SSM -Population Health 2 (2016) 237–243

Contents lists available at ScienceDirect

SSM -Population Health

journal homepage: www.elsevier.com/locate/ssmph

Article

Changes in visitor profiles and activity patterns following dog supportive modifications to parks: A natural experiment on the health impact of an urban policy

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ARTICLE INFO

Article history:
Received 22 September 2015
Received in revised form
30 March 2016
Accepted 31 March 2016

Keywords:
Natural experiment
Park
Dog walking
Physical activity
Built environment

ABSTRACT

Urban parks are important settings for physical activity, but few natural experiments have investigated the influences of park modifications on activity patterns and visitor profiles.We assessed the impact of implementing a municipal policy on off-leash dogs in city parks in Calgary (Alberta, Canada). Systematic observation undertaken in 2011 and 2012 within four parks captured patterns of use, activities, and visitors' characteristics. After baseline data collection, off-leash areas were created in two parks only. We compared changes in the sociodemographic and activity profiles in all parks between 2011 and 2012. Visitors *with* dogs participated in less intense activity relative to visitors *without* dogs. In both modified parks, the intensity of children's activities decreased, while the intensity of adults' activities remained stable. Adjusting for visitor characteristics, the likelihood of dog-related visits, relative to other activities, significantly decreased in one of the two modified parks (odds ratio 0.55, $p < .05$). Accommodating off-leash dogs in parks has the potential to modify activities undertaken inside parks as well as the profile of visitors, but may not increase park visits among dog-walkers in the short term. Recreation, park, and urban planners and policy-makers need to consider the needs and preferences of the broader community in the design and redesign of public parks.

Introduction

Exposure to greenspace and natural environments can provide mental and emotional health benefits (Bowler, Buyung-Ali, Knight & Pullin, 2010; Lee & Maheswaran, 2010; Francis, Wood, Knuiman & Giles-Corti, 2012). Urban parks, in particular, provide opportunities for physical activity, play, social interaction, and relaxation for different segments of the population (Lee and Maheswaran, 2010; Francis et al., 2012; Kazmierczak, 2013; Peters, Elands & Buijs, 2010). As a public good, parks are accessible to large proportions of urban populations, and can support a diverse range of activities. Thus, urban parks are important settings for improving population health (Bedimo-Rung, Mowen & Cohen, 2005).

To improve park planning and design, more evidence on how park environments influence usage patterns is needed. Evidence from natural experiments investigating the relations between the built environment and physical activity is beginning to emerge (McCormack & Shiell, 2012; Koohsari et al., 2015) yet few examine changes in park use and activity following park modifications. For instance, the installation of new play and outdoor fitness equipment in parks, in addition to ground surfacing and landscaping improvements, led to an increase in visitors and the amount of energy expended by park visitors (Cohen et al., 2015). Elsewhere, the installation of outdoor fitness equipment in parks led to increased energy expenditure among visitors, mainly due to increases in moderate and vigorous-intensity activity resulting from the use of the installed equipment and changes in the demographic profile of visitors following the modifications (Cohen, Marsh, Williamson, Golinelli & McKenzie, 2012). Likewise, improvement to ground surfaces, new fencing, lighting, landscaping, and addition of

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http://dx.doi.org/10.1016/j.ssmph.2016.03.002

benches to two parks in a US low-income neighbourhood resulted in increases in park and playfield use, changes in the demographic profile of visitors, but also increases in the proportion of sedentary activity (Tester & Baker, 2009). Indeed, not all studies report improvements in park physical activity or visits following park modifications. For example, Cohen et al. (2009) found no improvements in observed or self-reported physical activity following modifications to several parks, such as the development or refurbishment of gymnasia, landscaping, picnic areas, paths, and ground surfaces surrounding play equipment. Concurrent changes in park programming (organized sports, operating hours etc.) alongside park modifications however, may contribute to changes in park use and activity (Tester & Baker, 2009; Cohen et al., 2009).

Parks serve as destinations for dog-walkers, and dog-walking routines support physical activity (Cutt, Giles-Corti, Knuiman & Burke, 2007; Christian et al., 2013). Dogs may provide motivation for people to remain active, when built environment (e.g., low walkability) and weather conditions might otherwise discourage physical activity (Temple, Rhodes & Wharf Higgins, 2011; McCormack, Shiell, Doyle-Baker, Friedenreich & Sandalack, 2014). Furthermore, neighbourhood built environment characteristics appear to be important for encouraging dog-walking (Westgarth, Christley & Christian, 2014; Richards, McDonough, Edwards, Lyle & Troped, 2013). A recent study found that dog-owners who walk their dogs were more likely to report more frequent dog-walking if they lived near an off-leash area, but other dog-owners nearby were less likely to walk their dogs at all (McCormack, Rock, Sandalack & Uribe, 2011). Another Canadian study found frequent dog-walking in parks, some of which allowed off-leash dogs (Temple et al., 2011). Within US cities, park spaces where dogs can be exercised support physical activity via dog-walking (Cohen et al., 2010; Lee, Shepley & Huang, 2009). Whereas, dog-owners in Australia residing within 1-mile of parks, which contained dog-supportive features, were more likely than other owners to regularly walk their dogs (Christian, Giles-Corti & Knuiman, 2010). Improvements to an Australian neighbourhood park, which included the installation of a 'fenced' off-leash area along with a playground, walking track, perimeter fencing, and a barbeque area, led to an increase in park visitors and in walking and vigorous physical activity (Veitch, Ball, Crawford, Abbott & Salmon, 2012). However, changes in the visitor profiles and dog-walkers visiting the park were not fully explored (Veitch et al., 2012).

