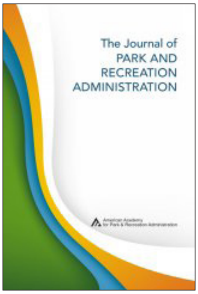

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Regular Paper

Green Grass in Urban Parks Are a Necessary Ingredient for Sedentary Recreation

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Executive Summary

Public health research tends to focus on park amenities that promote physical activity as an indicator of healthy community design. The leisure disciplines argue for a broader approach highlighting the physiological, psychological, and social benefits of park-based activities. We hypothesize that parks offering avenues for active recreation may be better utilized if they offer opportunities for relaxation before/after physical activity, as a standalone leisure activity, or other amenities for adults accompanying active children to relax and socialize. To test this hypothesis, in May 2016, we observed sedentary recreation (such as reading, lying down, or sitting) in a centrally located park based on colonial landscapes within the City of Liverpool, New South Wales, Australia using the validated System for Observing Play and Recreation in a Community (SOPARC) protocol; and an accompanying high-resolution landcover dataset to explore correlates of sedentary recreation. Specifically, we were interested in the demographic characteristics, the time, the place within the park, and landcover features of the places where people engaged in sedentary recreation. We found that 68% of adults visiting the park were engaged in sedentary recreation which peaked between 12-2 p.m. We also found that sedentary recreation was significantly associated ($p<0.05$) with a greater percent of grass in an area. Our findings are consistent with the propositions of attention restoration and socialization theories of greenspace utility. We conclude that parks should be designed to offer adequate amenities for leisure in addition to physical activity perhaps through the provision of adequate greenspaces.

Keywords

Parks, sedentary recreation, grass, Australia, SOPARC

Introduction

There is increasing recognition that parks and natural areas are public resources that promote human health and well-being in urban areas, particularly in light of the global rate of urbanization and loss of natural habitats (Hartig et al., 2014; Maller et al., 2002). In the public health discipline, the benefits of parks for promoting physical and mental health, social life, and economic activity were conceptualized around the opportunity to engage in leisure-time physical activities such as sports, active play, and exercise (Bedimo-Rung et al., 2005; Cohen et al., 2011). Consequently, a substantial public health evidence base exists that identifies park characteristics and attributes that are associated with promoting health-sustaining physical activity (i.e., activities of moderate-to-vigorous intensity)(Costigan et al., 2017; Evenson et al., 2016; Giles-Corti et al., 2005). However, park characteristics and attributes associated with sedentary park activities have received less attention with the physical activity aspects of park visits receiving more attention (Joseph & Maddock, 2016; Sami et al., 2020; Zhang et al., 2019). Indeed, sedentary leisure/recreation has been perceived as something to be cautiously monitored in relation to the amount of time spent sitting, (Brown et al., 2013; Canadian Society for Exercise Physiology, 2012) albeit this has been predominantly limited to indoor screen time or sitting in a vehicle (Canadian Society for Exercise Physiology, 2012).

Leisure and recreation research is guided by numerous disciplines including sociology, cultural studies, psychology, social psychology, and economics (Veal et al., 2015). Hence the theoretical framework supporting the health benefits of parks is broader than the current focus on active leisure physical activity highlighted by public health researchers. The theories supporting a broader framework stem from evolutionary psychology and/or sociology. First, the evolutionary argument known as the biophilia hypothesis, suggests that human beings are biologically conditioned to develop a bond with nature (Uhlrich, 1993). Uhlrich (1993) postulated that humans are attracted to elements of nature and natural sceneries with water, green vegetation and flowers. Since these elements of nature were vital to the survival of humans, there were evolutionary selection pressures toward developing a liking for nature. In addition to this adaptation, Uhlrich (1993) proposed two additional adaptive responses. One form of adaptation is the ability of humans to restore their energy and recover from stressors they perceive to threaten their survival through nature exposure; manifested in the form of various indicators such as a lower blood pressure and less stress hormones. The other form of adaptation is better cognitive function which Uhlrich (1993) attributed to the reduction of mental distress while in nature. Kaplan and Kaplan (1989) have proposed that a restorative environment has the ability to invoke the feelings of “being away,” to offer an immersive environment, soft fascination, and finally an appreciation of nature on the individual’s part. A large empirical literature has developed over the last two decades examining various aspects of greenspace and mental health; for instance, see Twohig-Bennett and Jones (2018) or Zhang et al. (2021). Other disciplines such as human geography have adapted these ideas into the concept of “therapeutic landscapes” or places with healing properties (Doughty, 2018).

