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Associations between urban greenspace and health-related quality of life in children

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ABSTRACT

With research to suggest that urban greenspace use can affect the health and wellbeing of adults, it is important to investigate this association in children. Compared with factors such as physical activity, research considering greenspace and its association with the health and wellbeing of children from urban areas is relatively rare.
This study examined the health-related quality of life of 276 children residing in the city of Edinburgh in relation to quantity and use of greenspace. As much of the existing research has employed parental reports of children's health, the current study assessed health-related quality of life via self-report, measured using the Kid-KINDL questionnaire (Ravens-Sieberer & Bullinger, 1998). Spatial analysis of greenspace quantity and typology was undertaken using mapping software, ArcGIS (Esri, 2011).
In regression analysis, higher greenspace use and having fewer siblings were significantly associated with better health-related quality of life. Further analysis revealed that these variables were also associated with the 'friends' sub-scale score of the Kid-KINDL. Higher greenspace use was positively associated with 'self-esteem' sub-scale scores. However, the quantity of residential greenspace was not associated with the health-related quality of life of children.
This study suggests that increased use of greenspace in urban areas might have a small but positive impact on child health-related quality of life, though future longitudinal and intervention studies are required to confirm these causal assumptions.

Introduction

The health and wellbeing of urban residents have become a major research focus (Nutsford et al., 2013). An increasing body of epidemiological research suggests that access to, and use of, greenspace within urban areas can positively impact many health and wellbeing issues (Mitchell, 2013; Carter and Horwitz, 2014). This study examined associations between the quantity and the use of greenspace and health-related quality of life in young children.

Previous research has suggested that viewing greenspace can provide restorative effects on mental and physical health. 'Stress Recovery Theory' (Ulrich, 1984; Ulrich et al., 1991) suggests that viewing natural scenes can reduce symptoms of stress and anxiety, contrary to typical urban scenes which can lead to decreased attention and happiness (Ulrich and Addoms, 1981; Van Den Berg et al., 2010). While Stress Recovery Theory relates specifically to adults, the potential health and wellbeing benefits derived by viewing natural scenes encompassed by the theory may be valid in both adults and children. In observational studies, children in rural areas surrounded by more greenspace were less susceptible to the psychological effects of everyday stressors and reported higher overall wellbeing than those in city areas (Wells and Evans, 2003). In research with adults, the use of greenspace for physical activity was associated with reductions in many chronic diseases (e.g. cardiovascular disease) (Wolch et al., 2014) and improved mental health (Maas et al., 2009). Furthermore, adults who believed local greenspace to be of practical use reported better general health (Carter and Horwitz, 2014). Positive associations have also been found between the quality and proximity of greenspace to people's homes and their use for physical activity (Nutsford et al., 2013; Crawford et al., 2008; Pikora et al., 2003).

It has been suggested that greenspace may moderate the negative effects of deprivation on health outcomes. For example, while reduced exposure to greenspace and residing in deprived urban areas were associated with all-cause and circulatory disease mortality, the association was not observed for individuals who lived in deprived areas with higher levels of greenspace (Mitchell and Popham, 2008). Using geographical information systems (GIS) analysis, Nutsford et al. (2013) reported that both higher levels of greenspace and smaller distances from the home to usable greenspace were associated with fewer depression and anxiety symptoms in adults from deprived areas. Researchers have therefore suggested that the health of residents from urban areas could benefit from greenspace which is of close proximity to their homes (Ward-Thompson et al., 2012).

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Fewer studies have considered how greenspace might benefit the health and wellbeing of children (Flouri et al., 2014; Spencer and Blades, 2006). It is essential to have an understanding of this relationship as lifestyle choices adopted at a young age may impact early outcomes and future habits and associated outcomes throughout the life course (Power and Elliott, 2006). Strong associations have been found between childhood use of greenspace and this behavior in adulthood (Ward-Thompson et al., 2008).

