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Influence of park visitation on physical activity, well-being and social connectedness among Australians during COVID-19

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Abstract

This cross-sectional study examined associations of park visitation with physical activity (PA), well-being, and social connectedness among 1089 participants during the coronavirus disease 2019 pandemic. In August 2020, adolescents and adults in Australia self-reported demographics, usual park visitation, frequency and duration of park visits, PA, well-being and social connectedness. Multilevel linear regression models examined associations of park visitation with well-being and social connectedness. Multilevel mixed-effects negative binomial regression models examined associations between visitation and PA. Compared to not visiting a park, visitation was positively associated with well-being (B = 3.92, 95% confidence interval [CI] = 1.24, 6.60) and days/week performing PA for 30 min (B = 1.24, 95% CI = 1.11, 1.39) per day and negatively associated with social connectedness (B = −3.75, 95% CI = −7.11, −0.39). Compared to visiting a park less than once/week, visiting once/week was positively associated with well-being (B = 3.90, 95% CI = 0.53, 7.21). Visiting more than once/week was positively associated with days/week performing PA for 30 min (B = 1.37, 95% CI = 1.21, 1.58) and 60 min (B = 1.34, 95% CI = 1.09, 1.64) per day and with well-being (B = 4.19, 95% CI = 0.90, 7.49). Duration of park visits was positively associated with days/week performing PA for 30 min (B = 1.09, 95% CI = 1.04, 1.13) and 60 min (B = 1.09, 95% CI = 1.02, 1.17) per day. Our findings highlight the role of parks in positively influencing health-related outcomes and the 'dosage' of park use needed to attain health benefits.

Keywords: COVID-19, pandemic, social health, park use, mental health, social interaction, active recreation

Contribution to Health Promotion

- This study provides insights regarding the influence of park visitation as a supportive environment on physical activity (PA), well-being and social connectedness among Australian adolescents and adults during the coronavirus disease 2019 (COVID-19) pandemic.
- Findings indicate the 'dosage' of park visitation associated with higher PA and well-being among adolescents and adults during the COVID-19 pandemic.
- While this study occurred during the pandemic, at a time when lockdowns, along with the pervasive threat of infection, significantly altered behavioural patterns in the built environment, it offers a methodology for understanding 'dosage' of park visitation for influencing health outcomes (well-being, social connectedness and PA) that is relevant to other periods and context.

BACKGROUND

Neighbourhood parks are critical public resources that can yield mental, physical and social health benefits (Bedimo-Rung *et al.*, 2005; Douglas *et al.*, 2017) by providing opportunities to connect socially, spend time in nature and be physically active (Sugiyama *et al.*, 2018; Jennings and Bamkole, 2019). Cross-sectional studies conducted among adults in the USA and Australia have found positive associations between park visitation and moderate- to vigorous-intensity physical activity (MVPA) (Hughey *et al.*, 2021), overall daily and weekly PA (Veitch *et al.*, 2013a; Stewart *et al.*, 2016) and adherence to PA guidelines (Flowers *et al.*, 2016; Arifwidodo *et al.*, 2022). While parks are generally not well attended by

adolescents (Joseph and Maddock, 2016; Marquet *et al.*, 2019), positive associations between park accessibility and availability and adolescents' PA have been observed (Cohen *et al.*, 2006; Kaczynski and Henderson, 2007; Babey *et al.*, 2008). Collectively, these findings demonstrate the scope for park visits to contribute to population levels of PA, which is important given that 81% of adolescents (Guthold *et al.*, 2020) and 28% of adults (Guthold *et al.*, 2018) worldwide are insufficiently active.

Additionally, park visitation has been linked to well-being and social connectedness. Systematic reviews have reported positive associations between park visitation and well-being among adolescents and adults (Houlden *et al.*, 2018; Zhang *et al.*, 2020), and higher well-being has been linked to improved mental health, longevity and life satisfaction (Steptoe *et al.*, 2015; Ruggeri *et al.*, 2020). Previous research has indicated that access to parks and nature in urban areas can improve people's resilience to crises and coping skills due to opportunities to socialize and the restorative effects of nature (Samuelsson *et al.*, 2020). Parks can also provide a venue for people to meet and connect socially, which can improve mental health (Lamblin *et al.*, 2017; Schwartz and Litwin, 2019) and well-being (Jose *et al.*, 2012) and protect against the negative health impacts of social isolation (Townsend and McWhirter, 2005) and loneliness (Jose and Lim, 2014). A cross-sectional study conducted among American adults found that regular (at least once/week) and long (>1 h) park visits were associated with greater park-based social capital (social capital accrued specifically in parks through social interaction and access to social networks in these settings) (Mowen and Rung, 2016), which is related to social connectedness (Haslam *et al.*, 2015). In contrast, a recent exploratory study in Australia observed limited evidence of associations between the frequency of park visitation and adolescents' social connectedness (Rivera *et al.*, 2022); however, park visitation was restricted to the nearest park, which may not reflect adolescents' park use more broadly (Smith *et al.*, 2015), and duration of visits was not examined. Thus, parks have great potential to enhance population health by promoting PA, well-being and social connectedness, which in turn may help combat the significant global health challenges presented by chronic health conditions (e.g. cardiovascular disease, diabetes and mental health disorders) (Dakic, 2019; Katzmarzyk *et al.*, 2021).