Stack and Shultis (2013) and others used these psychological theories for developing the rationale for parks; parks allow an escape from the irritability, stress, decreased concentration and aggression associated with life in modern cities. They suggest that urban parks have the potential to restore mental fatigue, by providing a sense of feeling in a "whole different world," evoke "fascination," provide time for effortless attention, and therefore eventually aid individuals in meeting their goals (Stack & Shultis, 2013), yet there is limited exploration in the literature of how this specific aspect of park use manifests.

Another set of theories adopt a more sociological perspective highlighting the importance of parks as places for social integration, developing a sense of community and a vehicle for acculturation of ethnic minorities or marginalized groups. (Gomez et al., 2015; Peters, 2010; Tinsley et al., 2002). Importantly, leisure and recreation theories emphasize the "freedom" of the individual to choose the activity that elicits enjoyment, self-determination, care for the self and care for others (Rojek, 2005) . A study by Irvine et al. (2013) found that while common motivations for visiting parks included walking, children and green space qualities, the derived effects from parks sided towards leisure benefits such as heightened relaxations, positive emotions, and spiritual well-being. In this respect, physical activity is one approach to utilizing park-related public health benefits, but not the only approach, since sitting/standing are also means of fulfilling the leisure and recreation requirements mentioned above. Of course, it is important to be cognizant of the fact that parks can only offer avenues of recreation, leisure and restoration to individuals who have the choice to exercise this option, in addition to the fact that, parks are also not always a place that all people feel comfortable recreating in.

While a rich theoretical base supports sedentary recreation (SR) in parks, no study has yet specifically investigated the nature, temporal and spatial distribution, and drivers of SR in parks with some studies making broad brush investigations of which park areas are associated with various activities (Hipp et al., 2016; Veitch et al., 2021), engagement with park features and spatial vitality (Mu et al., 2021), focussing specifically on children (Sargisson & McLean, 2012) or night-time park activities (Ngesan et al., 2013). Therefore, in this research, we pose a few specific questions to address this gap as follows: a) What are the demographic characteristics of people engaging in SR in parks?, b) When do people engage in SR?, c) Where in the park do people engage in SR?, and d) What landcover features of a park are associated with SR?

Note that in this study, by parks we imply public parks, or parks that are open and free for the public to use.

Methods

Setting, Park Use (SOPARC), and Landcover Data

The setting of this research is a park located in the densely populated mixed use Central Business District (CBD) of Liverpool, a city in southwestern Sydney, New South Wales, Australia (See Figure 1). Liverpool is a diverse region of Sydney with over 40% of all residents born abroad, and relatively higher levels of socioeconomic disadvantage than the rest of Sydney (.idcommunity, 2016). The park, established in 1819, is approximately 33,020 square meters (3.3 hectares) in size and is an example of designed colonial landscapes. Such parks are based on lawns and European landscape design patterns (OCP Architechts, 2015). Like many of the older parks in Australian cities, it was originally planted with non-native trees, but may also have native species (Ives et al., 2013). Thus, this park is a representative example of many such similar parks in Australia. We collected data on park use during May 2016 (week of 9th May) using the “System for Observing Play and Recreation in Communities” (SOPARC) tool. (McKenzie et al., 2006). May is Autumn in Sydney, and the weather is generally pleasant, making it ideal for such a study. Since this study, the Liverpool CBD has seen even further densification with a number of high-rise apartments being built in the area.

