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Observational Park-based Physical Activity Studies: A Systematic Review of the Literature

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Abstract

This article reports the outcomes of a systematic review of observational park-based physical activity (PA) studies. Five electronic databases and the Active Living Research website were searched in July 2015 to identify relevant articles. Studies were included if they: a) reported observational data collected at outdoor park-based settings during free living conditions, b) reported results of a park audit, c) included PA as an outcome measure of the park audit, and d) were published after 1990 in English-language peer-review journals. Thirty-two articles, reporting outcomes of 26 unique studies, met inclusion criteria for review. Most studies (n=20, 87%) had cross-sectional or non-interventional study designs, while 6 (23%) employed quasi-experimental designs. Studies were predominately conducted in the U.S. (n=19, 76%). The median number of park users across studies was 4,558 (Range= 815 to 76,632). Approximately half (51%) of all park users were female. Eighty-one percent of studies (n=21) reported PA outcomes for individuals of all ages, while 4 studies (15%) reported PA outcomes for children only and 1 study (4%) for adults only. Moderate-to-vigorous physical activity (MVPA) of park users ranged from 31% to 85% (Median=55.0%). Studies conducted in the U.S. reported a slightly higher median number of park-users engaging in MVPA than those outside the U.S. (60.5% vs. 52.8%). Fifteen studies examined gender differences in MVPA. Among these, 12 (87%) reported more males engaging in MVPA than females. Results of this review highlight the need for innovative strategies to promote MVPA among park users and to increase park use among children.

INTRODUCTION

Physical activity (PA) is an established mechanism to prevent numerous health conditions, including cardiovascular disease, type 2 diabetes, overweight/obesity, some cancers, and psychological disorders [1-3]. Despite these benefits, most individuals are insufficiently

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active. The World Health Organization estimates that only 23% of adults and 20% of children achieve recommended levels [4], making insufficient PA the fourth leading risk factor for global mortality causing an estimated 3.2 million deaths each year [5].

In an effort to combat the low PA levels across the world, public health professionals have become increasingly focused on how the built environment—broadly defined as the physical form of communities—influences the PA patterns of individuals in those communities [6-9]. The built environment is comprised of a variety of features (i.e., buildings, landscape patterns, layouts of communities, transportation infrastructures, parks, and trails) [10], all of which have the ability to influence PA engagement. Of particular interest, is the availability, design, and use of neighborhood parks to encourage PA. Parks are ideal settings to promote PA because they are composed of green spaces (i.e., trails, sports fields) and physical structures (i.e., playground and exercise equipment, sidewalks) specifically designed to promote PA [11]. Community parks also encourage social interaction [12, 13] and can be accessed by community members at minimal-to-no cost. Moreover, in urban and inner-city settings, parks are often the only place for residents to engage in outdoor recreation and/or sporting activities.

A substantial number of park-based PA studies have been published in the past two decades. However, the majority of these examine individual cities and do not assess whether park-based PA differs according to population characteristics and geographical location. The purpose of this article is to systematically review observational park-based PA studies and summarize park-user characteristics and park-based PA across the U.S. and internationally. Other park related studies that examined the quantitative relationship between parks located near one's place of residence and PA were not the focus of this review. Knowledge of how neighborhood parks contribute to the PA patterns of communities is imperative to develop interventions and public health programs to increase park-based PA among adults and children.

METHODS

Information Sources and Eligibility

The systematic review methodology used to identify and report outcomes of observational park-based PA studies was informed by the Preferred Reporting Items for Systematic Review and Meta-analysis (PRISMA) Statement [14]. Articles were included in the review if they: a) reported results of a systematic observational park-based assessment, b) included physical activity as an outcome measure, c) were published in English-language peer-review journals, and d) were published between 1990 and August 2015. We excluded studies that assessed park use during structured, sanctioned, or organized activity (i.e., school recess, physical education courses), as the purpose of the review was to examine park use under free-living conditions. Five electronic databases were searched to identify relevant articles (see Figure 1): PubMed, PsycINFO, CINAHL, Web of Science, and Scopus. In addition, we supplemented our electronic database search with a manual review of articles available on the Active Living Research (ALR) website (www.activelivingresearch.org).

Search Strategy

The Boolean strategy was used to identify articles during electronic database search procedures. Specifically, we searched titles and abstracts of peer-reviewed articles using the following key term sequence: “park” OR “parks” OR “built environment” AND “physical activity” OR “exercise” AND “observational” OR “SOPARC” OR “SOPLAY”. We decided not to use MeSH terms because they are less often used outside of the biomedical field and some search terms like SOPARC have no corresponding MeSH terms. To identify relevant articles from the ALR website, we manually reviewed the titles and abstracts of all publications (n=1275) available on the website. Search procedures were performed during July 2015.

Study Selection

Articles retrieved during search procedures were exported to Endnote® electronic referencing software [15]. Once duplicates were removed, titles and abstracts of articles were assessed for eligibility by one member of the research team (RPJ). Articles appearing to meet inclusion criteria after title and abstract review received a full-text review. The full-text review was conducted by RPJ. Articles not clearly meeting inclusion criteria from initial full-text review were reviewed by the senior research team member (JEM) and a consensus was reached among the two researchers.

Data Collection Process

For all articles included in the review, we abstracted the following information: authors, year of publication, study purpose, study design, study population(s), number of parks assessed per study, geographical location of park(s) assessed, total number of days each site was assessed, total number of observations per site, total number of park users by site, characteristics of park users, and physical activity outcomes. Data abstraction was conducted by both members of the research team (RPJ, JEM), with any discrepancies discussed until a consensus was reached.

Methods of analysis/synthesis of results

First, we grouped studies according to study design (i.e. cross sectional, experimental, longitudinal, etc.). Second, we grouped studies of similar designs based on the age characteristics of the population examined (i.e., children only, adults only, or park users of all ages). Third, we summarized year of study publication, study purpose, study design, study population(s), number of parks assessed per study, geographical location of park(s), total number of days each site was assessed, total number of observations per site, total number of park users by site, characteristics of park users, and physical activity outcomes. Finally, we synthesized, compared, and contrasted findings across studies.

Due to the heterogeneity of how outcomes were reported across studies, several decisions were made on how to handle individual study data in order to synthesize outcomes. For studies reporting within study variation regarding the number of days each park was assessed and the total number of observations per park (n=4 studies, encompassing 8 articles), we calculated a weighted mean for each of these studies and used that value in descriptive analysis (see Park Assessment Methodology section in Results). Likewise,

several studies (n=3) evaluated multiple parks located in different geographic regions. In order to synthesize and report PA outcomes based on geographical location of parks, we treated each park location as an independent study in this specific outcome analysis. For quasi-experiment/interventional studies that evaluated park-based PA at multiple time points, one of two strategies was used to synthesize PA data for comparison across studies: 1) if complete PA data were available at all time points, we calculated the mean value for each PA intensity level and used that value in the PA outcome analysis; 2) if detailed PA data for each assessment period were not available to calculate a mean value for PA outcomes, only baseline PA levels were used in descriptive analysis. When analyzing and reporting the outcomes of our review, each unique study was treated independently. Accordingly, studies with multiple publications describing study outcomes were collapsed into a single row in our descriptive tables (i.e., Tables 1-3). Lastly, PA outcomes reported as “walking” were classified as “moderate intensity” PA for descriptive purposes.

RESULTS

Figure 1 illustrates the article search and selection process. Search procedures retrieved a total of 7813 articles. After duplicates were removed (n=1564), the titles and abstracts of 6249 articles were screened for relevance. Following this review, 80 articles were determined as relevant and received a full text review. After applying inclusion criteria, 32 articles reporting the results of 26 unique studies were included in the review. The median year of publication for these 32 articles was 2012 (range 1994 to 2015).