One major global health challenge was the coronavirus disease 2019 (COVID-19) pandemic, which saw governments implement a variety of measures to manage the spread of the virus. This included self-isolation and social distancing policies (i.e. lockdowns), which were associated with decreases in PA (Karageorghis *et al.*, 2021; Stockwell *et al.*, 2021), well-being (Krendl and Perry, 2021; Thorisdottir *et al.*, 2021) and social connectedness (Li *et al.*, 2021) during the pandemic. Some of these policies included limited access to more formal recreation settings (e.g. recreation centres and competitive sports), which may have subsequently impacted access and use of community spaces, such as parks, for PA and social connectedness. Consequently, these restrictions may have impacted park use behaviour during this time and the pandemic may have posed a paradox for park visitors. In Australia, as there were fewer places to go due to the closures of other recreation facilities, it is possible that during the pandemic, adolescents and adults visited parks more often to be active, connect with nature and socialize with others from a safe distance (Glover, 2020). However, park visitation may also have been negatively impacted by concerns regarding possible virus transmission. Thus, the impact of the COVID-19 pandemic on park use behaviour among adolescents and adults in Australia and worldwide is not well understood.

A study conducted among adults in the USA during COVID-19 found that geotag-measured park visitation increased by 63% at a state level early in the pandemic (February–May 2020) (Volenec *et al.*, 2021). That same study found that following a park shutdown order, there was a 76% decline in visitation compared with pre-park shutdown levels and when parks were re-opened, park use returned to the higher levels observed at the pandemic onset (Volenec *et al.*, 2021). A further study found that geotag-measured park visitation among US adults increased by 20% on average at a county level in April 2020 (Rice and Pan, 2021) compared to before COVID-19; the study did not specify whether there were any restrictions imposed on park use across the counties at the time of data collection. Additionally, a global analysis (48 countries) of park visitation indicated that park use, measured by Google mobility data, increased during the start of the pandemic (May 2020) compared to before the pandemic in February 2020 (Geng *et al.*, 2021). It is unclear whether there were any restrictions imposed on parks across the various countries included in that study during the time of data collection (Geng *et al.*, 2021). Further, none of these US or global studies examined the frequency or duration of visitation.

Adolescents in the USA reported that they were motivated to go outside for fresh air and to walk around the neighbourhood due to a heightened sense of safety resulting from fewer cars on the road (Ng *et al.*, 2020), while adults stated that they were more inclined to visit parks for outdoor recreation activities (e.g. biking, walking, running, etc.) during the pandemic (April–October 2020) compared to before (Folk *et al.*, 2021). While this suggests that adolescents and adults may have used parks for PA more often during the pandemic, less is known about the associations between park visitation frequency and duration and PA among these age groups. This is important for better understanding the 'dose' of park visitation associated with PA levels within the COVID-19 context. Additionally, cross-sectional studies found that frequency (in the previous 2 weeks) of visitation to green spaces during the pandemic was positively associated with well-being among UK adults (Richardson and Hamlin, 2021). Low participation in outdoor and nature-based recreation activities (e.g. walking, running, playing sports, etc.) during the pandemic was associated with lower well-being among US adolescents (10–18 years) (Jackson *et al.*, 2021). Despite these few studies, the changes in park visitation frequency and duration levels during the pandemic and whether they were associated with PA, well-being and social connectedness are not well known.

While numerous studies have highlighted the positive role of parks for health, much less is known about their role during stressful and disruptive circumstances to normal mobility and behaviour patterns (e.g. during a pandemic) (Xie *et al.*, 2020; Heckert and Bristowe, 2021). Of the existing literature on this topic both pre-pandemic and during COVID-19, most studies, which have predominantly been conducted among adults (as opposed to adolescents and older adults), have only examined the influence of the use of parks on health outcomes and have overlooked contextual information about park visitation, such as frequency and duration (Heckert and Bristowe, 2021). Additionally, there is a need for a methodology for understanding the influence of 'dosage' of park exposure on health

outcomes, such as PA, social connectedness, and well-being, which is salient to other contexts and periods. Thus, further research concerning the influence of frequency and duration of park visitation on PA, well-being and social connectedness is needed to better understand the role of parks in positively affecting health outcomes and to inform the optimal 'dosage' of park use for benefits. Exploring 'dose' of park use is also important for informing recommendations for improving planning, maintenance and the equitable provision of green spaces and parks outside of pandemic contexts (Slater *et al.*, 2020; Afrin *et al.*, 2021) and the 'new normal' following a pandemic (Heckert and Bristowe, 2021). While COVID-19 is no longer declared a pandemic, insights regarding the 'dosage' of park use during pandemic contexts can inform strategies and planning for future public health crises and sustainable urban design more broadly (Grima *et al.*, 2020; Geng *et al.*, 2021; Moreno *et al.*, 2021).

Therefore, this study aimed to (i) examine associations of visiting parks (whether people visit and if so, frequency and duration of park visits) with PA, well-being and social connectedness 3 months post-COVID-19 national lockdown (August 2020) among a combined sample of adolescents and adults in Australia and (ii) examine whether associations between park visitation and PA, well-being and social connectedness varied by lockdown-impacted area of residence and age group.