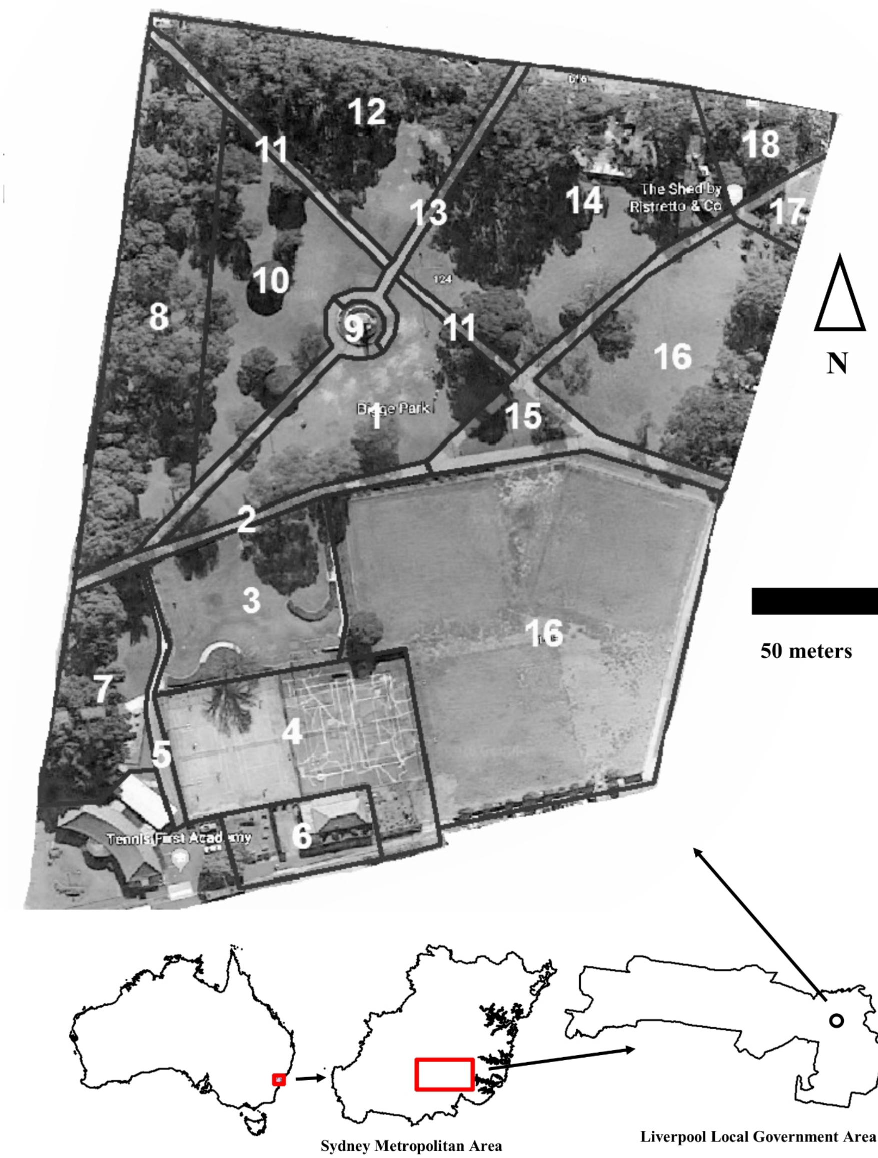
SOPARC is a widely utilized, validated tool to identify information on park users’ physical activity using momentary time sampling to record observations (Evenson et al., 2016). The tool provides an instrument for recording observations, in addition to extensive instructions on how to use the tool (Evenson et al., 2016; RAND, 2022). The methods outlined below follow the SOPARC guidelines.

The park was divided into eighteen sections (See Figure 1). While we use the term “section” for ease of understanding, SOPARC guidelines refer to these as “Target Areas”, where a target area is simply defined as a confined space in which park user activities are observed (Evenson et al., 2016; RAND, 2022). Among other guiding principles behind the delineation of target areas (henceforth “sections”), it is necessary to set boundaries where observers may record activities without obstructions of features such as tree lines and tennis courts. In this study some of the authors (SM, AE, KW) and other members of the project team assessed the park two months in advance of the observational period, and delineated sections following the above criteria before field data were collected.

Fourteen volunteers who were previously trained on the SOPARC method, scanned each section twice for 0.5 hours (or an average of one scan every 15 minutes) and for four days in the week of 9th May (Monday, Tuesday, Wednesday, and Saturday). Scans were done in the following periods: morning (7:30-8:30am), late morning (11:30-12:30pm), afternoon (14:30-15:30pm) and evening (16:30-17:30pm). While most of these time-periods are during daylight hours, sunset in Liverpool, Australia occurred on average at 5:00 pm, which made some parts of the park relatively dark in the evening. Note that the SOPARC tool recommends a minimum of one weekend day and one weekday of observations, and our chosen days were found to be optimal given existing resources, especially the availability of the volunteers. Most SOPARC studies range from one to 16 days, and also include one weekday and at least one weekend (Evenson et al., 2016). In addition, three to four one hour sessions are recommended (Evenson et al., 2016; RAND, 2022). Note that, if an active person were to sit down within the hour, she would be registered twice as active and sitting, but if she started moving after the hour, another observer may make another record of them as active. More generally, since each one-hour scan of a section is completed by a different observer, there is a possibility of duplicate observations of people who stay in the park over one hour, or are moving across sections. However, the SOPARC protocol, while acknowledging the possibility of duplicate observations also states that 12-16 hours of observation “provides a sufficiently robust schedule for estimating around 96 hours of park use and physical activity over a week” (Evenson et al., 2016; RAND, 2022).