Proximity of off-leash areas appear to be important for supporting dog-walking but the extent to which park modifications impact park activities and visitor profiles have not been investigated. This natural experiment examined the potential for creating off-leash areas to result in changes in: 1) demographic characteristics of park visitors, and; 2) patterns of park-based activity.

Methods

Study and sample design

Using purposive sampling, we selected four city parks in Calgary (Alberta, Canada). Taradale park (21.9 ha) had recently been designated as off-leash but had yet to undergo any environmental modifications (Parks Foundation Calgary, 2011). Martindale (2.48 ha), West Hillhurst (1.11 ha), and Meadowlark (1.39 ha) were publicly proposed as potential sites for new "off-leash" areas (City of Calgary, 2011), although only Martindale became designated during the study. West Hillhurst and Meadowlark parks remained in the study, serving as "comparison" sites. Using a pre-post study design, we collected quantitative systematic direct observation data from May to July in 2011 and 2012. The University of Calgary Research Ethics Board approved this study.

Park modifications

The physical characteristics of the four parks at baseline are fully described elsewhere (McCormack, Rock, Swanson, Burton & Massolo, 2014). No planned physical environmental changes occurred in the two parks that retained "on-leash" designations during the study (West Hillhurst and Meadowlark). West Hillhurst park is located at the neighbourhood periphery and separated from an adjacent major arterial road by a chain-linked fence. A bridge for pedestrians and cyclists joins the park with the river pathway located on the opposite side of the arterial road. The park includes an open area with trees, a playground, benches and garbage bins. Meadowlark park includes multiple open green areas and pedestrian and cycling paths that link the surrounding communities with a local major mall. The park is located on the neighbourhood periphery and a 10-foot tall concrete wall separates the park from an adjacent major arterial road. The park includes benches, garbage cans, public art, lighting, and landscaped gardens.

For Taradale and Martindale parks, the creation of off-leash areas resulted in modifications. At baseline, Taradale park was a 'natural' open field bisected by two paved pathways, and bordered by fences that separated the unmaintained green space from a baseball diamond, a major roadway, and residential neighbourhoods. One of the pathways connected the park with residential neighbourhoods, while the other formed part of a linear park system that was under development in land set aside as a transportation and utility corridor. Discreet signage pointed to an off-leash area but the boundaries were unclear. Prior to follow-up, a large section of the Taradale park, immediately adjacent to a residential neighbourhood, was fenced and gated as an off-leash area (4.13 ha). The fenced area was divided into two gated sections: one signed for larger dogs that included a pond, and the other signed for smaller dogs. The City's standard signs for off-leash areas were prominently installed within the fenced area. Gravel pathways, benches, and waste garbage bins were added within the fenced areas. A gravel parking lot was also installed near one of three gateways to the fenced off-leash area. The other gateways were located near the paved pathways in the larger park.

Martindale park included a natural but unkempt wooded area and a large open grassy area which contained a storm water drainage basin. The large park (2.48 ha) included a dual-use path and a garbage can placed by the path adjacent to street parking. The park featured a brass monument (a women pushing a girl on a swing set and an off-leash dog jumping) but neither a playground, dedicated lighting, nor seating (e.g., benches). Prior to follow-up in Martindale park, the City's standard signs for off-leash areas were prominently installed at the periphery of the main greenspace. An additional garbage bin for waste-disposal was also provided. Improvements to landscaping assisted with the drainage of storm water, although this modification was unrelated to the City's off-leash policy.

Data collection

Direct observation: quantitative data

The selected observation points within each of the four parks allowed most of the park area to be seen. Standing at the observation points, research assistants collected data in each park during the morning (830–1230 h) and an afternoon (1430–1830 h) on a Saturday, Sunday, and one weekday (Tuesday or Thursday). To begin the quantitative systematic observation, the research assistants selected the first park visitor within their field of vision and recorded their demographic characteristics and type of activity. The research assistants scanned the park in counter-clockwise direction and selected the next park visitor in their field of vision

for observation. Research assistants observed visitors for up to two minutes. Park visitor characteristics were captured with moderate-to-high inter-rater reliability (kappa statistic = 0.52–0.90) (McCormack et al., 2014).

Variables

Park visitor characteristics

Visitor variables presented in this article include sex, age (child/teenager or adult/senior), group (with dog or without dog), time of day recorded (morning or afternoon), and day of week (weekday or weekend) (McCormack et al., 2014).