METHODS

This research was conducted as part of the Our Life at Home (OL@H) study (Arundell *et al.*, 2021; Parker *et al.*, 2021), a 2-year longitudinal study designed to examine changes in activity-related behaviours (e.g. active recreation, sport and screen time), health and well-being and to identify the factors that may influence these as the COVID-19 pandemic progressed and eased among Australians from all states and territories aged 5–75 years. This analysis utilizes cross-sectional survey data collected from a sample of adolescents (13–17 years) and adults (18+ years) from the OL@H second timepoint of data collection (T2: 17 August–7 September 2020), approximately 6 months into the pandemic. Ethical approval was received from the university's Human Ethics Advisory Group-Health (HEAG-H 59_2020).

Australian COVID-19 context

A detailed timeline of the pandemic-related restrictions in Australia from March to May 2020 has been published elsewhere (Arundell *et al.*, 2021; Parker *et al.*, 2021). In early May 2020, national lockdown restrictions were eased due to reduced community transmission. However, on 30 June 2020, tight restrictions in the state of Victoria were enforced due to an increase in community transmission. Metropolitan Melbourne (the capital of Victoria and its most populous city) entered lockdown on 7 July 2020, resulting in temporary closures of 'non-essential' businesses, schools, playgrounds and leisure facilities (e.g. sports clubs and gyms). People were only allowed to leave home to shop for food and essential supplies, medical care or caregiving, essential work and/or to exercise outdoors (Stage 3 restrictions). On 2 August 2020, these restrictions were also enforced in regional Victoria and more restrictions (Stage 4) were enforced only in metropolitan Melbourne, such as a nightly curfew (8 pm–5 am), mandatory mask-wearing, confinement to places within a 5-km radius from home for shopping or exercise and limits on exercise to 1 h/day outside with only one other person. This lockdown remained in place for the entirety of the data collection period for those in the study residing in metropolitan Melbourne; however, parks were open across all Australian states and territories, although it should be noted that playgrounds within parks were generally closed.

At this same time, restrictions were much less strict in other states and territories. For example, gatherings (e.g. weddings and funerals) and household visitors were permitted; recreation facilities (e.g. indoor and outdoor gyms, public playgrounds, pools) and other indoor premises (e.g. cafes, restaurants, churches, museums, cinemas, salons, etc.) re-opened and public events resumed, although there were capacity limits, which varied across states and territories.

Participant recruitment

Participants residing in Australia were recruited in May 2020 via researcher and stakeholder organization networks, social media advertising (e.g. Instagram, Twitter and Facebook) and snowballing techniques (e.g. word of mouth). Participants were provided with study information, and informed consent was obtained (tick box) prior to survey completion. Adolescents also required parent/guardian consent for their participation. There were 6497 participants (n = 4093 adolescents, n = 2303 adults and n = 101 older adults) recruited at baseline. At the T2 timepoint, a recruitment booster occurred through the same channels. For the current analysis (August–September 2020), 3208 participants (n = 363 adolescents, n = 1934 adults and n = 911 older adults aged 65+ years) provided consent.

Measures

Participants self-reported their demographic characteristics, park visitation, PA, well-being and social connectedness during the past month. The month of recall was 3 months post-national lockdown and corresponded to the period of restrictions in regional Victoria (Stage 3) and metropolitan Melbourne (Stage 4).

Physical activity

PA was assessed using established survey items with demonstrated reliability and validity among adolescents and adults (Milton *et al.*, 2011; Ridgers *et al.*, 2012; Bennie *et al.*, 2018). In two separate questions, all participants were asked to report the number of days they performed MVPA for at least 30 min and for at least 60 min/day during a usual week in the past month, respectively. The response options for both items ranged from 0 to 7 days/week. These two variables were treated as continuous (days/week of MVPA for ≥30 min/day; days/week of MVPA for ≥60 min/day, respectively).

Well-being

Well-being was assessed using the five-item *World Health Organization Well-Being Index* (WHO-5) (Topp *et al.*, 2015). This measure has been shown to be suitable for individuals over 9 years, has good construct validity among younger persons and older adults (Topp *et al.*, 2015), and has satisfactory reliability across 35 countries (Sischka *et al.*, 2020). Participants were asked to 'indicate which is the closest to how you have been feeling over the last two weeks: 1) *I have felt cheerful and in good spirits;* 2) *I have felt calm and relaxed*; (3) *I have felt active and vigorous;* (4) *I woke up*

feeling fresh and rested; and (5) *My daily life has been filled with things that interest me*'. Responses to each item ranged from 6 (at no time) to 1 (all the time) and were reverse-coded so that a higher score reflected greater well-being. Responses were summed into a raw score (possible range 1–25), which was multiplied by four to determine the total well-being score. A higher score reflected a higher level of well-being (0 = absence of well-being, 100 = optimal well-being) (Topp *et al*., 2015).

Social connectedness

Social connectedness was measured using *The Social Connectedness Scale,* which consists of eight items pertaining to aspects of belongingness and has established internal reliability ($\alpha = 0.91$) among adults (Lee and Robbins, 1995). Additionally, this measure has been used in previous studies among adolescents (Rivera *et al*., 2022) and adults (Lee and Robbins, 1995).