Overview of Studies

Of the 26 studies meeting inclusion criteria for review, most (n=20, 87%) had cross-sectional or non-interventional study designs (see Tables 1 and 2), while 6 (23%) studies employed quasi-experimental designs (see Table 3). The majority of studies were conducted in the U.S. (n=18, 72%) [16-33]. Other countries where studies were conducted included Australia (n=3; 12%) [34-36], China (n=1; 4%) [37], Taiwan (n=1; 4%) [38], Canada (n=1; 4%) [39], and Brazil (n=1; 4%) [40]. One study (4%) was conducted in both the U.S. and Belgium [41]. Among U.S. studies, cities where parks were assessed included: Los Angeles, CA (n=4 studies), Durham, NC (n=2 studies), Chicago, IL (n=2 studies), Albuquerque, NM (n=1 study), Philadelphia PA (n=1 study), Honolulu, HI (n=1 study), Tampa, FL (n=1 study), San Diego, CA (n=1 study), San Francisco, CA (n=1 study), Denver CA (n=1 study), Grand Forks, ND (n=1 study), and Las Vegas, NV (n=1 study). Five studies reported the location of parks by only state or broad geographical location (as opposed to city). These locations included California, Michigan, North Carolina, and the Southeast and Mideast regions of the U.S. Twenty-one (81%) studies examined park use among individuals of all ages [16-21, 24-28, 31-33, 35-39, 41, 42], while 4 (15%) examined park use in children only [22, 23, 30, 34] and 1 (4%) examined park use in adults only [29]. The total number of parks assessed per study ranged from 1 to 50, with 9 being the median number of parks assessed per study.

Park Assessment Methodology

Twenty-five (96%) studies used a published measure to assess park use. The System for Observing Play and Recreation in Communities (SOPARC) was used in 22 (85%) studies

[16-21, 23, 25-31, 33-36, 38, 39, 41-43] and the System for Observing Play and Leisure Activity in Youth (SOPLAY) was used in 3 (11%) [22, 24, 32]. For the 1 study [26] that did not use a published measure to assess park use, the author reported using a systematic observation methodology similar to protocols employed by the SOPARC and SOPLAY. There was substantial heterogeneity across studies in regards to the total number of days and total number of observations each park was assessed. The total number of days each park was assessed ranged from 1 to 39 (median = 7) and the total number of observations per park ranged from 1 to 560 (median = 28). The most frequently used observation protocol was a 7-day assessment period with 4 observations per day (for a total of 28 observations per park). This methodology was used in 10 (38%) [17-21, 25, 29, 30, 32, 33] of the 26 studies and is the recommended observation method according to Cohen and colleagues [11].

Description of Park Users

The total number of park users across the 24 studies with sufficient data for calculation was 341,273 [16-18, 20-33, 35, 36, 38, 39, 41-43]. The median number of park users per study was 4,558 (range 815 to 76,632). Twenty (77%) studies provided data on the gender of park users [16-18, 20-25, 27-30, 33, 35, 36, 38, 41-43]. Of these, pooled analysis showed approximately equal numbers of males (49%) and females (51%) across studies. Sub-analysis of park-users for studies conducted in the U.S. versus those outside of the U.S. showed that U.S. studies reported a greater percentage of male park users (57%) than female users (43%), while studies conducted outside the U.S. reported greater percentage of female users (63%) than male users (37%).

Among the 21 studies evaluating park use among individuals of all ages, 12 (57%) reported more adult (i.e., aged ≥ 18) park users than children (i.e., aged < 18) [16-20, 31, 32, 35, 36, 38, 42, 43], 5 (24%) reported more children than adults [21, 24, 27, 28, 33], 1 (5%) reported approximately equal numbers of children and adults [41], and 3 (14%) did not report this information [25, 26, 39]. Sixteen studies [16-21, 27, 28, 31-33, 36-38, 41, 42] provided specific information regarding the percentage of adult park users versus child/adolescent park users. Of these, median percentage of adult park users was 59% (range 24% to 88%) and the median percentage of children/youth was 42% (range 12% to 76%). Older adults (i.e., > 60) appeared to be under-represented among park users. The median percentage of older adult park users among the 11 studies reporting this data [17, 20, 21, 30, 32, 33, 36, 38, 41-43] was 5% (ranged 2.1% to 61.5%), with only three studies (all conducted outside of the U.S.) [36-38] reporting a greater than a 15% prevalence of older adults in parks (i.e., 15.7%, 53.4%, and 61.5%). Six studies [24, 28-30, 32, 41] reported the race/ethnicity of park users, 4 [28-30, 41] reported a greater prevalence of White park users (i.e., range from 50% to 65%) than non-White users. Due to the limited number of studies reporting information on race/ethnicity of park users, further analysis of park users based on this characteristic was not performed.

Physical Activity Outcomes

PA outcomes were reported in several ways across studies. The most common method of reporting PA was based on percentage of observed individuals engaging in sedentary, moderate (or walking), and/or vigorous intensity PA. This methodology was used in 23

studies [16-24, 26-30, 32, 33, 35, 36, 38, 39, 41-43]. For the remaining 3 studies, 1 study reported PA outcomes using METs [31], 1 study reported percent time spent in MVPA based on observed park use time [25], and 1 reported outcomes based on the mean number of park users observed at varying PA intensities [34].

Table 4 summarizes the outcomes for the 23 studies reporting PA results based on percentage of observed users engaging in MVPA. Among these studies, sedentary time ranged from 13.7% to 68.0% (median = 43.0%), moderate PA ranged from 6.0% to 69.4% (median = 34.2%), vigorous PA ranged from 9.0% to 55.5% (median = 21.7%), and total moderate-to-vigorous PA (MVPA) ranged from 31.0 to 85.4% (median = 55.0%). We compared PA outcomes for studies performed in the U.S. versus outside the U.S. Results showed that studies conducted in the U.S. had a slightly higher median number of park-users engaging in MVPA than those outside the U.S. (60.5% vs. 52.8%; see Table 4). However, given twice as many studies were performed in the U.S. (n=16) than outside the U.S. (n=8), these results should be interpreted with caution. We also examined PA outcomes for U.S. studies based on the geographical region of park location. Results showed studies of parks located in the South (n=6 studies [23, 24, 29, 30, 32, 33] had highest median number park users engaging in MVPA (Median=63.3%, Range 29.0 to 85.4%), followed by the Midwest (n=3 studies [26, 28, 31]; Median=59.5%, Range 50.0 to 85.5%), and West (n=9 studies [16-22, 27, 41] Median=39.9%, Range 31.0 to 79.1%). One study assessed parks in the Northeast region of the U.S [25]; however, outcomes were not reported based on percentage of park-users engaging in MVPA which limited comparison to the other regions. Among studies reporting PA outcomes for children/adolescents (n=8 studies; [16, 22-24, 28, 30, 36, 38]) and adults (n=6 studies; [16, 22-24, 28-30, 36, 38]) separately, MVPA outcomes for children/adolescents were slightly higher (range 23.2% to 85.6%, median = 64.9) than outcomes for adults (range 32.6 to 86.9, median = 53.7%). These differences appeared to be driven by children/adults engaging in more vigorous intensity PA than adults (see Table 4).

Among the studies that did not report PA outcomes based on percentage of observed park users engaging in MVPA [25, 31, 34], outcomes reflected trends observed in the 23 studies that did. For example, Han et al. [25] estimated the amount of time spent in MVPA among park-users ranged from 35% to 46%, which is comparable to the median number of park users engaging in MVPA in Table 4 (i.e., 43%). Likewise, Roemmich and colleagues [31] reported more children engaging in MVPA than adults (based on METs), which coincides with the comparison of MVPA outcomes of children.