Park activity type

Observed park activities were collapsed into six general types including: 1) *stationary* (stretching, standing, sitting, laying, using motorized equipment); 2) *walking*; 3) *running*; 4) *cycling*; 5) *playing* (skating, ball/frisbee games, tag/chase; playing on playground equipment, kite flying; other play), and 6) *dog-related* stationary (standing; sitting; laying) and mobile (walking; jogging/running; cycling; skating; ball/frisbee; chasing games; other playing) with dog on-leash or off-leash.

Park activity intensity

We assigned Metabolic Equivalent of Task (MET) values to visitor's non-collapsed (or raw) activity types to obtain an estimate of their relative intensity level (i.e., the estimated energy cost of the activity relative to the energy cost at rest). For adults, MET values from Ainsworth et al. (1993) were assigned, while for children MET values from Ridley and Olds (Ridley & Olds, 2008) were used.

Statistical analysis

Pearson's Chi-square with Bonferroni adjusted z-tests for pairwise comparisons estimated within-park differences in the frequencies of visitor characteristics and park activity types between 2011 and 2012. Park-stratified binary logistic regression models estimated the adjusted odds ratios (OR) and 95% confidence intervals (CI) for the association between each activity type (sedentary vs. not sedentary, walking vs. no walking, running vs. not running, cycling vs. not cycling, playing vs. not playing, and dog-related vs. not dog-related) and data collection period, adjusting for visitor's sex, age, time of day recorded, and day of week. Separately for each park, we used age-stratified (child/teenager and adult/senior) multiple linear regression models to regress park activity intensity on data collection year and visitor characteristics (sex, with a dog, time of day, and day of week recorded). Linear regression model estimates included unstandardized coefficients (β) and 95% confidence intervals. Analysis was undertaken using SPSS version 21 (IBM Corp., NY, USA).

Results

Visitor characteristics

Across parks, visitors were more commonly male, adult, without a dog, and present on a weekend day or in the afternoon (Table 1). In the modified parks, we observed more visitors in 2012 compared with 2011 (Table 1). Nevertheless, a significant ($p < .05$) decrease in the proportion of visitors in afternoons was observed in Taradale park between 2011 and 2012 (72.5% vs. 55.5%; Table 1) although the absolute number of afternoon visitors increased. Despite no significant changes in the proportion of children or visitors with dogs, we observed increases in the number of

Table 1
Visitor characteristics observed in 2011 and 2012 by park.

Characteristic	Martindale (modified)		Taradale (modified)		West Hillhurst (unmodified)		Meadowlark (unmodified)	
	2011 $n = 184$ % (n)	2012 $n = 248$ % (n)	2011 $n = 167$ % (n)	2012 $n = 410$ % (n)	2011 $n = 230$ % (n)	2012 $n = 267$ % (n)	2011 $n = 205$ % (n)	2012 $n = 164$ % (n)
Male	61.4 (113)	65.7 (163)	64.7 (108)	55.9 (229)	54.8 (126)	50.2 (134)	57.6 (118)	51.2 (84)
Adult/senior	41.3 (76)	56.5 (140)*	76.6 (128)	79.0 (324)	64.3 (148)	65.9 (176)	66.8 (137)	86.0 (141)*
With a dog	23.4 (43)	18.1 (45)	38.3 (64)	37.1 (152)	42.6 (98)	40.1 (107)	4.9 (10)	6.7 (11)
Afternoon use	82.1 (151)	76.6 (190)	72.5 (121)	55.4 (227)*	50.9 (117)	61.8 (165)	70.2 (144)	55.5 (91)*
Weekend use	56.0 (103)	69.4 (172)*	68.9 (115)	71.0 (291)	64.8 (149)	71.9 (192)	75.6 (155)	72.0 (118)

* $p < .05$ for park difference between 2011 and 2012 based on Pearson's Chi-square.

children and dog-related visits observed in Taradale park between 2011 and 2012. In Martindale the number and proportion of adult (41.3% vs. 56.5%) and weekend visitors (56% vs. 69.4%) significantly increased between 2011 and 2012, while the number of children remained stable. The number of Martindale visitors observed with a dog was also similar in 2011 and 2012.

In Meadowlark park, we found a significant ($p < .05$) increase in the proportion of adults (66.8% vs. 86%) despite a decrease in the number of adults observed in the park between 2011 and 2012. There was also a decrease in the proportion of afternoon visitors (70.2% vs. 55.5%) in Meadowlark. Despite some changes in visitor characteristics in West Hillhurst, none reached statistical significance (Table 1).

Visitor activities in parks

The most common activities in the modified parks were walking, cycling, and dog-related. From the unadjusted comparisons, there were no statistically significant changes in the proportion of park activity for the modified parks between 2011 and 2012 (Table 2). Nevertheless, the number of visitors observed walking, playing, and being sedentary increased notably in Martindale and Taradale. The number of visitors cycling and undertaking dog-related activity also increased between 2011 and 2012. Despite a similar number of visitors undertaking dog-related activity in 2011 and 2012, after adjusting for sex, age, time of day, and day of week, the likelihood of observing dog-related activity in Martindale, relative to all other park activities, was significantly lower in 2012 (OR 0.55, 95CI 0.33, 0.93).