Participants were asked to report 'how much do you agree or disagree with the following statements about your social connectedness?: 1*) I feel disconnected from the world around me,* 2) *Even around people I know, I don't feel that I really belong,* 3) *I feel so distant from people,* 4*) I have no sense of togetherness with my peers,* 5) *I don't feel related to anyone,* 6) *I catch myself losing all sense of connectedness with society,* 7) *Even among my friends, there is no sense of brother/sisterhood* and 8) *I don't feel that I participate with anyone or any group.*' Participants indicated their level of agreement using a four-point Likert scale (1 = strongly disagree to 4 = strongly agree). To derive an overall social connectedness score, responses were reverse-coded and summed (possible range: 8–32) and transformed to a 0–100 scale (((summed score − 8)/24) × 100) for ease of interpretation, where a higher score indicated a higher level of social connectedness (Arundell *et al*., 2019).

Park visitation

Participants were first asked to recall whether they visited a park (no, yes) in a usual week in the past month. If participants reported yes, then they were asked to report the average number of times per week (frequency) and the minutes per week (duration) they visited parks in a usual week in the past month. These questions were modified for the present study based on existing research concerning parks, and the park-related items were shown to have acceptable test–retest reliability (Veitch *et al*., 2014). Responses for frequency of park visits were categorized as (0) visit less than once, (1) visit once and (2) visit more than once/week. The total duration of park visits was converted into hours/week and treated as a continuous variable.

Demographic characteristics (covariates)

Variables that could be potential confounders in the associations between the exposures and outcomes were selected a priori based on previous research (Veitch *et al*., 2015; Evenson *et al*., 2016; Parker *et al*., 2021; Rivera *et al*., 2022). These included participants' age (years), sex (male, female, other/prefer not to say), dog ownership (yes, no), employment (employed, not employed) and area-level disadvantage of the state or territory of residence. Given the broad age range of the sample, a categorical variable for age groups was created [1 = adolescents (13–17 years), 2 = adults (18–64 years) and 3 = older adults (65+ years)]. Participants reported their residential postcode, which was used to create tertiles of advantage using the Australian Bureau of Statistics (ABS) Socio-Economic Indexes for Areas, Index of Relative Socio-economic Advantage and Disadvantage (IRSAD) scores (Australian Bureau of Statistics, 2018) (1 = least disadvantaged, 3 = most disadvantaged) and the level of remoteness (five levels with a lower level indicating less remoteness) (Australian Bureau of Statistics, 2016).

To account for potential confounding due to the varying levels of COVID-19 restrictions during data collection, lockdown-impacted area of residence was adjusted for in the analyses (1 = metropolitan Victoria, 2 = regional Victoria and 3 = other states/territories), where remoteness was used to differentiate metropolitan versus regional Victoria.

Data reduction and analysis

Given the high proportion of missing responses for the exposure, confounder and outcome variables, a sensitivity analysis was performed to determine whether there were differences in the outcome variables for those with missing data versus those without missing data (Sterne *et al*., 2009). The sensitivity analysis revealed that the data were missing at random (i.e. missingness did not significantly differ by age, sex, lockdown-impacted area of residence, dog ownership, area-level disadvantage and employment status). Thus, complete case analyses were performed (Sterne *et al*., 2009). Participants with complete data for all outcomes (PA, well-being and social connectedness), exposures (park visitation, park visit frequency and park visit duration) and covariates (age, sex, employment, dog ownership, area-level disadvantage and lockdown-impacted area) were included in the analyses, reducing the sample from 3208 to 1089 participants ($n = 58$ adolescents, $n = 730$ adults and $n = 301$ older adults).

Associations of park visitation, park visit frequency and park visit duration with well-being and social connectedness (continuous variables) were examined separately using multilevel linear regression analyses (British Medical Journal, 2024), with the interpretation of unstandardized coefficients. Due to the zero-inflated nature of the PA variables (University of California Los Angeles, 2024a), multilevel mixed-effects negative binomial regression models were fitted to examine associations between park visitation, park visit frequency and park visit duration with PA (count of days/week on which 30 min of PA was performed per day), with the interpretation of the negative binomial regression using incidence rate ratios (University of California Los Angeles, 2024b). Separate models with random intercepts for lockdown-impacted areas of residence and age groups were also fitted to perform a sensitivity analysis. The interactive effect of area of residence and age group on associations between park visitation and each outcome (PA, well-being and social connectedness) were estimated by adding a two-way interaction term separately for each outcome. Significant interaction effects were presented graphically (estimated probability of meeting PA guidelines) and plotted against the frequency of park visitation. All models specified state/territory as random effects to account for clustering and also adjusted for the following covariates age, sex, dog ownership, area-level disadvantage, lockdown-impacted area of residence and employment status based on previous research (Veitch *et al*., 2015; Evenson *et al*., 2016; Parker *et al*., 2021; Rivera *et al*., 2022). Statistical significance was set at $p < 0.05$, and all analyses were performed using Stata/SE 17.0 (Stata Corp., College Station, TX, USA).