Average temperature during the study period hovered around a comfortable 20 degrees Celsius, with generally sunny days. The standard American SOPARC scan sheets were used for data collection (McKenzie & Cohen, 2006). Details of the data collected are provided below. In addition to physical activity levels, SOPARC also collects observed demographic data such as age, gender and “race” or “ethnicity” While all perceived demographic data are problematic, we categorized “race” as Caucasian and Culturally and Linguistically Diverse (CALD) to align with Australian social categories. While the strict definition of “CALD” simply implies non-White European

Figure 1
Location of Park and Park Sections



origin, for the purposes of this study, CALD implies anyone who was not perceived as White-European descent. Note that the SOPARC protocol has been utilized previously to report differences in park usage by race (Evenson et al., 2016; Shores & West, 2008).

The data collected also included date/time of observation, age group (child/teen/adult/senior), sex, activity level (sedentary/walking/vigorous), type of primary activity (e.g., standing or jogging), and other variables such as name of the park section and if the section was dark or inaccessible. The SOPARC protocol recommends that the age group categorizations follow these age groups—children from infancy to 12 years, teen/adolescents from 13 to 20 years, adults from 21 to 59 years of age as adults and people aged 60 years of age and older as seniors based on perceived age (RAND, 2022). Categorisation into age groups, sex and ethnicity are based on researchers' perception/observation following the SOPARC protocol, and while it can be argued that there is room for error in these categorizations, multiple studies have shown these perceived categorizations to be valid and robust when using the SOPARC tool (Marquet et al., 2019; McKenzie et al., 2006). The SOPARC protocol demarcates previously mentioned categories of activities as follows: sedentary (S) = lying down, sitting, or standing in place, walking (w) = walking at a casual pace, and vigorous (V) = engaged in an activity more vigorous than an ordinary walk (e.g., increasing heart rate causing people to sweat, such as jogging, swinging, doing cart wheels) (RAND, 2022). Following the SOPARC protocol, we use the term "sedentary recreation" or SR to indicate sedentary activities and behaviors (RAND, 2022). We utilize the term "leisure" occasionally to indicate the broader literature on leisure and recreation.

We did not evaluate inter-rater reliability, and only half of all SOPARC based studies evaluate this metric (Evenson et al., 2016). The different park sections were digitized into a Geographical Information System (GIS) (Figure 1).

Landcover data (at ~2 meter resolution) were obtained from GeoVision Australia (Pitney Bowes Australia, 2019), categorized as tree cover, grass cover or built-up areas/bare earth, processed and spatially attached with the park section data to calculate the proportion of different landcover in each section. We utilise specific terms to indicate specific components of green space, such as tree cover and grass, because there is evidence that these components have different relationships with humans (Astell-Burt & Feng, 2019). In addition to grass and tree covered areas, the third category of landcover in the park consisted of built-up areas and amenities such as walking paths, a tennis court, a café, a clock tower, some seats with varying degrees of shade from nearby trees, and small patches of bare earth.

The GIS data above delineates the percentage of grass or tree cover by each section. Thus, for instance, 49% of section 1 is plain ground and grass, but a tennis court has only 5% grass. Some concrete paths may have grass growing on and adjoining them. Also, from the SOPARC data we are aware of the section number in which the data of each set of individuals engaged in specific activities have been captured. Thus, simply linking the SOPARC data with the GIS data using the section number generates a dataset with both the SOPARC data and the GIS landcover data. Appendix 1A provides a list and short descriptions of each of the park sections. The park had very limited seating and other infrastructure, allowing us to effectively study the role of landcover on SR.

Statistical Methods

Results from both exploratory and inferential analyses are presented. Exploratory analyses results are displayed in the form of tables showing percent active, sedentary and walking with 95% confidence intervals were generated across categories of sex, weekday/weekend, park section and time of day. These tables do not distinguish by landcover categories.

Inferential linear models were also used. Due to overdispersion in Poisson models, Negative Binominal regression models were used instead to predict the counts of people who were sedentary as a function of the number of people who were either adult or senior, of CALD ethnicity, period of the day (Morning/Late morning /Afternoon/Evening), weekday/weekend, and percent trees (Model1) or percent grass (Model2).