The most common activities in the unmodified parks were play and dog-related in West Hillhurst, and walking and cycling in Meadowlark (Table 2). From the unadjusted comparisons, significant ($p < .05$) changes in the proportion of walkers (58.0–68.3%) and cyclists (25.9–15.9%) between 2011 and 2012 were found in Meadowlark park (Table 2). Furthermore, the number of observed visitors walking and playing increased in West Hillhurst, whereas the number of observed cyclists decreased in Meadowlark. The likelihood of walking was higher (OR 1.79, 95CI 1.13, 2.82) and the likelihood of cycling lower (OR 0.48, 95CI 0.28, 0.84) relative to all other park activities in Meadowlark in 2012, after adjusting for visitors characteristics.

Intensity of park activity

Based on the unadjusted comparisons, there was no significant difference in the intensity of activities undertaken in the modified parks among adult visitors over time (Taradale 2011: mean 4.2, (SD 2.0) vs. 2012: mean 4.3, (SD 2.1); Martindale 2011: mean 3.5, (SD 1.3) vs. 2012: mean 3.6, (SD 1.3)). However, intensity of activities observed in Meadowlark park was significantly ($p < .05$) lower in 2012 (mean 4.7, (SD 2.1) vs. mean 4.2, (SD 1.8)), even after adjusting for visitor characteristics (B-0.44, 95CI −0.88, −0.01) (Table 3). Notably, independent of data collection period and visitor characteristics, women in Martindale, Taradale, and Meadowlark and visitors with dogs in all four parks participated in less intense park activity compared with other women and those without dogs, respectively (Table 3).

For the modified parks, unadjusted results suggested a significant ($p < .05$) decrease in intensity of observed activities undertaken in Taradale park only among children (2011: mean 5.4, (SD 1.1) vs. 2012: mean 4.7, (SD 1.8)), although this difference was no longer statistically significant after adjustment for visitor characteristics (Table 4). After adjusting for visitor characteristics, the intensity of children's activity in Martindale park was significantly lower in 2012 compared with 2011 (B-0.35, 95CI −0.69, −0.00) (Table 4). Significant differences ($p < .05$) in the intensity

Table 2
Visitor activity observed in 2011 and 2012 by park.

Activity	Martindale (modified)		Taradale (modified)		West Hillhurst (unmodified)		Meadowlark (unmodified)	
	2011 $n = 184$ % (n)	2012 $n = 248$ % (n)	2011 $n = 167$ % (n)	2012 $n = 410$ % (n)	2011 $n = 230$ % (n)	2012 $n = 267$ % (n)	2011 $n = 205$ % (n)	2012 $n = 164$ % (n)
Sedentary	1.1(2)	4.0 (10)	0.6 (1)	2.4 (10)	13.5 (31)	10.1 (27)	6.3 (13)	6.7 (11)
Walking	41.3 (76)	46.4 (115)	26.9 (45)	26.8 (110)	6.5 (15)	10.9 (29)	58.0 (119)	68.3 (112)*
Jog/running	4.3 (8)	2.8 (7)	2.4 (4)	2.7 (11)	3.9 (9)	4.5 (12)	2.9 (6)	2.4 (4)
Cycling	24.5(45)	19.8 (49)	28.1 (47)	26.1 (107)	3.0 (7)	1.9 (5)	25.9 (53)	15.9 (26)*
Play	6.0 (11)	8.9 (22)	5.4 (9)	5.6 (23)	32.2 (74)	33.3 (89)	2.0 (4)	0.0 (0)
Dog-related	22.8 (42)	18.1 (45)	36.5 (61)	36.3 (149)	40.9 (94)	39.3 (105)	4.9 (10)	6.7 (11)

* $p < .05$ for park difference between 2011 and 2012 based on Pearson's Chi-square.

Table 3
Mean differences (and 95% confidence intervals) in intensity of park-based activity (METS) between 2011 and 2012 adjusting for user characteristics among adult visitors only.

Characteristic	Martindale (modified) $n=216$ B (95CI)	Taradale (modified) $n=452$ B (95CI)	West Hillhurst (unmodified) $n=324$ B (95CI)	Meadowlark (unmodified) $n=278$ B (95CI)
2012 (vs. 2011)	−0.09 (−0.40, 0.23)	0.04 (−0.31, 0.38)	0.02 (−0.30, 0.35)	−0.44 (−0.88, −0.01)*
Male (vs. female)	0.43 (0.12, 0.73)*	0.56 (0.25, 0.87)*	0.06 (−0.26, 0.38)	0.57 (0.13, 1.01)*
With a dog (vs. no dog)	−1.20 (−1.52, −0.88)*	−2.56 (−2.87, −2.24)*	−1.27 (−1.60, −0.94)*	−1.56 (−2.40, −0.72)*
Afternoon (vs. morning)	0.37 (0.04, 0.70)*	0.39 (0.08, 0.70)*	−0.04 (−0.37, 0.29)	0.28 (−0.18, 0.74)
Weekend (vs. weekday)	0.18 (−0.14, 0.50)	0.26 (−0.07, 0.59)	−0.15 (−0.50, 0.20)	0.12 (−0.37, 0.62)

Estimates based on fully-adjusted linear regression models stratified by park.