Among all studies included in the review (n=26), 15 reported examining gender differences based on MVPA [16-18, 21-29, 34, 36, 43]. Of these, 87% (n=13) reported significantly more males engaging in MVPA than females [16-18, 21-29, 36]. Due to the limited number of studies (n= 6) examining the race/ethnicity of park-users, PA outcomes based race/ethnicity were not examined.

DISCUSSION

This article provides a comprehensive review of observational park-based PA studies. Overall, findings show that the majority of park users were observed engaging in MVPA.

This outcome is promising and supports the notion that parks are key assets in communities to help facilitate PA. Findings of this review also elucidate several trends in regards to demographic and age characteristics of park users, as well as how park-based PA behaviors in the U.S. may differ from countries outside of the U.S. The following paragraphs will discuss these trends and highlight potential future directions for authors to consider when conducting observational park-based PA studies.

Among the studies included in the review, 96% (i.e., 25 of 26) used a published observational audit measure to assess park-based PA (22 used the SOPARC, 3 used the SOPLAY). This outcome suggests a consensus among researchers in regards to the most appropriate audit measures to evaluate park-based PA (i.e., the SOPARC and SOPLAY). This may be due to the high rate of inter-rater reliability of the instrument or the availability of well-documented training procedures and videos. However, given the high level of time commitment to collect the data it is surprising that other methods incorporating technology have not been developed. There was considerable variability in the number of days parks were assessed and the total observations performed. For example, the number of days each park was assessed across studies ranged from 1 to 39 and the total number of observations performed at each park ranged from 1 to 560. This variability emphasizes the need for researchers to achieve agreement on observational protocols to examine park-based PA. Based on our review of the literature, we recommend a 7-day observation period with 4 observations per day. This protocol has been validated for the SOPARC [11] and was also the most commonly used protocol across studies reviewed (i.e., 10 of 26 studies used this protocol). Using this protocol will also allow researchers to more easily compare outcomes across studies in future research.

PA outcomes across studies revealed that most individuals observed at parks were engaging in some type of MVPA (as opposed to sedentary activities), with moderate PA contributing to most of the energy expenditure associated with MVPA. This outcome may suggest that U.S. park users view parks as a place to purposefully engage in PA, while individuals and cultures outside of the U.S. view parks as places to engage in more sedentary activities (i.e., board games, lunch, social gatherings). However, since the number of U.S. studies outnumber those outside the U.S. almost three-fold, these findings should be interpreted with caution. Additional research is needed to compare the park-based behaviors between the U.S. and other countries.

Among U.S. studies, we observed a trend for studies auditing parks in the South and the Midwest to report a higher prevalence of park users engaging in MVPA than the West (see Table 4). This outcome was unexpected, as both the South and Midwest have higher obesity prevalence than the West [44]. Given PA is an established mechanism to prevent and help treat obesity [45-47], future research is needed to examine how park-based PA can play a role in combatting the current obesity epidemic in the U.S. Our review also highlights the lack of studies evaluating park-based PA in the Northeast. Only 1 study evaluated PA at a park located in the Northeast [25] region of the U.S. Likewise, only 3 studies examined parks in the Midwest. Future studies are warranted to examine park-based PA behaviors in both of these regions.

Several other trends in regards to park-user characteristics emerged. Across studies, approximately equal numbers of men and women were observed, suggesting that park-based activities are equally appealing for both men and women. However, the types and intensity of park-based activities performed by men and women differed. For example, among studies reporting PA outcomes by gender, most (i.e., 13 of 15; 87%) reported more males engaging in MVPA than females. Likewise, several studies reported that males were more likely to engage in sporting activities, while females were more likely to engage in sedentary or walking activities. These findings, particularly in relation to women engaging in more sedentary park behaviors, corroborates the results of a qualitative review [13] examining characteristics associated with park-use which reported that women viewed parks as safe places to meet and socialize with others. With female attendance high at parks, future interventions should examine how to get women more physically active while at parks.

Among studies reporting the age characteristics of park-users, the majority (12 of 17; 71%) reported more adult park-users than children. This outcome was somewhat surprising, as parks are generally viewed as a place for children to play. We note though, that this outcome may have been biased by the assessment protocols implemented by researchers. Park observations for many studies were frequently performed during weekdays at times when most children should be in school (see Tables 1-3), which would result in fewer children observed in parks. We attempted to analyze park user characteristics for after-school hours and weekend days only, however, no studies provided sufficient data for this analysis. Such analyses are needed in future research to further explore this outcome.

While more adults were observed in parks than children, most studies reported children engaging in more MVPA. Few studies reported a substantial number of older adults observed in parks. In fact, only 3 studies, all conducted outside of the U.S., reported a greater than 15% prevalence of older adult park-users. This finding demonstrates that perhaps, older adults, in general, do not view parks as a viable resource for social and/or PA engagement. However, there are several alternative explanations including safety/crime concerns, lack of a park in close proximity to their residence, and the tendency of PA to decrease with age. Future research is needed to further explore how parks in the U.S. can be utilized to promote PA among older adults.

Our review is not without limitations. Study outcomes were reported in a variety of ways which made it difficult to synthesize and present review outcomes in a cohesive and simplistic manner. In many instances, authors did not explicitly report the outcomes of interest for our review; therefore, we extrapolated this information from available data reported by authors. Together, these issues may have introduced bias or error into the outcomes of this review. There was also variation across studies in the total number of days, time of day of data collection and total observations per park. This heterogeneity also likely influenced the PA outcomes. Another limitation was the paucity of studies performed in countries outside of the U.S. and number of studies performed in the Northwest and Midwest regions of the U.S. Generalization of PA outcomes reported in this review to countries outside of the U.S. and to the Northwest and Midwest regions of the U.S. is cautioned. Likewise, even among U.S. regions where the majority of studies were conducted, only a few of the overall number of parks present in these regions were assessed.

Therefore, the possibility exists that data presented from the studies reviewed do not actually reflect the overall park use trends in these regions, which may limit the generalization of our findings. We also intended to examine whether MVPA outcomes differed among parks located urban, suburban, and rural areas. However, due to the lack of specification (for many studies) in regards to the type of neighborhood where parks were assessed and heterogeneity in how PA outcomes were reported, we were unable to perform this analysis. Similarly, differences in the conceptualization and design of cities where parks were located likely influenced the PA outcomes. Given an in-depth examination of this topic was beyond the scope of this review, future research is needed examine whether park-based PA differs among cities with different urban planning structures and environmental designs.

We did not evaluate the association between park design/physical park structures and park-based PA. Such evaluation supersedes the scope of this review and due to variation in how authors described park setting/design characteristics, would be difficult to accomplish. However, a recent qualitative review [13] examining the association between park characteristics and park-based PA provides some insight on this topic. Researchers are referred to this reading for further information on this topic. Lastly, we only reviewed park-based PA studies that were published in English language peer-reviewed journals and indexed in PubMed, PsycINFO, CINAHL, Web of Science, Scopus, or The Active Living Research website. Accordingly, studies published in non-peer-reviewed journals, in languages other than English, and/or in databases other than the six we searched (e.g., Google Scholar or ProQuest) were not included in the review.

Despite these limitations, our review has several strengths. To our knowledge, this is the first review to synthesize PA outcomes for observational park-based PA studies. Findings provide important insight on how parks contribute to the PA levels of populations. Another strength was the comprehensive search method used to identify park-based PA studies. We adhered to PRISMA guidelines [14] and searched 5 electronic databases, as well as the Active Living Research website to identify articles. These rigorous search procedures increased the likelihood of including all published articles meeting inclusion criteria into the review. Finally, our review highlights several shortcomings in the current park-based PA literature for researchers to address in future research, including: lack of a standardized observational protocol (i.e., number of days parks were assessed and number of observations per day) to evaluate park-based PA, variation in reporting methods PA outcomes, paucity of published studies evaluating park-use outside of the U.S., and lack of interventional studies examining how the parks can be designed or manipulated to promote PA. To address these shortcomings, we propose the following 6 guidelines for researchers conducting future park-based PA studies:

1. Use a standardized audit measure and observation protocol to assess park use. As previously noted, we recommend using the SOPARC with a 7 consecutive day observation period and 4 observation times per day. This is a validated protocol for the SOPARC and was the most commonly used observational method among studies reviewed. For researchers who are unable to perform this recommended protocol, a 4 day observation period

with 4 observations per day represents a viable alternative, as it provides close to perfect reliability replication as a 7-day assessment [48].