Note that percent grass or tree canopy within a discrete area is a well-established greenspace measures, for instance see Reid et al. (2017).Three categories were used for percent grass (<19%, 19%-30%, >30%) and percent trees (<11%, 11%-50%, >50%) based on prior examination of the Generalized Additive Modelled relationships between these variables and numbers sedentary, and by using inflection points in the relationship as cut-offs (Barrio et al., 2013). In addition, the histograms of these variables were also examined for choosing the cut-offs if the GAM curves showed no obvious inflexions. Using GAM curves and histograms to choose cut-offs are a data driven approach and can be useful in a situation such as this where no pre-determined cut-offs are available (Barrio et al., 2013; Jenks, 1967). Also note, that some of the observations may have been duplicates, and since it is impossible to identify which observations are duplicates, no adjustment could be utilized in the statistical models to adjust for this, which is the standard procedure followed by other researchers utilizing linear models with SOPARC data (Salvo et al., 2017; Van Dyck et al., 2013).

Also, the dependent variable (numbers sedentary) was not clustered (Intra Class Coefficient: 0.2) within park sections which would otherwise require hierarchical or multilevel linear models. Odds ratios and percentages are presented along with 95% confidence intervals (CIs). Since, the consensus on epidemiological statistical reporting guidelines discourage the interpretation of results based on just p values, but also require that confidence intervals and effect sizes be taken into consideration (Greenland et al., 2016), we discuss results with their confidence intervals in the text of this paper but superscript all results with p values <0.1 in the regression results table with asterisks. Odds ratios with p values <0.05 were considered statistically significant and discussed in the text. All statistical analyses were implemented in R (R Core Team, 2019). GIS analyses were implemented using ArcMap 10.7 (ESRI 2018, 2018).

This study required no human contact, was based on the distant observation of people in public spaces and was part of an evaluation project done in collaboration with a local council within a regional health department. No identifiable data were collected, and the study posed no risk to the investigators, or the people being observed. As a result, no ethics review was required.

Results

A total of 1,366 people were observed over the study period. Table 1 summarizes the percent of people engaging in sedentary, walking and vigorous activities as defined in the SOPARC protocol (RAND, 2022), by weekday, time of day, park section, and gender. Overall, more people were sedentary 58.4% (95%CI: 55.7%, 61%), compared to walking 35.4% (95%CI: 32.8%, 38%) or vigorous activities such as jogging or exercising 6.3% (95%CI: 5.1%, 7.7%), especially on the weekends. Women are more likely than men to be sedentary, such as to read and to sleep (RAND, 2022). Compared to weekdays, more people were sedentary (and less likely to be walking) on the weekends. Late morning and afternoons were the most popular times for SR (peak at 12–2 p.m.), with vigorous activities (such as jogging and aerobics) peaking in the evening and walking in the morning. Between 56% to 100% of park users in sections 1, 3, 6-8, 10, 12, 14, 17-18 were sedentary. These areas included contiguous grassy patches and areas with some trees and seats (sections 1, 3, 7, 8, 10, 12, 14). Other areas (sections 6, 17, 18) featured dedicated seating areas for a tennis court and a cafe. A large percentage (85% to 90%) of people in sections 2, 5 and 9 (which are walking-paths) were walking, though some walking paths (sections 2 and 5) have more traffic than others (section 13). Only sec-

Table 1

Numbers and Percentage of People Engaged in Sedentary, Walking and Vigorous Activities

Name	Sedentary	Walking	Vigorous
Sex			
Female	373, 59.2% (55.3%, 63.1%)	211, 33.5% (29.8%, 37.3%)	46, 7.3% (5.4%, 9.6%)
Male	424, 57.6% (53.9%, 61.2%)	272, 37% (33.5%, 40.6%)	40, 5.4% (3.9%, 7.3%)
Day of week			
Weekday	641, 57.6% (54.7%, 60.6%)	417, 37.5% (34.6%, 40.4%)	54, 4.9% (3.7%, 6.3%)
Weekend	156, 61.4% (55.1%, 67.4%)	66, 26% (20.7%, 31.8%)	32, 12.6% (8.8%, 17.3%)
Park Section			
1	48, 85.7% (73.8%, 93.6%)	8, 14.3% (6.4%, 26.2%)	0, 0% (0%, 6.4%)
2	5, 13.5% (4.5%, 28.8%)	32, 86.5% (71.2%, 95.5%)	0, 0% (0%, 9.5%)
3	36, 85.7% (71.5%, 94.6%)	5, 11.9% (4%, 25.6%)	1, 2.4% (0.1%, 12.6%)
4	70, 44.9% (36.9%, 53%)	36, 23.1% (16.7%, 30.5%)	50, 32.1% (24.8%, 40%)
5	0, 0% (0%, 5.1%)	69, 97.2% (90.2%, 99.7%)	2, 2.8% (0.3%, 9.8%)
6	21, 100% (83.9%, 100%)	0, 0% (0%, 16.1%)	0, 0% (0%, 16.1%)
7	44, 56.4% (44.7%, 67.6%)	18, 23.1% (14.3%, 34%)	16, 20.5% (12.2%, 31.2%)
8	64, 61.5% (51.5%, 70.9%)	35, 33.7% (24.7%, 43.6%)	5, 4.8% (1.6%, 10.9%)
9	4, 4% (1.1%, 9.9%)	95, 95% (88.7%, 98.4%)	1, 1% (0%, 5.4%)
10	30, 71.4% (55.4%, 84.3%)	11, 26.2% (13.9%, 42%)	1, 2.4% (0.1%, 12.6%)