* Unstandardized beta (B) coefficient significant at $p < .05$. 95CI: 95% Confidence Interval.

Table 4
Mean differences (and 95% confidence intervals) in intensity of park-based activity (METS) between 2011 and 2012 adjusting for user characteristics among child visitors only.

Characteristic	Martindale (modified) $n=216$ B (95CI)	Taradale (modified) $n=125$ B (95CI)	West Hillhurst (unmodified) $n=173$ B (95CI)	Meadowlark (unmodified) $n=91$ B (95CI)
2012 (vs. 2011)	−0.35 (−0.69, −0.00)*	−0.34 (−0.89, 0.21)	0.78 (0.34, 1.23)*	−0.76 (−1.36, −0.17)*
Male (vs. female)	0.63 (0.25, 1.00)*	0.23 (−0.28, 0.73)	0.10 (−0.34, 0.53)	0.40 (−0.11, 0.90)
With a dog (vs. no dog)	−1.86 (−2.50, −1.22)*	−1.70 (−2.23, −1.16)*	−1.32 (−1.97, −0.69)*	−0.94 (−3.34, 1.46)
Afternoon (vs. morning)	0.10 (−0.40, 0.61)	0.63 (0.02, 1.24)*	0.04 (−0.42, 0.49)	0.05 (−0.52, 0.62)
Weekend (vs. weekday)	0.24 (−0.12, 0.60)	0.37 (−0.22, 0.96)	−0.82 (−1.27, −0.36)*	−0.06 (−0.67, 0.56)

Estimates based on fully-adjusted linear regression models stratified by park.

* Unstandardized beta (B) coefficient significant at $p < .05$. 95CI: 95% Confidence Interval.

of park activity between 2011 and 2012 were also found for West Hillhurst (2011: mean 4.2, (SD 1.4) vs. 2012: mean 5.2, (SD 1.7), and; B 0.78, 95CI 0.34, 1.23) and Meadowlark parks (2011: mean 4.7, (SD 1.2) vs. 2012: mean 3.9, (SD 1.3), and; B −0.76, 95CI −1.36, −0.17). We also found that children visiting parks with dogs, on average, participated in less intense park activity independent of other characteristics (Table 4).

Discussion

The findings from this natural experiment suggest that modifying the park environment to accommodate off-leash dogs may influence park use patterns and activities. Specifically, we found that creating off-leash areas within parks potentially lowers the intensity of physical activity undertaken by children. We also found that the likelihood of dog-related activity, relative to other activities, *decreased* following the designation of an off-leash area in one of the modified parks. Nevertheless, regardless of whether the park was modified, children and adults visiting parks with dogs, on average, participated in less intense park activity compared with those visiting without dogs.

Proportion of dog-related activity did not increase in either park with a new off-leash area, despite park modifications intended to make both environments conducive to dog-exercise. After accounting for visitor characteristics, a significantly lower likelihood of dog-related activity was found in Martindale park. By contrast, a notable increase in the number of visitors with a dog was observed in Taradale park. Park design and amenities may have therefore been insufficient to increase dog-walkers' use of the Martindale park. Indeed, the availability of garbage cans, litterbags, signage, off-leash areas and dog-specific exercise equipment are some features identified by dog-owners as facilitating park visits (Lee et al., 2009; Cutt, Giles-Corti, Wood, Knuiman & Burke, 2008). In our study, Martindale and Taradale parks were modified to include garbage cans, signage and the allocation of greenspace. Taradale park, where an increase in visitors with dogs was observed, also included new fenced-in areas for small and larger dogs, and the latter surrounded an existing pond that was popular with dogs at baseline and follow-up. Encouraging dog-walkers' use of new off-leash areas may benefit from additional features such as dog-specific agility equipment or swimming ponds within fully fenced areas (Lee et al., 2009; Cutt et al., 2008). To increase the intensity of activity among dog-walkers (and non-dog-walkers) within parks with off-leash designations, additional modifications might be necessary to meet the needs of a diverse range of visitors (e.g., enclosed children play areas, paths, and trails). Park-based programming (Cohen et al., 2009) as well as active promotion of off-leash areas also merits consideration.