2. Report PA outcomes based on percentage of park users and by age, sex, and race/ethnicity. The heterogeneity of how authors reported PA outcomes limited comparison of PA outcomes across all 26 studies based on age, sex, and race/ethnicity. Following these coding and reporting procedures will help standardize how PA outcomes are reported across studies and support comparison of PA outcomes across multiple studies.
3. Conduct more studies outside of the U.S. Only 9 of the 26 studies reviewed included populations from outside the U.S., which limits the generalizability of this review to other countries. Given social and cultural norms vary across countries, more research is needed to examine the park-based behavior of individuals outside of the U.S.
4. Conduct more studies comparing U.S. park use to other countries. Only 1 study [41] compared park-based PA between parks located in 2 different countries. Examining how park-based activities differ based on country or geographic region will provide a more in-depth understating of how various cultures use parks and provide valuable information to researchers on the how to leverage community parks to promote.
5. Conduct more studies evaluating park use in the Northeast and Midwest regions of the U.S. Only 4 of the studies assessed parks located in the Midwest (n=3 studies) and Northwest (n=1 study) regions of the U.S. Additional studies in these geographical regions are needed to help provide a more in-depth understanding of how park-based PA varies across the U.S.
6. Conduct more intervention/manipulation studies to determine how the physical structures of park environments can be designed to promote PA. Five studies included in the review examined how constructing, modifying, and/or redesigning the physical spaces of parks influenced PA levels of park-users [19, 27, 31, 34, 35]. While in-depth discussion of how park modifications influenced PA outcomes supersedes the purpose of this article, results generally showed (with the exception of 1 study [34]) that increasing play equipment for children, removing sitting structures, enhancing green space, and providing outdoor exercise equipment was associated with higher MVPA levels [19, 27, 31, 35]. However, due to the limited number of studies examining how the physical environment of parks influences PA levels, more research is needed on this topic. This knowledge will help inform researchers and park planners on best practices to design parks in order to effectively promote PA among users.

Conclusion

Parks are ideal places to promote PA. In most cases, parks can be accessed free of charge by community members and provide safe environments for children and adults to socialize and

engage in walking, sporting, gaming, and various other activities. Results of this review provide encouragement of the use of parks to promote PA since the majority of park users across studies were observed engaging in moderate-to-vigorous PA. As more studies are conducted, a more comprehensive understanding of how parks can contribute to PA engagement among the community members they serve will be gained.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Abbreviations

PA	Physical Activity
MVPA	Moderate-to-vigorous physical activity
SOPARC	System for Observing Play and Recreation in Communities
SOPLAY	System for Observing Play and Leisure Activity in Youth

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HIGHLIGHTS

- A systematic review of observational park-based physical studies was conducted.
- Thirty-two articles encompassing 26 unique studies were reviewed.
- Moderate-to-vigorous physical activity among park users ranged from 31% to 85%.
- Guidelines for future observational park-based physical activity studies are discussed.

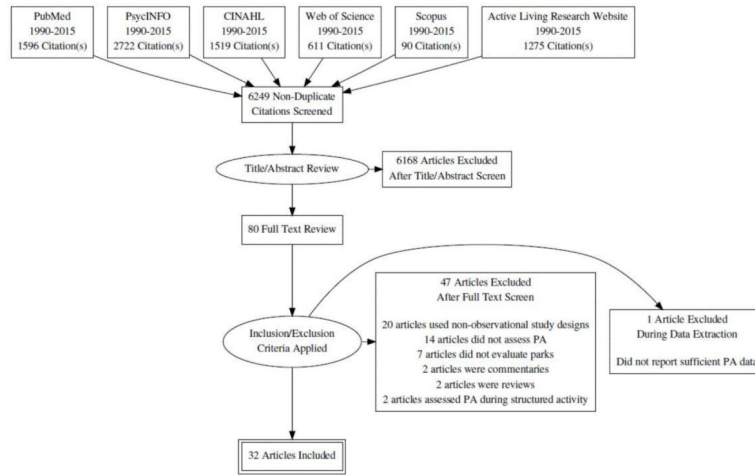


Fig. 1. PRISMA flow diagram illustrating article search and selection procedures for systematic review of observational park-based physical activity studies

Table 1

Cross sectional design studies.

Author(s)/year ^a	Study Purpose	Number of Parks Assessed	Geographical Location of Park(s)	Assessment Measure	Number of Days each Park was Observed	Number of Observations per Park	Number of Park Users and Demographic Characteristics	Physical Activity Outcomes ^b
Chung-Do, 2011 [16]	To examine use and conditions of 6 urban parks, varying in size, location, and neighborhood income level, in predominately Asian and Pacific Islander communities.	6	Honolulu, Hawaii, USA	SOPARC	5 days (3 weekday, 2 weekend)	20 (4 observations per day for 5 days)	Total: 6,477 (not reported per park) By gender: 64% males 36% females Ethnicity: NR By age: 29% children 71% adults	Overall: 60.2% Sedentary 25.6% Moderate 14.2% Vigorous By gender: Females 64.1% Sedentary 23.8% Moderate 12.4% Vigorous Males 58.0% Sedentary 26.5% Moderate 15.4% Vigorous By Age: Adults 61.6% Sedentary 26.8% Moderate 11.6% Vigorous Children 56.9% Sedentary 22.4% Moderate 20.7% Vigorous Ethnicity: NR
Cohen 2007 [17]* McKenzie 2006 [11]	To examine how 8 parks in minority communities were used, and how much physical activity occurs in them.	8	Los Angeles, CA, USA	SOPARC	7 days (5 weekday, 2 weekend)	28 (4 observations per day for 7 days)	Total: 14,791 (mean 1849 per park) By gender: 62% males 38% female By Ethnicity: NR By age: 33% children 19% adolescents 43% adults <5% over age of 60	Overall: 66% Sedentary 19% Walking 16% Vigorous Females 71.3% Sedentary 18.4% Moderate 10.2% Vigorous Males 62.1% Sedentary 19.1% Moderate 18.8% Vigorous Additional outcomes reported: Males were twice as likely to engage in vigorous activity as females (19% vs. 10%)
Cohen 2010 [20]	Assess how park characteristics and demographic factors are associated with park use.	30	Southern California, USA	SOPARC	7 days (5 weekday, 2 weekend)	28 (4 observations per day for 7 days)	Total: 54,660 (average 1822 per park) By gender: 61% male 39% female By ethnicity: NR By age: 34% children 17% teens 46% adults 3% over age of 60	Overall: 68% Sedentary 20% Walking 12% Vigorous Note: Age and gender breakdown was not presented or able to be calculated with data in the article.
Han 2013 [25]* Cohen 2011 [48]	To quantify the contribution of	10	2 parks were observed in	SOPARC	14 days; 7 days	98 (14 observations	Total: 76,632 (average 7663	The proportion of park-use time in

