%) | 52 (40.0%) | 0.66 |
| Adults in MVPA (% of age-gender group) | 19 (23.5%) | 141 (25.0%) | 0.86 |
| Seniors in MVPA (% of age-gender group) | 1 (33.3%) | 11 (24.4%) | & |

& = Insufficient sample size for hypothesis testing.
What does the *p* value testing – is it col. 2 vs 3 - can that be added as a footnote? (Yes p value compares column 2 and 3)

female teens than male teens, and 6.6% more girls than boys.

Children were significantly more likely to engage in MVPA in playgrounds than in other park activity areas: 63.6% of boys and 59.7% of girls were in MVPA in the playgrounds compared to 49.4% of boys and 43.1% of girls in other park activity areas, with *p*-values of 0.007 and 0.003 respectively (Table 2). Meanwhile, there were no statistical differences in the MVPA in playgrounds and other activity areas by other age-gender groups (either *p*-value > 0.05 or non-testable).

### *4.3. Relationship of playground structures to playground use*

After controlling for population density, park acreage, neighborhood poverty level, and park-level correlations related to the time of observations, we found associations between several playground elements, number of park users, and amounts of MVPA in playgrounds by gender. The number of structures and play elements were both associated with more person-hours of use and more MVPA among both males and females. The number of different play elements had a much stronger effect than the number of independent structures, such that each additional element was associated with about 50% more person-hours of use and 50% more MVPA. Each additional structure was associated with only 9% more person-hours and 7% more MVPA. Climbing structures and crawling tubes were also associated with more person-hours of use by both males and females and more MVPA. Playgrounds that contained some dirt surfaces were associated with almost 82% fewer person-hours, but no other surface types were associated with playground use or MVPA. The only differences by gender were in the magnitude of the associations, with stronger associations for boys than for girls (Table 3).

The bottom half of Table 3 shows relationships between playground use and playground MVPA and features outside the playground by gender. Parks with restrooms, particularly accessible restrooms were associated with more than double the playground use and on-site MVPA. The presence of marketing materials like bulletin boards, banners and posters were also associated with 76–86% more person-hours of use and more MVPA. Signs that promoted more physical activity and picnic areas were also associated with 64%–76% more playground person-hours and more MVPA. The presence of walking loops, sports fields and parking lots were not associated with more playground use. The association of the park facilities, amenities and playground features with use and MVPA did not differ significantly by gender. Patterns were similar by age group, with higher use and MVPA among both adults/seniors and children/teens in playgrounds with more features and with restrooms in the park (data not shown).

## 5. Discussion

Playgrounds are critical components of parks, given that they were only one of an average of 7.4 facilities in the parks, but contained nearly 25% of all children's activity in the park. Moreover, they were the locations where children were most likely to engage in higher rates of MVPA. The association between the variety of playground elements that allow for different types of movements and activities, especially climbing, swinging, balancing, spinning, and crawling and the number of users and the amount of MVPA being generated should inform future playground design and renovation to better promote MVPA in playgrounds for both children and adults. Previous studies of schoolyards and public playgrounds have shown that the number of playground structures is related to both the number of users and the amount of MVPA that children engage in, but these studies did not identify the specific features associated with greater use or MVPA and have largely omitted adult and senior users (Reimers and Knapp, 2017; Farley et al., 2008; Haug et al., 2010; Nielsen et al., 2012; Nielsen et al., 2010; Colabianchi et al., 2011). Playground designers may want to include spinning equipment and splash pads, as these were associated with substantially more users and greater MVPA among both boys and girls. Climbing apparatuses and crawl tubes were associated with more MVPA by both boys and girls, but the association was stronger for boys.

Although the presence of slides was strongly associated with MVPA, this finding should be considered with caution. Slides were the most common type of playground structure, with 92% of playgrounds having them. The playgrounds without slides (8%) had an average of only 2 different types of equipment, which would, by itself, make the park less interesting and less attractive, rather than merely the absence of a slide.