The intensity of children's activity decreased after the park modifications, although the number of visitors playing in the modified parks increased. Further, children and adults visiting parks with dogs participated in less intense physical activity than those visiting parks without dogs. Elsewhere, use of dog-exercise areas has been associated with lower energy expenditure in humans (Floyd, Spengler, Maddock, Gobster & Suau, 2008). These findings have potential health implications as higher intensity physical activity can confer additional health benefits (Janssen & Leblanc, 2010; Warburton, Nicol & Bredin, 2006). Thus, people visiting off-leash areas with dogs may be more inclined to remain stationary than in settings where dogs are only allowed on-leash. Nevertheless, the stationary activity of dog-walkers and non-dog-walkers in parks might be compensated by the health benefits gained through social interactions with other park users (Umberson & Montez, 2010; Graham & Glover, 2014), and the

experience of nature within the park (Bowler et al., 2010; Lee and Maheswaran, 2010; Francis et al., 2012). Based on evidence elsewhere (Lee et al., 2009; Price, Reed, Grost, Harvey & Mantinan, 2013), the location of the parks in our study likely encouraged active transportation among most park visitors, hence contributing health benefits (Temple et al., 2011; Berrigan, Troiano, McNeel, DiSogra & Ballard-Barbash, 2006; Xu, Wen & Rissel, 2013; Pucher, Buehler, Bassett & Dannenberg, 2010). Calgary has over 150 neighbourhood and regional off-leash areas, such that the majority of households are within walking or cycling distance. Parks, including those with "off-leash" areas, need to be accessible and provide opportunities for both stationary and mobile pursuits and in proximity to households where active transportation, with or without a dog, is a convenient option.

The observed proportion, but not the absolute number of children, visiting Martindale park decreased following the designation. For children, park use is positively associated with achieving recommended levels of physical activity (Edwards, Giles-Corti, Larson & Beesley, 2014). Although our methodological approach did not allow us to capture the length of time that children spend in the parks, we did find that the installation of an off-leash area was associated with children participating in less intense physical activity. In contrast, Veitch et al. (2012) found that a modification to a park, which included installation of a fenced off-leash area, resulted in an overall increase in park walking and vigorous-intensity physical activity. However, because the park upgrades in that study included additional modifications (e.g., installation of playground, walking track) the extent to which the new off-leash area, specifically, influenced changes in park behaviour is unknown. Speculatively, the decrease in the intensity of children's park activity might reflect safety concerns among parents and/or children regarding off-leash dogs (e.g., dog-bites, dog-chases). Perceived risks associated with interactions with unattended off-leash dogs can modify behaviours such as walking and cycling (Loukaitou-Sideris, 2006), although it should be noted that bites in children occur most often in the home environment involving the family dog (Gilchrist, Sacks, White & Kresnow, 2008). Park policies and programming should address the issue of safety for all visitors, particularly when off-leash dogs are present in shared public space and of multi-use parks like those included in our study.

Our natural experiment design allowed monitoring of park activity and use before and after physical environment modification, but the extent to which the same individuals visited the parks in 2011 and 2012 could not be determined. We captured change in park activity within one-year of the designation and modification but it is possible that changes to the park's environment take a longer time to influence behaviour. Our protocol of collecting data on one weekday and one weekend on two occasions may not have represented typical visiting and activity patterns in the parks and did not allow us to consider weather as an influence on park visits (Temple et al., 2011). Difference-in-difference analysis, often undertaken in natural experiments to estimate the intervention or exposure effect, assumes that the groups (exposed and unexposed) are comparable or similar with regard to the extraneous factors that may affect the outcome of interest (Meyer, 1995; Craig et al., 2012). As described elsewhere (McCormack et al., 2014), the parks in our study differed with regard to their baseline characteristics (activities, visitor characteristics, and sociodemographic profile of surrounding neighbourhood), which could modify the extent to which park modifications influence use. In addition, the civic consultation process that occurred to determine whether an area was designated as on or off-leash might have indirectly influenced patterns of park use, independent of any changes to the built environment. For instance, we found an increase in the intensity of park activities in West Hillhurst and decrease in intensity of park activities in Meadowlark among children despite neither park being designated as off-leash nor undergoing any other modifications prior to follow-up. Due to these and other unknown threats to internal validity, we used a simple analysis (i.e., one-group pre-post design for each park) and we refrained from making any between-park comparisons at follow-up. Overall, we remain cautious about whether built-environment modifications within the parks entirely explain the changes that we observed in visitation and activity patterns.

Creating off-leash areas in parks could result in decreased intensity of activity among children, especially if other investments in children's play and development do not coincide with the creation of off-leash areas. At the same time, off-leash areas can support active lifestyles, notably by reinforcing routine walking to and from neighbourhood parks. Our study found designating off-leash areas in multi-use parks resulted in changes in the profile of activities and visitors. We found inconclusive evidence to support off-leash designations as an intervention for increasing physical activity in urban populations.

Conflicts of interest

The authors declare there is no conflict of interest.