Author(s)/year ^a	Study Purpose	Number of Parks Assessed	Geographical Location of Park(s)	Assessment Measure	Number of Days each Park was Observed	Number of Observations per Park	Number of Park Users and Demographic Characteristics	Physical Activity Outcomes ^b
	U.S. neighborhood parks to the time spent in moderate-to-vigorous physical activity by the local population.		each of the following US locations: Los Angeles, California Albuquerque, New Mexico Durham, North Carolina Columbus, Ohio Philadelphia, Pennsylvania		(5 weekday, 2 weekend) during spring and 7 during fall	per day for 7 days)	per park) By gender: 53.8% male 46.2% female By ethnicity: 6 parks had majority White populations, exact breakdown NR By age: NR	MVPA varied between 35% and 46% among parks assessed.
Cohen 2014 [21]	To assess the use of new pocket parks in low-income neighborhood. Park use was evaluated between 3 pocket parks and 15 full-size comparison parks.	18 (n=3 pocket parks, n=15 full-size parks)	Los Angeles, California, USA	SOPARC	7 days (5 weekday, 2 weekend)	28 (4 observations per day for 7 days)	Total: 2452 (average 136 users per park) By gender: 57.3% female 42.7% male By ethnicity: NR By age: 76.3% children/teens 20.6% adult 3.1% older adult Pocket Parks: 37% male 63% female 64% children/teens 32.4% adults 3.6% over age of 60 Comparison Parks: 44% male 56% female 79% children/teens 18% adults 3% over age of 60	Overall: 63% Sedentary 37% moderate-to-vigorous PA Pocket Parks: 76% Sedentary 24% moderate-to-vigorous PA Females were less active than males in pocket parks (22% engaged in MVPA vs. 29% males). Comparison parks: 60% Sedentary 40% moderate-to-vigorous PA Additional outcomes reported: Children and teens were primary users of pocket and comparison parks. <i>Note: Due to limited results, age/sex breakdowns of PA is not possible.</i>
Floyd 2008 [24]* Floyd 2008 [49] Spengler 2011 [50] Suau 2012 [51]	To examine physical activity and selected correlates in 28 parks.	28	Tampa, Florida (n=10 parks) and Chicago, Illinois (n=18 parks)	SOPLAY	Approximately 39 days; exact number of days NR; parks were observed daily Monday-Friday for 2 months.	156 (4 observations per day Monday-Friday over a 2 month period)	Total: 9,454 (average 337 users per park) By gender: 55.7% male 44.3% female By ethnicity: 25.1% White 21.1% AA 53.8% Hispanic By age: Significantly more children observed than adults.	Overall: 11% vigorous 23% walking 65% sedentary Additional outcomes reported: Males more likely to be observed in MVAP than women. More children than

Author(s)/year ^a	Study Purpose	Number of Parks Assessed	Geographical Location of Park(s)	Assessment Measure	Number of Days each Park was Observed	Number of Observations per Park	Number of Park Users and Demographic Characteristics	Physical Activity Outcomes ^b
							<i>Note: exact % by age not provided and could not be calculated with available data.</i>	adults observed in walking or vigorous PA. Tampa: 8% vigorous 21% walking 70% sedentary Chicago: 22% vigorous 28% walking 51% sedentary
Hutchison 1994 [26]	To examine differences in leisure and recreational activities between men and women and among elderly people and those in other age groups.	13	Chicago, Illinois	Exact measure NR. Assessment strategy similar to, SOPARC and SOPLAY	At least 6 (each park was assessed at least 4 weekdays and 2 weekend days—exact number of days for each park NR)	Approximately 324 per park; exact number NR; across all 13 parks there was a total 3,072 observations---resulting in a mean of 324 observations per park	Total: 18,334 (1410 average users per park) <i>Note: % by sex, ethnicity and age could not be calculated with data provided in article.</i>	<i>Notes: Outcomes were classified by gender groups performing activities (males, females, and mixed male/female) and by age groups. Activities were classified as mobile (i.e., bicycling, walking, jogging), stationary (i.e, sedentary, picnicking, lounging), or sport.</i> Gender Group Outcomes: Males 28.6% stationary 48.9% mobile 22.6% sport Females 55.6% stationary 34.5% mobile 10.2% sport Mixed 46.5% stationary 37.9% mobile 16.0% sport Age Group Outcomes: Child 42.3% stationary 34.3% mobile 23.4% sport Teen 23.5% stationary 51.5% mobile 25.3% sport Adult 34.5% stationary 50.4% mobile 15.4% sport Elderly 64.4% stationary 30.5% mobile 5.3% sport Mixed 52.4% stationary 32.3% mobile

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Author(s)/year ^a	Study Purpose	Number of Parks Assessed	Geographical Location of Park(s)	Assessment Measure	Number of Days each Park was Observed	Number of Observations per Park	Number of Park Users and Demographic Characteristics	Physical Activity Outcomes ^b
								15.3% sport
Parra 2010 [42]	To assess park use and difference in physical activity and occupation rates in public parks with and without supervised physical activity classes.	10	Recife, Brazil	SOPARC	11 (detailed information on observation schedule NR)	Approximately 558.9 per park; exact number NR. 5589 Total observations across the 10 parks.	Overall 32,974 By gender: 44% female 56% male By Ethnicity: NR By age: 13% children 13% teen 64% adult 11% older adult Parks with PA classes N= 18,007 45.1% female 54.9% male 13% children 13.3% teen 60.5% adult 14.7% older adult Parks Without PA Classes N=14,967 42.5% female 57.5% male 11.9% children 12.7% teen 67.8% adult 5.7% older adult	Overall: 43% Sedentary 39% Walking 18% Vigorous <i>Note: Data were not presented for gender or age.</i> Parks With PA Classes 36.3% Sedentary 39.1% Walking 24.6% Vigorous Parks without PA classes 50.8% Sedentary 38.9% Walking 10.4% Vigorous
Pleson 2014 [38]	To better understand older adults usage and perceptions of community parks in Taipei, Taiwan through direct observation and structured interviews.	7	Taipei, Taiwan	SOPARC	6 parks were observed for 1 day 1 park was observed for 2 days	1 observation per day for 4 parks 2 observations per day for 2 parks, 4 observations per day for 1 park	Total: 1231 By gender: 44% males 55.6% female .3% missing data By ethnicity: NR By age: 12.4% children 3.2% teen 21.5% adults 61.5% over age of 60	Overall: 13.7% Sedentary 36.5% Walking 44.1% MVPA 3.8% missing data Male 10.3% sedentary 48.6% walking 41.1% MVPA Female 17.7% sedentary 33.2% walking 49.1% MVPA Child/Teen 21.1% sedentary 25.8% walking 53.2% MVPA Adult 23.0% sedentary 43.7% walking 33.3% MVPA Older adult 9.5% sedentary 42.5% walking 48.0% MVPA
Reed 2008 [29]	To examine adult activity park settings in 25 community parks to determine the most and least frequently used settings.	25	Southeastern, USA	SOPARC	7 (consecutive days)	28 (4 observations per day for 7 days)	Total: 2544 By gender: 37% female 63% male By ethnicity: 67.8% White 32.2% Non-white By age:	Overall: 14.6% Sedentary 49.7% Walking 35.7% Vigorous Males 13.7% Sedentary 42.6% Walking 42% Vigorous Females