While we identified several types of play elements that appear to attract greater playground use, our findings suggest that less than one-

**Table 3**
Negative binomial model estimates for the marginal association between observed playground use, MVPA and playground characteristics and park features outside the playground ($N$ = 147 parks with playgrounds). Estimates are on the natural log scale.

| | # of playground person-hours | | | MVPA for males | | | MVPA for females | | |
|---|---|---|---|---|---|---|---|---|---|
| | Estimate | S.E. | *p*-Value | Estimate | S.E. | *p*-Value | Estimate | S.E. | *p*-Value |
| Playground characteristics | | | | | | | | | |
| #playground features | 0.44 | 0.05 | < 0.0001* | 0.43 | 0.06 | < 0.0001* | 0.39 | 0.05 | < 0.0001* |
| #separate structures | 0.09 | 0.02 | < 0.0001* | 0.08 | 0.01 | < 0.0001* | 0.07 | 0.01 | < 0.0001* |
| Balance bars/beams | 0.50 | 0.22 | 0.02* | 0.51 | 0.23 | 0.03 | 0.44 | 0.20 | 0.03 |
| Climbers, ladders, jungle gyms | 0.84 | 0.36 | 0.02* | 1.27 | 0.41 | 0.002* | 1.01 | 0.38 | 0.01* |
| Crawl tubes | 0.60 | 0.21 | 0.004* | 0.65 | 0.22 | 0.003* | 0.49 | 0.19 | 0.01* |
| Sand boxes | 0.21 | 0.23 | 0.37 | 0.24 | 0.25 | 0.33 | 0.10 | 0.21 | 0.64 |
| Slides | 1.90 | 0.46 | < 0.0001* | 1.75 | 0.51 | 0.001* | 1.76 | 0.58 | 0.002* |
| Spinning equipment | 0.94 | 0.20 | < 0.0001* | 0.89 | 0.22 | < 0.0001* | 0.86 | 0.19 | < 0.0001* |
| Splash pads | 1.16 | 0.27 | < 0.0001* | 1.24 | 0.28 | < 0.0001* | 0.98 | 0.26 | 0.0002* |
| Swings | 0.54 | 0.39 | 0.17 | 0.47 | 0.48 | 0.33 | 0.52 | 0.42 | 0.21 |
| Other play elements | 0.09 | 0.22 | 0.68 | −0.07 | 0.23 | 0.75 | 0.03 | 0.19 | 0.87 |
| Shade structure over play area | 0.26 | 0.20 | 0.19 | 0.28 | 0.23 | 0.22 | 0.27 | 0.20 | 0.18 |
| Fenced play areas | 0.12 | 0.18 | 0.52 | 0.08 | 0.20 | 0.68 | 0.10 | 0.18 | 0.56 |
| Surface: dirt | −0.60 | 0.20 | 0.002* | −0.57 | 0.22 | 0.01* | −0.36 | 0.21 | 0.08 |
| Surface: grass | −0.17 | 0.23 | 0.45 | −0.20 | 0.25 | 0.44 | −0.03 | 0.22 | 0.90 |
| Surface: much or wood chips | 0.14 | 0.22 | 0.52 | 0.06 | 0.23 | 0.78 | 0.02 | 0.20 | 0.92 |
| Surface: other | −0.70 | 0.36 | 0.05 | −0.90 | 0.43 | 0.04 | −0.41 | 0.42 | 0.34 |
| Surface: pavement or concrete | 0.21 | 0.18 | 0.25 | 0.10 | 0.20 | 0.59 | 0.27 | 0.18 | 0.13 |
| Surface: rubber | 0.18 | 0.21 | 0.40 | 0.23 | 0.24 | 0.34 | 0.21 | 0.21 | 0.31 |
| Surface: sand | 0.03 | 0.19 | 0.86 | −0.01 | 0.20 | 0.98 | 0.05 | 0.18 | 0.80 |
| Park characteristics (beyond the playground) | | | | | | | | | |
| Accessible restroom | 0.91 | 0.27 | 0.001* | 1.01 | 0.29 | 0.001* | 0.72 | 0.27 | 0.01* |
| Restroom | 0.78 | 0.18 | < 0.0001* | 0.81 | 0.19 | < 0.0001* | 0.8 | 0.17 | < 0.0001* |
| Marketing bulletin board | 0.62 | 0.2 | 0.002* | 0.64 | 0.21 | 0.002* | 0.56 | 0.19 | 0.003* |
| Marketing banner | 0.58 | 0.23 | 0.01* | 0.65 | 0.23 | 0.005* | 0.52 | 0.2 | 0.01* |
| Sign promoting physical activity | 0.57 | 0.23 | 0.01* | 0.68 | 0.22 | 0.002* | 0.58 | 0.2 | 0.003* |
| Any buildings | 0.52 | 0.19 | 0.01* | 0.56 | 0.2 | 0.01* | 0.51 | 0.19 | 0.01* |
| Marketing poster | 0.52 | 0.22 | 0.02* | 0.49 | 0.25 | 0.05 | 0.57 | 0.21 | 0.01* |
| Picnic area | 0.5 | 0.19 | 0.01* | 0.6 | 0.2 | 0.003* | 0.6 | 0.17 | 0.001* |
| Walking loop | 0.28 | 0.19 | 0.15 | 0.29 | 0.22 | 0.19 | 0.28 | 0.19 | 0.14 |
| Other sport fields | 0.19 | 0.18 | 0.29 | 0.22 | 0.2 | 0.27 | 0.16 | 0.17 | 0.35 |
| Baseball field | 0.18 | 0.21 | 0.37 | 0.05 | 0.22 | 0.81 | 0.16 | 0.2 | 0.4 |
| Adjacent to highway or freeway | 0.11 | 0.22 | 0.63 | 0.01 | 0.23 | 0.97 | 0.12 | 0.22 | 0.58 |
| Many trees | 0.07 | 0.21 | 0.73 | −0.03 | 0.23 | 0.9 | −0.003 | 0.2 | 0.99 |
| Parking lot | 0.05 | 0.22 | 0.84 | 0.07 | 0.23 | 0.77 | 0.19 | 0.22 | 0.37 |
| Grill or fire pit | 0.05 | 0.19 | 0.79 | 0 | 0.2 | 1 | 0.16 | 0.19 | 0.4 |