Acknowledgements

The authors are grateful for the fieldwork data collection undertaken by student and assistants from the Faculties of Environmental Design (Karina Lamy), Medicine (Lindsay Burton, Ann Toohey, Monica Viapiana), Science (Stefano Liccioli and Sarah Gingerick), and Veterinary Medicine (Barbara Behiels) at the University of Calgary. This project was funded by a Canadian Institutes of Health Research (CIHR), Institute of Population and Public Health Population Health Intervention Research Strategic Competition Grant (GIR-112745). Melanie Rock was supported by an Alberta Innovates Population Health Investigator Award and CIHR Health Research New Investigator Award. Gavin McCormack is supported by a CIHR New Investigator Award. The collaborative support from the Calgary Humane Society, the Calgary Parks Foundation, the Federation of Calgary Communities, and the City of Calgary Animal and Bylaw Services and City of Calgary Parks is also acknowledged.

References

Ainsworth, B., Haskell, W., Leon, A., Jacobs, D., Jr., Montoye, H., Sallis, J., et al. (1993). Compendium of physical activities: classification of energy costs of human physical activities. *Medicine and Science in Sports and Exercise*, *25*(1), 71–80.

Bowler, D. E., Buyung-Ali, L. M., Knight, T. M., & Pullin, A. S. (2010). A systematic review of evidence for the added benefits to health of exposure to natural environments. *BMC Public Health*, *10*, 456.

Bedimo-Rung, A. L., Mowen, A. J., & Cohen, D. A. (2005). The significance of parks to physical activity and public health: a conceptual model. *American Journal of Preventive Medicine*, *28*(2 Suppl. 2), S159–S168.

Berrigan, D., Troiano, R. P., McNeel, T., DiSogra, C., & Ballard-Barbash, R. (2006). Active transportation increases adherence to activity recommendations. *American Journal of Preventive Medicine*, *31*(3), 210–216.

Cohen, D. A., Han, B., Isacoff, J., Shulaker, B., Williamson, S., Marsh, T., et al. (2015). Impact of park renovations on park use and park-based physical activity. *Journal of Physical Activity and Health*, *12*(2), 289–295.

Cohen, D. A., Marsh, T., Williamson, S., Golinelli, D., & McKenzie, T. L. (2012). Impact and cost-effectiveness of family Fitness Zones: a natural experiment in urban public parks. *Health & Place*, *18*(1), 39–45.

Cohen, D. A., Golinelli, D., Williamson, S., Sehgal, A., Marsh, T., & McKenzie, T. L. (2009). Effects of park improvements on park use and physical activity: policy