Author(s)/year ^a	Study Purpose	Number of Parks Assessed	Geographical Location of Park(s)	Assessment Measure	Number of Days each Park was Observed	Number of Observations per Park	Number of Park Users and Demographic Characteristics	Physical Activity Outcomes ^b
							100% adult	16.3% Sedentary 61.8% Walking 20% Vigorous Whites 18.7% Sedentary 44.5% Walking 36.8% Vigorous Non-whites 22.0% Sedentary 54.4% Walking 23.8% Vigorous
Reed 2012 [30]	To examine park user demographics, compare park user demographics to the demographic characteristics of Michigan residents, and examine physical activity patterns of park users.	16	Michigan, USA Parks located throughout the state of Michigan.	SOPARC	NR	NR	Total: 4,359 By gender: 44.8% female 55.2% male By ethnicity: 54.7% White 42.8% Non-white By age: 44.5% children 25.6% teen 27.9% adult 2.1% older adult	Overall: 21.2% Sedentary 37.9% Walking 40.8% Vigorous Males 17.4% Sedentary 36.3% Walking 46.3% Vigorous Females 25.9% Sedentary 40.0% Walking 34.1% Vigorous Whites 20.9% Sedentary 30.7% Walking 48.5% Vigorous Non-whites 19.6% Sedentary 48.1% Walking 32.3% Vigorous Child 12.6% Sedentary 36.2% Walking 51.2% Vigorous Teen 17.6% Sedentary 31.8% Walking 50.6% Vigorous Adult 37.8% Sedentary 44.9% Walking 17.3% Vigorous Older Adult 27.8% Sedentary 57.8% Walking 14.4% Vigorous
Shores 2008 [32]	To describe the relationship between micro-level environmental components and park visitors' physical activity.	4	Mid-eastern region of the United States	SOPLAY	7 (consecutive days)	28 (4 observations per day for 7 days)	Total: 2,113 By gender: Exact % NR; Slightly more women than men observed By ethnicity: 49.6% White 38.4% AA 10.6% Hispanic 1.5% Missing data By age: 29% children 15% teen 52% adult 5% older adult	Overall: 33.3% Sedentary 20% Moderate 45% Vigorous Additional outcomes reported: More children were observed in vigorous PA. Boys achieved moderate activity through participation in baseball and tennis. Girls achieved moderate activity by

Author(s)/year ^a	Study Purpose	Number of Parks Assessed	Geographical Location of Park(s)	Assessment Measure	Number of Days each Park was Observed	Number of Observations per Park	Number of Park Users and Demographic Characteristics	Physical Activity Outcomes ^b
								walking or tennis. Adults were most often observed in sedentary activities. <i>Note: No outcomes reported by ethnicity.</i>
Shores 2010 [33]	Examine the use and physical activity outcomes associated with rural and urban parks.	8 (4 rural and 4 urban)	North Carolina, USA	SOPARC	7 (consecutive days)	28 (4 observations per day for 7 days)	Total: 6545 By gender: 48.7% female, 51.3% male By Ethnicity: NR By age: 39.2% children, 20.8% teen, 34.3% adult, 5.8% older adult Rural Parks N= 3730 51.1% female, 48.9% male, 28.4% children, 23.3% teen, 42.3 adult, 6% older adult Urban Parks N= 2815 51.6% female, 48.4% male, 53.5% children, 17.4% teen, 23.7 adult, 5.5% older adult	Overall: 38.5% Sedentary, 6.0% Walking, 55.4% Vigorous Rural Parks 50.5% Sedentary, 6.7% Walking, 42.8% Vigorous Urban Parks 22.7% Sedentary, 5.1% Walking, 72.2% Vigorous <i>Note: Data were not presented for gender or age.</i>
Temple 2011 [39]	To examine if self-reported dog walking practices of dog owners could be confirmed with observation data.	6	Victoria, British Columbia, Canada	SOPARC	6 (2 weekday, 1 weekend day; 2 assessment periods 6 weeks apart)	6 (1 observation per day, 3 observation days per park at 2 separate assessment periods)	Total: 2844 Data on age, sex, race, or ethnicity not provided.	Overall: 19.6% Sedentary, 69.4% Walking, 11.0% Vigorous <i>Note: Data on age, sex, race, or ethnicity not provided.</i>
Tu 2015 [43]	To determine the association between park user characteristics and physical activity.	8	Nanchang, China	SOPARC	12 (2 weekdays, 2 weekend days; for 3 weeks)	48 (4 observations per day, 4 days per week, per week for a 3 week period)	Total: 75,678 By gender: 52% male, 48% female By Ethnicity: NR By age: 9.1% children, 2.9% teen, 34.6% adult, 53.4% older adult	Overall 45% Sedentary, 38.8% Walking or moderate PA, 16.2% Vigorous Males 52.3% Sedentary, 47.7% MVPA Females 37% Sedentary, 63% MVPA Children 56.6% Sedentary, 53.4% MVPA Teens 39.4% Sedentary, 60.6% MVPA

Author(s)/year ^a	Study Purpose	Number of Parks Assessed	Geographical Location of Park(s)	Assessment Measure	Number of Days each Park was Observed	Number of Observations per Park	Number of Park Users and Demographic Characteristics	Physical Activity Outcomes ^b
								<p>Adults 39.2% Sedentary 60.8% MVPA</p> <p>Other outcomes: Females (63%) more likely to be active than males (47.7).</p> <p>Additional outcomes reported: Teens (60.8%) and adults (60.6) were more active than children (53.4) and older adults (51.4).</p>
Van Dyck 2013 [41]	To examine whether the overall number of park visitors and their activity levels depend on study site, neighborhood walkability, and neighborhood crime.	20	10 Ghent, Belgium 10 San Diego, California, USA	SOPARC	3 (2 weekday, 1 weekend)	12 (4 observations per day for 3 days)	<p>Total: 1836</p> <p>By gender: 40.1% female 59.9% male</p> <p>By ethnicity: 64.7% White 11.2% Latino 7.5% AA 13.6% other .3% missing</p> <p>By age: 22.3% children 27.7% teen 46.9% adult 3.1% older adult</p> <p>Ghent N= 766 48.7% female 51.3% male 89.4% White 0% Latino .7% AA 9.1% other .8% missing 13.8% children 45.7% teen 35.3% adult 5.2% older adult</p> <p>San Diego N= 1070 34.0% female 66.0% male 51.7% White 19.2% Latino 12.4% AA 16.7% other 0% missing 28.3% children 4.9% teen 55.2% adult 1.6% older adult</p>	<p>Overall 44.9% Sedentary 18.3% Walking 36.1% Vigorous .7% Missing data</p> <p>Ghent 53.3% Sedentary 20.8% Walking 24.2% Vigorous 1.5% Missing data</p> <p>San Diego 38.8% Sedentary 16.5% Walking 44.7% Vigorous 0% Missing data</p> <p><i>Note: PA outcomes for age, ethnicity, or sex was not presented.</i></p>
Vietch 2015 [36]	To describe the observed baseline characteristics	2	Melbourne, Australia	SOPARC	8 (4 weekend days, 4 weekdays)	59 (weekdays: 8 observations per day for 3	<p>Total: 4756</p> <p>By gender: 51.3% female 47.8% male</p>	<p>Overall 25% Sitting 37% Standing 29% Walking</p>

Author(s)/year ^a	Study Purpose	Number of Parks Assessed	Geographical Location of Park(s)	Assessment Measure	Number of Days each Park was Observed	Number of Observations per Park	Number of Park Users and Demographic Characteristics	Physical Activity Outcomes ^b
	of park visitors and characteristics of visitation and explore how these characteristics were associated with observed park-based physical activity.					days, only 7 observations per day for 1 due to rain; weekend days: 7 observations per day for 3 days)	By ethnicity: NR By age: 23.4% children 7.4% teen 53.4% adult 15.7% older adult	9% Vigorous Males 19.7% Sitting 38.9% Standing 30.3% Moderate 11.1% Vigorous Females 29.2% Sitting 35.7% Standing 27.4% Moderate 7.7% Vigorous Additional outcomes reported: Higher proportion of children and teens participated in moderate and vigorous PA than adults. Males more likely to participate in MVPA. Children had higher odds of participating in MVPA than other age groups.

Abbreviations: NR=Not Reported; SOPARC= System for Observing Play and Recreation in Communities; SOPLAY= System for Observing Play and Leisure Activity in Youth; PA= physical activity, MVPA= moderate-to-vigorous physical activity.

^aFor studies with multiple published articles describing outcomes, an asterisk (*) denotes the article referenced in the study throughout the article text.

^bPhysical activity outcomes are reported as percent of park-users unless otherwise noted.