Abbreviations: MVPA, moderate to vigorous physical activity; SE, standard error.
All results adjusted for park size in acres, local population density, poverty rate, and intra-park correlations.
* Significant after controlling for the false discovery rate < 0.05.

third of all playgrounds in the U.S. contain any of those elements. Twenty-nine percent of all playgrounds had only 3 or fewer elements–typically, a slide, a ladder, and swings. In contrast, only 2% of the playgrounds had 7 features. Playgrounds with limited features may quickly lose their novelty and appeal, discouraging repeat visits.

While playground design is clearly important, the presence of restrooms in the park was also associated with playground use. Onsite restrooms may make parks a more attractive destination, especially if people plan on spending large amounts of time there. Only about half of the neighborhood parks had restrooms, and the fact that nearly 10% were closed during our observation visits suggests that their maintenance and repair is a challenge for park agencies. Installing restrooms is a high-cost investment, although there are new lower-cost restroom units that might make it more feasible for localities to include them in neighborhood parks (M, 2012).

The association of playground visits with signage may be an indication that the park has other types of programming that may be attracting family members. For example, younger children might use the playground, while older family members might be participating in sports or other programs of interest such as performances or classes. In general, parks with more features attract more use (Farley et al., 2008; Haug et al., 2010; Nielsen et al., 2012; Nielsen et al., 2010), and when a park is busy it may also engender feelings of safety.