and programming implications. *American Journal of Preventive Medicine*, *37*(6), 475–480.
Cutt, H., Giles-Corti, B., Knuiman, M., & Burke, V. (2007). Dog ownership, health and physical activity: a critical review of the literature. *Health Place Part Special Issue: Environmental Justice, Population Health, Critical Theory and GIS*, *13*(1), 261–272.
Christian, H., Westgarth, C., Bauman, A., Richards, E., Rhodes, R., & Evenson, K. (2013). Dog ownership and physical activity: a review of the evidence. *Journal of Physical Activity and Health*, *10*, 750–759.
Cohen, D. A., Marsh, T., Williamson, S., Derose, K. P., Martinez, H., Setodji, C., et al. (2010). Parks and physical activity: Why are some parks used more than others? *Preventive Medicine*, *50*(Suppl. 0), S9–S12.
Christian, H., Giles-Corti, B., & Knuiman, M. (2010). "I'm just a' – walking the dog" correlates of regular dog walking. *Family and Community Health*, *33*(1), 44–52.
City of Calgary. (2011). Off-leash areas – proposed new and improved locations. Calgary, Alberta. ⟨http://www.calgary.ca/CSPS/Parks/Pages/Locations/Off-leash-areas-proposed-new-and-improved-locations.aspx⟩.
Cutt, H. E., Giles-Corti, B., Wood, L. J., Knuiman, M. W., & Burke, V. (2008). Barriers and motivators for owners walking their dog: results from qualitative research. *Health Promotion Journal of Australia*, *19*(2), 118–124.
Craig, P., Cooper, C., Gunnell, D., Haw, S., Lawson, K., Macintyre, S., et al. (2012). Using natural experiments to evaluate population health interventions: new Medical Research Council guidance. *Journal of Epidemiology and Community Health*, *66*(12), 1182–1186.
Edwards, N. J., Giles-Corti, B., Larson, A., & Beesley, B. (2014). The effect of proximity on park and beach use and physical activity among rural adolescents. *Journal of Physical Activity and Health*, *11*(5), 977–984.
Francis, J., Wood, L. J., Knuiman, M., & Giles-Corti, B. (2012). Quality or quantity? Exploring the relationship between Public Open Space attributes and mental health in Perth, Western Australia. *Social Science and Medicine*, *74*(10), 1570–1577.
Floyd, M. F., Spengler, J. O., Maddock, J. E., Gobster, P. H., & Suau, L. J. (2008). Park-based physical activity in diverse communities of two U.S. cities. An observational study. *American Journal of Preventive Medicine*, *34*(4), 299–305.
Graham, T. M., & Glover, T. D. (2014). On the Fence: dog parks in the (un)leashing of community and social capital. *Leisure Sciences*, *36*(3), 217–234.
Gilchrist, J., Sacks, J., White, D., & Kresnow, M. (2008). Dog bites: still a problem? *Injury Prevention*, *14*(5), 296–301.
Janssen, I., & Leblanc, A. G. (2010). Systematic review of the health benefits of physical activity and fitness in school-aged children and youth. *International Journal of Behavioral Nutrition and Physical Activity*, *7*, 40.
Kazmierczak, A. (2013). The contribution of local parks to neighbourhood social ties. *Landscape and Urban Planning*, *109*(1), 31–44.
Koohsari, M. J., Mavoa, S., Villanueva, K., Sugiyama, T., Badland, H., Kaczynski, A. T., et al. (2015). Public open space, physical activity, urban design and public health: Concepts, methods and research agenda. *Health & Place*, *33*, 75–82.
Lee, A. C., & Maheswaran, R. (2010). The health benefits of urban green spaces: a review of the evidence. *Journal of Public Health*, *33*(2), 212–222.
Lee, H.-S., Shepley, M., & Huang, C.-S. (2009). Evaluation of off-leash dog parks in Texas and Florida: a study of use patterns, user satisfaction, and perception. *Landscape and Urban Planning*, *92*(3-4), 314–324.
Loukaitou-Sideris, A. (2006). Is it safe to walk? 1 neighborhood safety and security considerations and their effects on walking. *Journal of Planning Literature*, *20*(3), 219–232.
McCormack, G., & Shiell, A. (2012). In search of causality: a systematic review of the relationship between the built environment and physical activity among adults. *International Journal of Behavioral Nutrition and Physical Activity*, *8*(1), 125.
McCormack, G. R., Shiell, A., Doyle-Baker, P. K., Friedenreich, C. M., & Sandalack, B. A. (2014). Subpopulation differences in the association between neighborhood urban form and neighborhood-based physical activity. *Health & Place*, *28*, 109–115.
McCormack, G. R., Rock, M., Sandalack, B., & Uribe, F. A. (2011). Access to off-leash parks, street pattern and dog walking among adults. *Public Health*, *125*(8), 540–546.
McCormack, G. R., Rock, M., Swanson, K., Burton, L., & Massolo, A. (2014). Physical activity patterns in urban neighbourhood parks: insights from a multiple case study. *BMC Public Health*, *14*, 962.
Meyer, B. (1995). Natural and quasi-experiments in economics. *Journal of Business and Economic Statistics*, *13*(2), 151–161.
Peters, K., Elands, B., & Buijs, A. (2010). Social interactions in urban parks: Stimulating social cohesion? *Urban Forestry Urban Greening*, *9*(2), 93–100.
Parks Foundation Calgary. (2011). Phase 1 of the Calgary Greenway opens with a tweet. Calgary, Alberta. ⟨http://www.parksfdn.com/news/annualreportnewsletters?year=2011⟩.
Price, A. E., Reed, J. A., Grost, L., Harvey, C., & Mantinan, K. (2013). Travel to, and use of, twenty-one Michigan trails. *Preventive Medicine*, *56*(3–4), 234–236.
Pucher, J., Buehler, R., Bassett, D. R., & Dannenberg, A. L. (2010). Walking and cycling to health: a comparative analysis of city, state, and international data. *American Journal of Public Health*, *100*(10), 1986–1992.
Richards, E., McDonough, M., Edwards, N., Lyle, R., & Troped, P. (2013). Psychosocial and environmental factors associated with dog-walking. *International Journal of Health Promotion and Education*, *51*(4), 198–211.
Ridley, K., & Olds, T. S. (2008). Assigning energy costs to activities in children: a review and synthesis. *Medicine and Science in Sports and Exercise*, *40*(8), 1439–1446.
Tester, J., & Baker, R. (2009). Making the playfields even: evaluating the impact of an environmental intervention on park use and physical activity. *Preventive Medicine*, *48*(4), 316–320.
Temple, V., Rhodes, R., & Wharf Higgins, J. (2011). Unleashing physical activity: an observational study of park use, dog walking, and physical activity. *Journal of Physical Activity and Health*, *8*(6), 766–774.
Umberson, D., & Montez, J. K. (2010). Social relationships and health: a flashpoint for health policy. *Journal of Health and Social Behavior*, *51*(Suppl.), S54–S66.
Veitch, J., Ball, K., Crawford, D., Abbott, G. R., & Salmon, J. (2012). Park improvements and park activity: a natural experiment. *American Journal of Preventive Medicine*, *42*(6), 616–619.
Westgarth, C., Christley, R. M., & Christian, H. E. (2014). How might we increase physical activity through dog walking?: A comprehensive review of dog walking correlates. *International Journal of Behavioral Nutrition and Physical Activity*, *11*, 83.
Warburton, D. E., Nicol, C. W., & Bredin, S. S. (2006). Health benefits of physical activity: the evidence. *CMAJ*, *174*(6), 801–809.
Xu, H., Wen, L. M., & Rissel, C. (2013). The relationships between active transport to work or school and cardiovascular health or body weight: a systematic review. *Asia-Pacific Journal of Public Health*, *25*(4), 298–315.