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Table 2

Cross sectional Youth and Children Studies.

Author(s)/year ^a	Study Purpose/Design	Number of Parks Assessed	Geographical Location of Park(s)	Assessment Measure	Number of Days each Park was Observed	Total number of Observations per Park	Number of Park Users and Demographic Characteristics	Physical Activity Outcomes ^b
Coughenour 2014 [22]	To evaluate the relationship of environmental and social determinants to youth physical activity intensity.	10	Las Vegas, Nevada, USA	SOPLAY	8 (4 weekdays, 4 weekend days)	32 (4 observations per day for 8 days)	Total: 1,423 By gender: 41% female 59% male By ethnicity: NR	Overall: 20.9% Sedentary 38.2% Walking 40.9% Vigorous Males: 17.5% Sedentary 26.7% Walking 45.8% Vigorous Females: 25.6% Sedentary 39.9% Walking 34.5% Vigorous Additional outcomes reported: Males were significantly more likely than females to be walking or performing vigorous activity than being sedentary.
Floyd 2011 [23]	To examine associations among individual, park, and neighborhood environmental characteristics and children's and adolescent's park-based physical activity.	20	Durham, North Carolina, USA	SOPARC	NR	NR	Total: 2712 By gender: 56.5% Female 43.5% Males By ethnicity: NR By age: 42.6% aged 0-5 41.0% aged 6-12 16.4% aged 13-18	Overall: 52.6% Sedentary 34.2% Walking 13.2% Vigorous Additional outcomes reported: Girls were associated with lower PA intensity levels than boys. Children in the youngest age group (age 0-5) were more active than older children (age 6-12) and adolescents (age 13-18).
Reed 2012 [28]	Identify the activity settings used and physical activity intensity achieved by boys and girls in 45 parks in Southeastern U.S. Community.	45	Southeastern region of the US	SOPARC	7 (consecutive days)	28 (4 times per day for 7 days)	Total: 2852 By gender: 42% female 58% male By ethnicity: 41.5% White 58.5% other	Overall: 18% Sedentary 36% Walking 45% Vigorous <i>Note: Data were not available for PA intensity by ethnicity or gender.</i>

Abbreviations: NR=Not Reported; SOPARC= System for Observing Play and Recreation in Communities; SOPLAY= System for Observing Play and Leisure Activity in Youth; PA= physical activity, MVPA= moderate-to-vigorous physical activity.

^aFor studies with multiple published articles describing outcomes, an asterisk (*) denotes the article referenced in the study throughout the article text.

^bPhysical activity outcomes are reported as percent of park-users unless otherwise noted.

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Table 3

Quasi-experimental intervention studies

Author(s)/year ^a	Study Purpose/Design	Number of Parks Assessed	Geographical Location of Park(s)	Assessment Measure	Number of Days each Park was Observed	Total number of Observations per Park	Number of Park Users and Demographic Characteristics	Physical Activity Outcomes ^b
Bohn-Goldbaum 2013 [34]	Purpose: To determine how a park playground renovation impacts usage and PA of children ages 2-12 years. Design: Quasi-experimental pre-post design with a comparison park.	2	Sydney, Australia	SOPARC	7 days (5 weekday, 2 weekend) for each observation period	Pre-intervention: Park: 84 Comparison Park: 84 Post Intervention: Park: 84 Comparison Park: 80	<i>Note: number of park users is based on mean number of users.</i> Pre-intervention: Intervention Park: Overall: 4.5 By gender: 3.95 Males 5.05 Females By Ethnicity: NR Comparison Park: Overall: 8.52 By gender: 7.76 Males 9.29 Females By Ethnicity: NR Post Intervention: Overall: 4.98 Intervention Park: Overall: 5.33 Males 4.62 Females By Ethnicity: NR Comparison Park: Overall: 6.69 By gender: 7.71 Males 5.67 Females By Ethnicity: NR	Pre-intervention: On average, 1.7 children in the intervention park and 2.86 children in the comparison engaged in MVPA. No difference in MVPA by gender. Post Intervention: On average, .67 children in the intervention (decrease of 41%) park and 1.98 children in the comparison (decrease of 32%) engaged in MVPA. No difference in MVPA by gender. No difference between parks in the number of children engaging in MVPA.
Cohen 2012 [18]* Cohen 2013 [52]	Purpose: To determine if a community-based participatory approach with park directors and park advisory boards could increase physical activity	50	Los Angeles, CA, USA	SOPARC	14 total; 7 days (5 weekday, 2 weekend) at each assessment period.	56 (28 observations per assessment period; 4 observations were performed each day)	Pre-intervention: Total: 6328 By gender: 38% Female 62% male By Ethnicity: NR By age: 32.5% Children 15.2% teens 48.1% adults	Pre-intervention^c: 66% Sedentary 17% Walking 14% Vigorous Additional outcomes reported: Females more likely to be sitting or using the

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	<p>in local parks Design: RCT where 50 parks were assigned to one of 3 study arms: a) park director-led arm (PD-only), b) combined park advisory board and park director arm (PAB/PD), or c) measurement only control arm.</p>						<p>4.2% older adults <i>PD-Only Parks: Total:</i> 1970 By gender: 62.7% male 37.3 female By ethnicity: 62% Hispanic, 22.2% White, 9.1% AA, 6.7% Asian/other By age: NR <i>PAB/PD Parks:</i> Total: 1930 By gender: 60.6% male 39.45% female By age: NR By ethnicity: 50% Hispanic, 30.3% White, 9.6% AA, 10.1% Asian/other <i>Comparison Parks:</i> Total: 2340 By gender: 62.8% male 37.2 female By ethnicity: 62% Hispanic, 58.6% White, 14.9% AA, 4.6% Asian/other By age: NR Post-Intervention: In comparison to the control parks, PD-only and PAB/PD parks had a combined increase of 7%-12% or 196 person-hour visits/week ($p=.035$). Note: Descriptive information on park users at follow-up was not presented.</p>	<p>playground area. Males were more likely to be participating in sports activities. Post-Intervention Outcomes: In comparison to the control parks where PA marginally declined ($p=.07$), PA increased in both the PD-only and PAB/PD parks generating an estimated increase in 1830 MET-hours of PA/week/park. Intervention parks saw an increase in energy expenditure among men and boys. No differences were noted between the PD-only and PAB/PD study arms.</p>

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Cohen 2015 [19]	<p>Purpose: To examine the impact of park renovations on park usage and PA.</p> <p>Design: Quasi-experimental pre-post design involving 3 pairs of parks. One pair of parks was evaluated before and after a renovation. Findings were compared with a pair of parks that were unrenovated and a pair that was undergoing renovation.</p>	6	San Francisco, CA, USA	SOPARC	14 total; 7 days (5 weekday, 2 weekend) at baseline and 7 days at follow-up.	56 (4 observations per day for each day during the assessment period)	<p>Pre-Renovation: Total: NR (could not be determined due to multiple assessments of the same individuals) By gender: More males than females at all parks. Exact % not provided. By ethnicity: NR By age: 38.5% children/teens 57% adult 4.5% older adult Post Renovations: NR</p>	<p>Pre-Renovations^c: Across all parks, the majority of participants were classified as sedentary (range 49.9%-79.5%), followed by moderate (range 15.5% to 33%) and vigorous (5% to 22%). <i>Note: Data not presented for gender or race.</i> Post-Renovations: Among renovated parks, use increased while use in comparison parks had not change. Increased use was reflected by more children, teens, and adults using the parks (no change for older adults).</p>
King 2015 [27]	<p>Purpose: To quantify and report use of the surrounding streets, alleys, parking lots, and green space for play and leisure activities pre-(conducted in 2010) and post-park construction (conducted in 2012).</p> <p>Design: Prospective, non-randomized design pre-posttest design.</p>	1 Note: Only post-renovation park data is presented.	Denver, Colorado, USA	SOPARC	18 (4 days per month for 4 months)	144 (72 observations for each assessment year)	<p>4525 By gender: 46.4% female 53.6% male By gender: 98.9% Non- White By age: 43.3% children 28.1% adolescents 25.3% adult 3.3% older adult</p>	<p>Overall^d: 34.0% Sedentary 40.8% Walking 25.2% Vigorous Males: 42% sedentary 38% Moderate 20% Vigorous Females: 26% sedentary 32% Moderate 42% Vigorous By ethnicity: NR Additional outcomes reported: Post-construction, average number of users of the park increased, children made up a smaller</p>