Today, children spend the majority of their leisure time engaged with electronic media (Loprinzi and Davis, 2016; AAPCOUNCIL ON COMMUNICATIONS AND MEDIA, 2016). Given that electronic media are so stimulating, motivating children to engage in outdoor activities in playground settings may require that playgrounds be made more interesting by containing more varied play elements. Playgrounds also need to cater to the needs of caregivers who are necessary to bring and supervise the children in these settings.

The percentage of adults engaged in MVPA in the playground area was no different than in other areas of the park, but it was about half the MVPA engaged in by children of respective genders. Existing playgrounds are not designed to include adults who bring children to the parks to be active. Given that time is a limited resource, spending taking children to a park reduces adults' leisure time for their own physical activity, unless it can be obtained while chaperoning a child. Playgrounds that don't also include ways to engage adults in MVPA represent an important missed opportunity.

The gender disparities in playground use among children were striking. The increased concentration of girls on playgrounds contrasts with their lower representation in other park activity areas. Among adults, there were 83% more females than males on the playgrounds, suggesting that mostly mothers and female caregivers accompany children to parks.

Males were less likely to be in the playground and more likely to engaging in physical activity elsewhere in the parks. In general, males

typically outnumber females in parks (Cohen et al., 2016a). Future park improvements and renovations should consider the needs and preferences of women and girls so that, beyond the playgrounds, the other areas of a park could be more equitably used as well as support more physical activity for people of all ages and genders.

### 5.1. Limitations

The playgrounds were observed only during clement weather during spring and summer, and the findings may not reflect their use during other conditions (e.g., rain) and other seasons. Prior studies have demonstrated reduced physical activity in winter compared to spring and summer (Gracia-Marco et al., 2013; Silva et al., 2013). We did not have information on the age of the playground equipment, which might have influenced its attractiveness. However, nearly all the playground equipment and structures were rated as usable. In addition, all observations were aggregated to entire playground areas, so data were not available for each playground structure or feature separately. Thus, the fact that more visitors were observed in playgrounds with spinning equipment and splash pads doesn't necessarily mean that more people used this specific type of equipment overall. Moreover, our statistical analysis provides marginal associations, so our findings do not account for correlations between the features.

We assumed that adults in the playgrounds were caregivers, but it is possible they were not. We saw more female than male adults there, possibly a reflection that females are more likely to be chaperones and that it may be less socially acceptable for males to be around children in play areas.

Strengths of the study include use of valid and reliable methods of direct observation that were corroborated by photos and the use of a nationally representative sample of playgrounds in all geographic areas of the country and representing high and low-income areas. Nevertheless, assessments of age, gender, race/ethnicity are based on observation and may not be fully accurate, even if observers agree on their perceptions. Although SOPARC measures physical activity in three categories, sedentary, moderate and vigorous, physical activity is actually a continuum and the nuanced differences of energy expenditure within these three categories cannot be captured.

## 6. Conclusion

Playgrounds have the potential to contribute more to health and well-being and there are multiple opportunities for their redesign that would support more physical activity engagement among all age groups. Public playgrounds are community assets and are a critical part of the long-term solution to prevent and reduce the impact of activity-related chronic diseases like diabetes, osteoporosis, and cardiovascular disease.

## Contributions of authors

Deborah A. Cohen was the PI who took the lead in study design and manuscript preparation. Bing Han was the statistician responsible for sample selection and also supervised the data analysis. Stephanie Williamson was the programmer and prepared the dataset and conducted the basic data analyses. Catherine Nagel was the study co-investigator, assisted in protocol development, supervised the data collection and assisted in the analysis and manuscript preparation. Thomas L. McKenzie assisted in training of data collectors, data analysis and manuscript preparation. Kelly R. Evenson and Peter Harnik assisted in protocol development, data analysis and manuscript preparation.


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