RESULTS

Participant characteristics for the sample are presented in Table 1. The sample was predominantly adults (67%), female (86%), not employed (62%) and not dog owners (62%). Participants were from all eight states and territories with the highest proportions in New South Wales, Queensland and Victoria. Almost half of the sample reported visiting a park at least once per week (47%), with a mean duration of 0.6 h (36 min) per week. The mean number of days performing ≥30 min and ≥60 min of PA per week were 2.6 days and 1.5 days, respectively. Supplementary Table 1 includes the data for the outcome and exposure variables.

Tables 2 and 3 show associations between park visitation (frequency and duration) and days/week performing ≥30 and ≥60 min/day of PA per week, well-being and social connectedness.

Table 1: Sample characteristics (combined adolescents and adults)

n = 1089	*n* (%)
Age groups	
Adolescents (13–17 years)	58 (5.3)
Adults (18–64 years)	730 (67.0)
Older adults (≥65 years)	301 (27.6)
Sex	
Male	147 (13.5)
Female	934 (85.8)
Other/prefer not to say	8 (0.7)
State or territory of residence	
Australian Capital Territory	47 (4.3)
New South Wales	395 (36.3)
Northern Territory	9 (0.8)
Queensland	225 (20.6)
South Australia	104 (9.5)
Tasmania	68 (6.2)
Victoria	151 (13.9)
Western Australia	90 (8.3)
Lockdown-impacted area of residence	
Metropolitan Melbourne	113 (10.4)
Regional Victoria	38 (3.5)
Other states	938 (86.1)
Area-level disadvantage	
T1 (least disadvantaged)	484 (44.4)
T2	342 (31.4)
T3 (most disadvantaged)	263 (24.2)
Dog ownership	
Yes	413 (37.9)
No	676 (62.1)
Employment status	
Not employed	670 (61.5)
Employed (part-time or full-time)	419 (38.5)
Park visitation in past month	
Yes	524 (48.1)
No	565 (51.9)
Park visit frequency in past month	
<1/week	574 (53.0)
1/week	241 (22.2)
>1/week	268 (24.8)
	Mean (SD)
Park visit duration (hour/week) in past month	0.6 (1.2)
Days performing ≥30 min of PA per day/week	2.6 (2.2)
Days performing ≥60 min of PA per day/week	1.5 (1.9)
Social connectedness score (0–100)	34.4 (28.8)
Well-being score (0–100)	51.2 (22.9)

Associations with PA, well-being and social connectedness

Significant positive associations between park visitation (whether visit, park visit frequency and park visit duration) and PA were observed (Table 2). The expected rate of days/week on which 30 min of PA per day were performed was 1.24 times greater among those who visited parks compared with those who did not visit a park (Incidence Rate Ratio = 1.24; 95% confidence intervals [CI] [1.11, 1.39]). The expected rate of days/week on which 30 min and 60 min of PA per day were performed was 1.37 times (IRR = 1.37; 95% CI [1.21, 1.58]) and 1.34 times (IRR = 1.34; 95% CI [1.09, 1.64]) greater, respectively, among those who visited more than once per week compared with those who visited a park less than once per week (Table 2). A 1-h increase in park visitation was significantly associated with a 9% higher number of days/week of performing at least 30 min (IRR = 1.09; 95% CI [1.04, 1.13]) and 60 min (IRR = 1.09; 95% CI [1.02, 1.17]) of PA per day (Table 2).

As shown in Table 3, there was a significant positive association between visiting a park and well-being score (B = 3.92; 95% CI: 1.24, 6.60). Compared with those who visited a park less than once per week, there were significant positive associations between visiting a park at least once per week (B = 3.90; 95% CI: 0.53, 7.21) and more than once per week (B = 4.19; 95% CI: 0.90, 7.49), with well-being scores.

As shown in Table 3, compared with those who did not visit a park, there was a significant negative association between visiting a park and social connectedness scores (B = −3.75; 95% CI: −7.11, −0.39).

Interactions between PA, well-being and social connectedness and park visitation by areas of residence and age group

The association between park visitation frequency and number of days/week performing at least 30 min/day of PA differed by region/state (Figure 1). Positive associations were observed among participants living in regional Victoria only. Those who visited a park at least once per week (B = 2.39; 95% CI [1.01–5.63]) and more than once per week (B = 2.18; 95% CI [1.01–4.69]) engaged in at least 30 min/day of PA on more days per week. No association was found among those living in metropolitan Victoria and other states or territories.

Associations between park visitation (including frequency and duration) and PA, social connectedness and well-being did not statistically significantly differ by age group.

DISCUSSION

This study examined associations between park visitation, including frequency and duration of park visits and PA,

Table 2: Associations between usual park visitation in the last month (frequency and duration) and PA (days/week of ≥30 min/day and ≥60 min/day of PA)

	Physical activity			
	Days/week with ≥30 min PA per day		Days/week with ≥60 min PA per day	
	IRR (95% CI)[a]	*p*-value	IRR (95% CI)[a]	*p*-value
Park visitation				
No (ref)	—		—	
Yes	1.24 (1.11, 1.39)	**<0.0001**	1.18 (0.99, 1.41)	0.055
Park visit frequency				
<1/week (ref)	—		—	
1/week	1.09 (0.95, 1.26)	0.193	1.03 (0.83, 1.29)	0.747
>1/week	1.37 (1.21, 1.58)	**<0.0001**	1.34 (1.09, 1.64)	**0.006**
Park visit duration (h/week)	1.09 (1.04, 1.13)	**<0.0001**	1.09 (1.02, 1.17)	**0.008**

Significant associations ($p < 0.05$) are bolded. All models adjusted for: age group (adolescents, adults and older adults), sex (male, female, other/prefer not to say), area-level disadvantage (T1, T2 and T3), lockdown-impacted areas of residence (metropolitan Victoria, regional Victoria and other states), dog ownership (yes or no) and employment status (employed and not employed).
IRR, incidence rate ratio; PA, physical activity; Ref, reference variable.
[a]Negative binomial regression with interpretation using incidence rate ratios.