Table 1 (cont.)

Name	Sedentary	Walking	Vigorous
11	7, 20% (8.4%, 36.9%)	26, 74.3% (56.7%, 87.5%)	2, 5.7% (0.7%, 19.2%)
12	29, 70.7% (54.5%, 83.9%)	11, 26.8% (14.2%, 42.9%)	1, 2.4% (0.1%, 12.9%)
13	13, 24.1% (13.5%, 37.6%)	40, 74.1% (60.3%, 85%)	1, 1.9% (0%, 9.9%)
14	43, 84.3% (71.4%, 93%)	6, 11.8% (4.4%, 23.9%)	2, 3.9% (0.5%, 13.5%)
15	12, 26.7% (14.6%, 41.9%)	31, 68.9% (53.4%, 81.8%)	2, 4.4% (0.5%, 15.1%)
16	33, 48.5% (36.2%, 61%)	33, 48.5% (36.2%, 61%)	2, 2.9% (0.4%, 10.2%)
17	176, 88% (82.7%, 92.2%)	24, 12% (7.8%, 17.3%)	0, 0% (0%, 1.8%)
18	162, 98.2% (94.8%, 99.6%)	3, 1.8% (0.4%, 5.2%)	0, 0% (0%, 2.2%)
Period of day			
Morning 7:30-8:30am	159, 53.4% (47.5%, 59.1%)	130, 43.6% (37.9%, 49.5%)	9, 3% (1.4%, 5.7%)
Lunch 11:30-12:30pm	267, 69.9% (65%, 74.5%)	97, 25.4% (21.1%, 30.1%)	18, 4.7% (2.8%, 7.3%)
Afternoon 14:30-15:30pm	274, 58.2% (53.6%, 62.7%)	179, 38% (33.6%, 42.6%)	18, 3.8% (2.3%, 6%)
Evening 16:30-17:30pm	97, 45.1% (38.3%, 52%)	77, 35.8% (29.4%, 42.6%)	41, 19.1% (14%, 25%)

tion 4 (a tennis court) had a majority of people undertaking vigorous activity. The most common form of SR was sitting (59%), followed by standing (26%). Some children were sedentary during tennis lessons (8%), and a small number of people were either lying down, or having a picnic. Also, around 72% of park visitors were either adults or seniors and around 62% were CALD.

As stated earlier, grass or tree percent is a commonly used metric in the greenspace literature, for instance see Reid et al. (2017) or Astell-Burt and Feng (2019). Median grass percent in park sections was 16% and median tree percent was 10%. Table 2 presents the results of the regressions predicting the number of sedentary people as a function of grass/tree cover percent and other covariates. People in a park section with 19% to 30% grass were 71% (95%CI: 35%, 119%) more likely to be sedentary, and people in a park section with more than 30% grass were 93% (95%CI: 54%, 144%) more likely to be sedentary, than people in an area with less than 19% grass (Table 2, Model 2). These differences are statistically significant at the 0.05 level. No such relationships were observed with tree canopy (Model 1). Agreeing with the findings of the initial descriptive table (Table 1), people were significantly less likely to be sedentary in the evenings (16:30-17:30pm) relative to the afternoons (14:30-15:30pm), with the odds ratios varying from 0.58 (95%CI: 0.43, 0.79) for Model 1 to 0.64 (95%CI: 0.48, 0.87) for model 2. Men were significantly less likely to be sedentary than women with the odds being 21% (95%CI: 4%, 35%) to 20% (95%CI: 3%, 34%) lower in the two models.