Author(s)/year ^a	Study Purpose/Design	Number of Parks Assessed	Geographical Location of Park(s)	Assessment Measure	Number of Days each Park was Observed	Total number of Observations per Park	Number of Park Users and Demographic Characteristics	Physical Activity Outcomes ^b
Reimmich 2014 [31]	<p>Purpose: To test whether moving seating away from a park playground would increase the physical activity and length of stay of park users.</p> <p>Design: Two individual studies were conducted, both had a prospective, single-site, A-B-A design. Seven-days of observation were taken during baseline (A₁) with seating close to the playground. Seating was removed and another 7-day assessment was conducted (B), then seating was returned to baseline placement (A₂).</p>	1	Grand Forks, North Dakota, USA	SOPARC	21 (7 days at each assessment period)	21 (one observation per day for a 7-day period at each assessment)	<p>Overall: N=815 By gender: NR By ethnicity: NR By age: 47% Children 53% Adults Note: Only children aged 0-12 and adults 19+ were included in this article. Study 1: Condition A₁ Children: 3.1 METs Adult: 1.8 METs Condition B Children: 3.8 METs Adult: 2.0 METs Study 2: Condition A₁ Children: 3.1 METs Adult: 1.4 METs Additional outcomes reported: Overall, activity intensity for both children and adults was greater when eating was not accessible. Study 2: Condition A₁ Children: 3.2 METs Adult: 1.7 METs Condition B Children: 3.6 METs Adult: 2.3 METs Condition A₂ Children: 3.4</p>	<p>porter of users, but there was an increase in teen use, and a lower proportion of adults and seniors. PA intensity among vigorous activity among females increased (mostly children). There was a significantly greater proportion of males engaging in vigorous PA after construction.</p>

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Veitch 2012 [35]	<p>Purpose: To examine whether park improvements are associated with increased park use and park-based physical activity of users.</p> <p>Design: Two-arm quasi-experimental design where one park received renovations and another park did not. Outcomes were assessed at 3 different time points: Baseline (T1), Post-renovation (T2), and 12-months after baseline (T3).</p>	2	Victoria, Australia	SOPARC	27 (9 days at each assessment period)	108 (each park was observed 4 times per-day over a 9 day period at each of the 3 assessment period)	<p>Condition A₂ Total: 122 59.2% Children 40.2% Adult <i>Note: Data not presented for gender.</i></p> <p>Overall: 2050 By gender: 53.5% Male 46.5% Female By ethnicity: NR By Age: 8.5% Aged 2-4 27.3% Aged 5-18 63.9% Aged > 18 T1: Intervention Park: 235 44.7% Female 55.3% Male 6.0% Aged 2-4 24.3% Aged 5-18 69.6% Aged > 18 T1: Comparison Park: 83 51.8% Female 48.2% Male 1.2% Aged 2-4 16.9% Aged 5-18 81.9% Aged > 18 T2: Intervention Park: 582 43.3% Female 56.7% Male 15.3% Aged 2-4 21.2% Aged 5-18 63.7% Aged > 18 T2: Comparison Park: 114 58.8% Female 41.2% Male 3.5% Aged 2-4 11.4% Aged 5-18 85.1% Aged > 18 T3: Intervention Park</p>	<p>MET's Adult: 1.6 MET's Additional outcomes reported: Overall, outcomes replicated Study 1 with activity intensity for both children and adults was greater when eating was not accessible.</p> <p>Overall^c: 9.3% Sitting 23.7% Standing 45.7% Walking 21.4% Vigorous Additional Outcomes: In the intervention park, there was a significant increase in total users and those observed walking and being vigorously active. At the control park, usage decreased and no differences in walking or vigorous activity was observed.</p>

Author(s)/year ^a	Study Purpose/Design	Number of Parks Assessed	Geographical Location of Park(s)	Assessment Measure	Number of Days each Park was Observed	Total number of Observations per Park	Number of Park Users and Demographic Characteristics	Physical Activity Outcomes ^b
							Total: 985 47.5% Female 52.5% Male 6.6% Aged 2-4 36.4% Aged 5-18 57.0% Aged > 18 T3: Comparison Park: 51 41.2% Female 55.8% Male 2.0% Aged 2-4 3.9% Aged 5-18 94.1% Aged > 18	

Abbreviations: NR=Not Reported; SOPARC= System for Observing Play and Recreation in Communities; SOPLAY= System for Observing Play and Leisure Activity in Youth; PA= physical activity, MVPA= moderate-to-vigorous physical activity.

^aFor studies with multiple published articles describing outcomes, an asterisk (*) denotes the article referenced in the study throughout the article text.

^bPhysical activity outcomes are reported as percent of park-users unless otherwise noted.

^cPre-intervention PA outcomes were used in descriptive analysis.

^dMean PA levels for each intensity levels used in descriptive analysis.

Table 4

Median (range) of park-users engaging in sedentary, moderate, vigorous and total moderate-to-vigorous physical for the 23 studies reporting physical activity outcomes based on percentage of observed users.

	No. Studies included in analysis	Percent Sedentary	Percent Moderate	Percent Vigorous	Percent MVPA
All Studies	23 ^a	43.0 (13.7 – 68.0)	34.2 (6 – 69.34)	21.7 (9.0 – 55.5)	55.0 (31.0 – 85.4)
U.S. Studies	15 ^b	39.7 (14.6 – 68.0)	28.6 (6.0 – 49.7)	35.7 (11.0 – 55.5)	60.5 (31.0 – 85.4)
West Region	9	60.2 (20.9 – 68.0)	22.8 (16.8 – 42.1)	16.0 (12.0 – 44.7)	39.9 (31.0 – 79.1)
Midwest Region	3	40.5 (21.2 – 51.0)	33.9 (28.0 – 39.7)	31.4 (22.0 – 40.8)	59.9 (50.0 – 85.5)
South region	6	35.9 (14.6 – 70.0)	27.6 (6.0 – 49.7)	40.4 (8.0 – 55.5)	63.4 (29.9 – 85.4)
Northeast	0	-	-	-	-
Studies Outside the U.S.	8	44.0 (13.7 – 62.0)	38.9 (20.8 – 69.4)	17.1 (9.0 – 36.5)	52.8 (38.0 – 80.4)
Children only	8 ^c	35.0 (14.4 – 76.6)	35.3 (22.4 – 38.2)	30.8 (13.2 – 51.0)	64.9 (23.2 – 85.6)
Adults Only	6 ^c	46.35 (13.1 – 67.5)	36.3 (25.6 – 49.7)	15.55 (7.0 – 35.7)	53.65 (23.2 – 85.6)

Notes:

^a 1 study [26] did not provide separate analysis of moderate and vigorous intensity PA; thus only 22 studies are presented in descriptive outcomes at these two PA intensities.

^b 2 studies [19, 26] did not provide separate analysis of moderate and vigorous intensity PA; thus only 13 studies are presented in descriptive outcomes at these two PA intensities.

^c 2 studies [24, 38] did not provide separate analysis of moderate and vigorous intensity PA; thus only 6 studies are presented in descriptive outcomes at these two PA intensities for children only and 4 for adult only.