Table 3: Associations of usual park visitation in the last month (frequency and duration) with social connectedness and well-being

	Social connectedness score[b]		Well-being score[c]	
	B (95% CI)[a]	*p*-value	*B* (95% CI)[a]	*p*-value
Park visitation				
No (ref)	—		—	
Yes	−3.75 (−7.11, −0.39)	**0.029**	3.92 (1.24, 6.60)	**0.004**
Park visit frequency				
<1/week (ref)	—		—	
1/week	−3.64 (−7.86, 0.57)	0.091	3.90 (0.53, 7.21)	**0.023**
>1/week	−3.67 (−7.79, 0.45)	0.081	4.19 (0.90, 7.49)	**0.013**
Park visit duration (h/week)	−0.11 (−1.50, 1.27)	0.871	0.90 (-0.21, 2.00)	0.111

Significant associations ($p < 0.05$) are bolded. All models adjusted for: age group (adolescents, adults and older adults), sex (male, female, other/prefer not to say), area-level disadvantage (T1, T2 and T3), lockdown-impacted areas of residence (metropolitan Victoria, regional Victoria and other states), dog ownership (yes or no), employment status (employed and not employed).
B, unstandardized coefficient/regression coefficient; Ref, reference variable.
[a]Multilevel linear regression with interpretation using unstandardized coefficients.
[b]Possible range 0–100: a higher score indicates a higher level of social connectedness.
[c]Possible range 0–100: a higher score reflects a higher level of well-being (0 = absence of well-being, 100 = optimal well-being).

well-being and social connectedness. To our knowledge, no single study has examined these exposures with all three of these outcomes simultaneously. Visiting parks was positively associated with PA and well-being but, contrary to expectation, negatively associated with social connectedness. Compared to visiting a park less than once per week, visiting once per week was associated with greater well-being and visiting more than once per week was positively associated with both PA and well-being, regardless of age group. Spending more time in parks was associated with more days of PA, whereas park visit duration was not significantly associated with well-being. Although not directly comparable due to different participation groups and measures, the findings from our study indicate that fewer adults visited a park in August 2020 compared to park visitation rates measured before the pandemic (Rivera *et al.*, 2022). Additionally, on average, adults reported lower well-being compared to well-being scores measured before the pandemic (Topp *et al.*, 2015) and adolescents and adults had lower social connectedness scores (Lee and Robbins, 1995; Arundell *et al.*, 2019; Rivera *et al.*, 2022).

We observed a positive association between park visitation (whether people visited) and PA, which aligns with pre-pandemic research among adults (Flowers *et al.*, 2016; Stewart *et al.*, 2016; Hughey *et al.*, 2021; Arifwidodo *et al.*, 2022). Given the cross-sectional nature of this study, it may also be that more active people visited parks. Greater frequency and duration of park visits were also associated with higher odds of being active for 30 min and for 60 min/day per week. These findings are consistent with previous research, albeit before the pandemic, where those visiting a park were more likely to meet PA guidelines (Flowers *et al.*, 2016). Taken together, these findings suggest that regular park visitation (more than once per week) and more time spent in parks is related to higher levels of PA.

We examined whether associations differed by lockdown-impacted area of residence, and a positive association with PA was observed among those who visited a