Discussion

We found that a significant proportion of park visitors were sedentary with the proportion varying across different sections of the park and time periods. Most people were sedentary at times and in places where sitting down or reclining was necessary, such as during lunchtime, in café sitting areas, and a spectator/parent sitting area beside a tennis court; SR was also associated with sections of the park that had large contiguous grassed areas which could be called "turf" or "greenbelt"(Zhu et al., 2017). While our study does not provide direct evidence to support any of the two theoretical lines of argument—parks as a vehicle for socialization and parks as a locale for recreation—both lines of theoretical evidence are indirectly supported in parks being used as venues for sedentary recreation as described below.

First, the percent of people engaging in SR found here (58.4%) aligns with previous studies from Australia, showing a range between 43%-80% and that a large proportion of people are sedentary around 12:30-1:30 pm (Veitch et al., 2012; Wang & Shi, 2023). One survey of park users in the United States (US) indicated that the top reason for visiting parks (49% of respondents), was for "relaxing" (Scott, 1997) . In the Sydney Park Use Survey 2004 (Veal, 2006), 61% of the population surveyed indicated that the activity they did in their last visit to a park was to "relax and unwind," and 59% said they were "enjoying or experiencing the natural environment." The proportion of "sitters" in the park found in the Veal (2006) study is comparable with the findings from our current study. The central location of the park within the city of Liverpool, and the fact that most SR appears around lunchtime may suggest that many employees from the offices surrounding the park use the park for rest and relaxation potentially providing opportunities for "mental recovery," restoration from stressors, and "being away" (Kaplan & Kaplan, 1989; Stack & Shultis, 2013; Uhlrich, 1993). Indeed, evidence from two randomized controlled trials have shown that park walks and relaxation during

Table 2

Relationship between Number of People Sedentary as a Function of Various Factors and the Percent of Landcover Devoted to Tree Canopy (Model 1) and Grass (Model 2)

Dependent Variable	Model 1		Model 2
Age group			
(Ref: Child or Teenager)			
Adult or Senior	0.153 (-0.139, 0.447)		0.060 (-0.226, 0.347)
(Ref: Female Gender)			
Male Gender	-0.235** (-0.430, -0.041)		-0.222** (-0.413, -0.032)
Ethnicity			
(Ref: Not CALD ethnicity)			
CALD Ethnicity	-0.177 (-0.422, 0.067)		-0.161 (-0.396, 0.074)
Day of week			
(Ref: Weekday)			
Weekend	0.089 (-0.159, 0.337)		0.235* (-0.012, 0.482)
Period of Study			
(Ref: Afternoon)			
Evening	-0.539*** (-0.844, -0.237)		-0.441*** (-0.743, -0.144)
Lunch	0.034 (-0.210, 0.278)		0.070 (-0.169, 0.309)
Morning	-0.156 (-0.432, 0.118)		-0.154 (-0.424, 0.115)
Percent Tree Canopy in Section (Ref :< 11%)		**Percent Grass in Section** (Ref :< 19%)	
11% to 50%	-0.037 (-0.261, 0.187)	19% to 30%	0.540*** (0.297, 0.783)
Greater than 50%	-0.135 (-0.406, 0.134)	Greater than 30%	0.662*** (0.434, 0.890)
N	1,366		1,366
Note:	*p<0.1; **p<0.05; ***p<0.01	Note:	*p<0.1; **p<0.05; ***p<0.01

Abbreviations: Ref: Reference

lunch breaks results in feeling less tense, and better recovery from job stress (de Bloom et al., 2017).

While previous research has investigated in detail the features of parks that encourage people to be involved in various activities (Mu et al., 2021) including sitting (Goličnik & Thompson, 2010), the importance of the both the timing and the location of sedentary recreation, in addition to the location of the park, and the theories that support the utilization of these recreational spaces have not been fully realized. Our study, by providing focused evidence on the timing and location of SR in a CBD environment lends indirect support to the psychological and sociological aspect of sedentary recreation in parks.

There is some evidence supporting the sociological aspect of sedentary recreation (Gomez et al., 2015; Peters, 2010; Tinsley et al., 2002). This study investigates a park in a densely settled, diverse area CBD area; 41% of Liverpool residents were born overseas, and 52% are CALD (Australian Bureau of Statistics, 2018). The value of parks to different ethnic groups has been extensively studied in the leisure discipline. In our study, CALD visitors were over-represented (62%) compared to their share of the population. A study from the US highlighted that ethnicity plays an important role in shaping park preferences, with some groups preferring intracultural socialization or bonding social capital in parks (Ho et al., 2005). Also, a US study found that park visits by ethnic groups were positively associated with the degree of acculturation (Gomez et al., 2015) pointing to the fact that such socialization also encourages cultural integration or the building of bridging social capital in the longer term. Note that while socialization activities such as picnics and gatherings are more likely to be sedentary (Veitch et al., 2015), we found that CALD was not a predictor of SR. This is in line with the findings that ethnic groups view urban parks as having multiple values (e.g., physical health, psychological health, social connections etc.) (Stodolska et al., 2011).