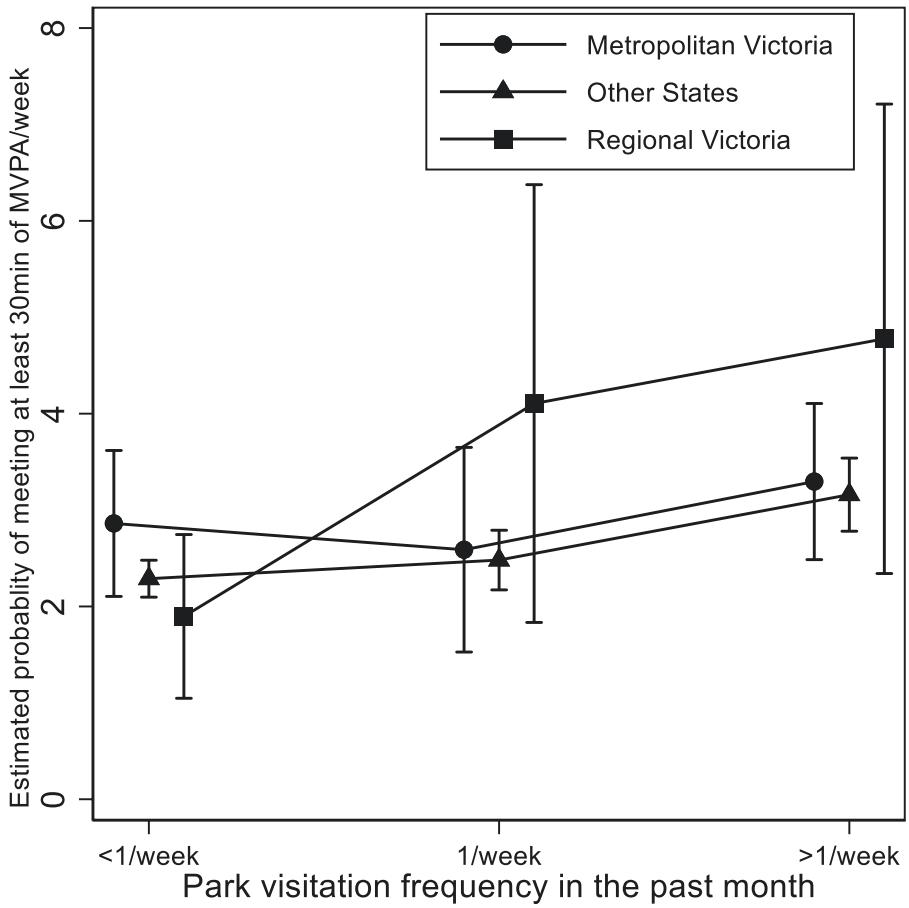

Fig. 1: Interaction between PA and park visitation frequency by areas of residence.

park once per week and more than once per week for those living in regional Victoria but not for residents of metropolitan Melbourne or other states. Cross-sectional studies conducted in Australia have indicated that park characteristics and quality may differ between parks located in urban and rural areas and according to the socio-economic status of the neighbourhood (Crawford *et al.*, 2008; Veitch *et al.*, 2013b), and therefore, differences in aesthetics and/or specific features of the parks may have impacted participants' visitation and how they used the parks. Differences in COVID-related restrictions between urban and rural areas may have also impacted access and related park use. For example, it could be that people residing in regional Victoria had higher access to parks compared to metropolitan Melbourne, where access was constrained by only being permitted to leave the house for exercise for 1 h/day. Previous research from the USA indicated that the COVID-19 pandemic highlighted disparities in access to park use among disadvantaged populations (Slater *et al.*, 2020), for example, inequities in the distribution of park use among vulnerable populations, such as the elderly, women and people of a low socio-economic position, due to inequalities in park access (Yu *et al.*, 2023). These findings may apply to parks in Melbourne, where access to public green space has been shown to vary throughout the metropolitan area (Hsu *et al.*, 2022). Supportive urban planning policies and infrastructure plans that provide access to and maintain high-quality parks for all may be promising for encouraging people of all ages to visit parks and attain health benefits associated with use. This is likely to be important under 'usual' circumstances, and 'new normal' conditions where flexible working/studying arrangements have persisted in some industries, and during public health crises.

Similar to pre-pandemic research among adolescents and adults (Houlden *et al.*, 2018; Zhang *et al.*, 2020), we observed positive associations between park visitation and park visit frequency (≥1/week) with well-being, suggesting that visiting parks and visiting at least once per week may improve well-being. More specifically, compared with those who visited a park less than once per week, visiting a park once per week was associated with a 3.9-point higher well-being score (0–100 scale) and visiting a park more than once per week was associated with a 4.2-point higher well-being score. We observed no significant association between the duration of park visits and well-being, which differs from a previous cross-sectional study where the hours spent visiting parks per month were positively associated with well-being domains among adults in Singapore (Petrunoff *et al.*, 2021); however, this may be due to varying measures for visit frequency and differing built environments (e.g. high concentration of high-rise buildings and very urban form in Singapore). A pre-pandemic cross-sectional study found that spending at least 120 min/week in nature was associated with higher well-being among adults compared with those with no nature contact (White *et al.*, 2019). It is possible that during the pandemic (August 2020), visiting parks was enough to positively impact well-being, regardless of duration, as observed in the present study. Thus, it is plausible that in contrast to not

visiting parks altogether and staying indoors, visiting parks is important for positively impacting well-being even if for a short period of time. Based on previous research, it may be that the more time people spend visiting a park, the better this is for well-being; however, we did not observe this, and it may potentially be due to the short amount of time that the sample spent using the park as the mean park visit duration was 0.6 h/week (36 min/week). Further research is needed to better understand the associations between park visitation (including frequency and duration), especially in a 'new normal' and post-pandemic context.

Contrary to our hypothesis, visiting a park in the past week was inversely associated with social connectedness and there were no significant associations between frequency or duration of park visits and social connectedness. This is in contrast to findings from two cross-sectional studies conducted in Australia and the USA among adults, which showed positive associations between the frequency of community park use and social interaction during the pandemic (Yang *et al.*, 2022) and between park visit frequency and duration and park-based social capital pre-pandemic (Mowen and Rung, 2016). However, neither study examined social connectedness specifically. Our findings are consistent with a recent pre-pandemic cross-sectional study, which observed no significant associations between the frequency of park visitation and Australian adolescents' social connectedness (Rivera *et al.*, 2022), although that study did not examine the duration of park visits. There are several potential explanations for our findings. According to Gibson's Affordance Theory, environments afford different actions and behaviours and the needs and interests of users in the environment influence their perceived opportunities for the use of place (Lennon *et al.*, 2017). It is possible that the pandemic-imposed restrictions may have influenced the needs of users so that they sought to use parks in ways that did not impact social connectedness. Additionally, it is plausible that even though people may have been co-present with others in the park (i.e. physically in the same location as other people), feelings of poor social connection were generally heightened during the pandemic and there was a requirement in Victoria at the time to be physically separated from others, not in the same household (i.e. 1.5 m). In addition, park visitors may have minimized social interactions with others due to fear of spreading or catching COVID-19 and/or people may have visited parks to restore and have time to themselves (Humphrey *et al.*, 2022). It could also be that the people who visited parks during this time period were those who were already less socially connected to others or who did not have easy access to parks close to home.

A challenge of comparing findings from different studies is that there is no universal measure for assessing social connectedness (Barber and Schluterman, 2008; Haslam *et al.*, 2015; Carroll *et al.*, 2017). The findings may have differed if another instrument had been utilized. Further, social connectedness can be fostered across many contexts (e.g. family, community/neighbourhood, peer and school/work) (Jose *et al.*, 2012; Carroll *et al.*, 2017; Rose *et al.*, 2019). It could be that social connectedness in a neighbourhood context from visiting parks, could be tempered by the more limited opportunities to socialize in other contexts (e.g. peers, family and school), particularly given that people were often separated from their social networks and were mostly attending work/school online. There are also other social constructs that are closely related to social connectedness (Haslam *et al.*, 2015), such as social cohesion, social capital, social integration and sense of community. These may be cultivated by visiting parks and should be considered in future studies.

This is one of few studies to examine associations between park visitation (including frequency and duration) and PA, well-being and social connectedness. While this study occurred during the pandemic, a time when lockdowns and the risk of infection significantly altered behavioural patterns in the built environment, it offers a methodology for understanding 'dosage' of park exposure for influencing health outcomes (e.g. PA, well-being and social connectedness) that is highly relevant to other contexts and periods. Another strength of this study is the large national sample of adults. However, the cross-sectional study design, the small number of adolescents, and the reliance on self-report means the data may be subject to social desirability and recall biases (Kohl *et al.*, 2000; Klesges *et al.*, 2004). Future longitudinal and experimental study designs are needed to determine causal relationships between the factors explored in this study. The generalizability of our findings may also be limited due to the sample being predominantly female and adults, which is not representative of the broader Australian population (Parker *et al.*, 2021). While not all states and territories were consistently impacted by COVID-19 restrictions, a strength of our study was the investigation of whether associations differed by lockdown-impacted area of residence. As the built environment may vary between countries, our findings may not be entirely applicable to other cultures and nations. Given that this study was conducted during August 2020 (winter in Australia), seasonality may have impacted park visitation, especially since climate varies across Australian states and territories (Roemmich and Johnson, 2014). Additionally, some 95% CIs were wide, for example, for the association between park visitation and social connectedness ($B = -3.75$, 95% CI = −7.11, −0.39). Thus, results should be interpreted with caution. Further, given the unexpected nature of the pandemic and associated lockdowns and the time-sensitive nature of the data collection, the park visitation measures were adapted from similar items from a previous study (Veitch *et al.*, 2014). Additional psychometric testing of these measures could assist future data collection. Lastly, a limitation of our findings was the high proportion of missing responses for the exposure and outcome variables. We conducted a sensitivity analysis to analyse patterns of missingness, which indicated that the data were 'Missing at Random' (MAR) (Sterne *et al.*, 2009). Consequently, it does not appear that the use of complete case analyses, a common method used to address missing data in epidemiological studies (Sterne *et al.*, 2009), biased the observed associations (Sterne *et al.*, 2009; Stephens *et al.*, 2018). Moreover, as required by ethical approval, there was no requirement for participants to complete every question within the survey, which led to missing data.

CONCLUSIONS

This study provides insights regarding the role of parks in relation to PA, well-being and social connectedness in the context of the COVID-19 pandemic among adolescents, adults and older adults in urban, regional and rural areas of Australia. Visiting a park more than once per week and the time spent in parks were positively associated with days on which at least 30 min of PA per week is accrued, and

visiting a park at least once per week or more was favourably associated with well-being. However, visiting a park was negatively related to social connectedness. Our findings are generally consistent with those from previous pre-pandemic studies and contribute to a better understanding of the role of parks in promoting health under 'usual' circumstances, 'new normal' conditions (e.g. flexible working) and during public health crises. Future longitudinal and experimental studies are needed to clarify causal associations between park use, PA, well-being and social connectedness among different subgroups.

SUPPLEMENTARY MATERIAL

Supplementary material is available at *Health Promotion International* online.

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AUTHORS' CONTRIBUTIONS

KP and LA planned and received funding for the Our Life At Home study. ER, KP, LA, JV, VL and AT conceptualized the research question and the analytical approach. VL and ER analysed the data and interpreted the results. ER drafted and edited the original manuscript, and VL drafted the Results section. All authors provided critical intellectual feedback on drafts. All authors read and approved the final manuscript version.

ETHICAL APPROVAL

Ethical approval was received from the Deakin University Human Ethics Advisory Group-Health (HEAG-H 59_2020).

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