We found more walking in the morning, evening, and weekdays, which is consistent with foot traffic across the park, some of which may be to a public transportation hub located next to the park. The fact that men and youth were more active in parks than women or older people, is in agreement with findings from two recent systematic reviews on the characteristics of park users (Evenson et al., 2016; Joseph & Maddock, 2016).

The results of this study are generalizable across a number of different contexts. First, the design of this park, that reflects Australia's European heritage and distinct colonial character (Ives et al., 2013), with both native and other vegetation, is common across Australia. Second, parks in densely populated CBD locations, and parks in disadvantaged or low socioeconomic locations, which this study investigates are of special interest to policymakers because of the benefits they deliver to the resident population relative to costs (Lee & Hong, 2013; Veitch et al., 2014). This may be specifically true in metropolitan cities of Australia and elsewhere with disadvantaged or low socioeconomic populations (Veitch et al., 2014).

Limitations of the Study

While this study is the only one to investigate the effects of landcover such as grass, or tree canopy on activity levels/types, there are a number of limitations that should be noted. First, our study was implemented at a time when the weather was conducive to sitting outdoors. It is possible that in more extreme weather, the patterns of park usage may differ, with one study from New Zealand, noting that adults accompanying children in parks prefer to sit in the shade of trees (Sargisson & McLean, 2012). Another important factor is the measure of being sedentary in parks. The measure may be too generic to assign the type of sedentary leisure that was undertaken while sitting (i.e., reading, listening to music) or if the sitting was done in solitude or in the company of others. Another limitation is the cross-sectional design with a single park in a specific area of Sydney and in a single season (fall/autumn), which limits its generalizability. There, may be some bias introduced from the inclusion of duplicate observations, all of which are problems inherent of using observational data, and of not including for instance, interview data. Finally, the landcover data processed in ArcGIS are satellite data, which have their own limitations, such as not exactly being able to infer the extent of greenspace cover, though while providing reasonable estimates for analysis. We used an observational approach, which may have limitations, such as the inferring of ethnicity and age-group through observation, though SOPARC is a validated tool for this specific purpose (Cohen et al., 2011). Finally, landcover is not the only aspect of parks that influence individual behavior in parks, but the specific park had little seating or other infrastructure, allowing us to study the effect of landcover without undue bias.

Management Implications

Recent policy measures from the public health discipline have been directed towards improving avenues for physical activity in parks. The leisure literature has argued that in addition to the more publicized active living roles of parks, designers of parks should provide features that optimize mental restoration; "landscaping should attempt to create a rich and engaging environment that provides opportunities for fascination, with seating near scenic areas for solitude and contemplation" (Stack & Shultis, 2013). The empirical evidence from this study, such as the provision of areas with more than 30% grass, complements this approach. Needless to say, such areas also need to have available seating, be aesthetically landscaped and have other features that encourage SR, and provision of just grassy patches is not sufficient to encourage SR. Park managers should therefore encourage and/or include adequate provision of grassy patches, to allow for necessary for relaxation and restoration through SR. However, this provision should be done in balance with what is sustainable, maintains biodiversity, and respects the park's natural ecosystem. From a management perspective, large patches of grass may also pose an extra burden in terms of regular mowing and maintenance. Further, if SR in such areas involve consumption of food, picnics, etc., then waste removal and cleaning may also pose a challenge. Conversely, the provision of such areas may increase park traffic, improve public perception or popularity of the park among the public, perhaps drawing in greater amounts of public funding allowing the necessary maintenance and more.

Conclusion

A large literature has developed, underscoring the importance of parks in generating physical activity, however sedentary recreation in parks is yet to be explored in depth. This study establishes the importance of grassy patches in encouraging sedentary recreation, especially around 12–2 p.m. Our study suggests that parks should provide amenities for sedentary recreation in addition to opportunities and infrastructure for physical exercise. By offering a variety of amenities, parks can be more appealing to a wider range of people and can provide a variety of benefits for both physical and mental health. It is hoped that our findings will inform further research in the topic and help inform the design of parks in the future.

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