Greenspace research with children has predominantly focused on physical activity (Flouri et al., 2014; Wheeler et al., 2010). Despite evidence that children prefer an outdoor setting (Wells and Evans, 2003; Evans, 2006), they are increasingly spending their free time indoors (Louv, 2010). Childhood obesity is rising (Lobstein, 2014; Ng et al., 2014), though children with greater access to greenspace are more active and less obese than children without such access (Wolch et al., 2014). Children in Scotland living at increasing distances from greenspace watch more television and have more psychological and general health problems than children living closer to greenspace, when measured through parental reports (Aggio et al., 2015).

Associations have been reported between limited time spent outdoors and behavioral problems in children (Louv, 2010). Markevych et al. (2014) found that the further children lived from greenspace, the more behavioral problems and symptoms of ADHD they displayed, and the more relationships with friends suffered. This is consistent with the findings of Flouri et al. (2014) which suggested both increased access to, and use of, greenspace in children aged 3–5 were related to fewer symptoms of hyperactivity, and fewer problems with friends.

The current study examined associations between quantity and use of greenspace and health-related quality of life of children in Edinburgh. As much of the existing research has employed parental reports of children's health and greenspace use, the current study was therefore conducted as a "proof of concept" by assessing these factors via child self-report, while greenspace quantity was assessed objectively using ArcGIS (Esri, 2011).

Methodology

Design

The study was a cross-sectional survey, designed to explore associations between greenspace (use and quantity) and health-related quality of life. For 95% power to detect a small effect size (.1) at $p < 0.05$ in a multiple regression with 7 predictors, a sample size of at least 226 was required.

The main outcome was total self-reported health-related quality of life assessed by the Kid-KINDL questionnaire (Ravens-Sieberer and Bullinger, 1998). The two main predictor variables were self-reported use of greenspace and the percentage of greenspace within the residential area, measured using ArcGIS version 10.0 (Esri, 2011).

Participants

Participants were recruited from primary schools within Edinburgh, UK. Eighty-eight potential schools were split into 10 groups based on their Scottish Index of Multiple Deprivation (SIMD) ranking (Scottish Index of Multiple Deprivation, 2012) and were contacted for participation through random assignment within each group. When a school declined participation, a further random selection from that group occurred. A total of 37 schools were contacted, and eight agreed to take part. At participating schools, all children aged 8–11 years were given consent forms for their parent/guardian to complete. From an estimated upper maximum of 900 potential participants, a total of 287 completed the questionnaire. Nine participants were excluded due to a high proportion of missing data, and two were removed for ticking multiple responses on more than one occasion. Therefore, the number of participants ranged from 254 to 276 because of minor instances of missing data, detailed below.

Procedure

Data collection occurred between November and December 2014. Participants were given a questionnaire to complete regarding experiences during the previous week. The participants completed the questionnaire individually, though the researcher (DM) went through each question in turn, allowing time for explanation.

Ethical considerations

Ethical approval was obtained from Heriot-Watt University and the Children and Families Department of Edinburgh City Council. Only children who received permission from their parent/guardian participated, after being briefed on the nature of the study and their right to withdraw at any time.

Materials

Health-related quality of life

Health-related quality of life was measured using the Kid-KINDL questionnaire (Ravens-Sieberer and Bullinger, 1998), a developmentally tailored questionnaire for children aged 7–13 years. Health and wellbeing across six different domains were assessed by 24 statements, each answered on a five-point scale from never (1) to all of the time (5). A total score was calculated by adding the sub-scale scores transformed to a scale of 100 as per the instructions. Each sub-scale and the number of participants are displayed in Table 1.

Use of urban greenspace

Use of greenspace over the previous week was assessed by self-report. Based on the 'Planning Advice Note 65: Planning and Open Space' (Planning Advice Note 65, 2008) created by the Scottish Government, outdoor areas relevant to children were separated into seven different categories. These were: public park/garden; own garden; allotment garden; playpark; outdoor sports facilities; woodland areas; the street or other hard surfaces for people. Frequency of use for each was reported using a five-point scale from never (0) to every day (5), and transformed to a score out of 100. Participants were also asked how often they had exercised outside in the previous week.

Residential greenspace

Greenspace data were obtained from the Central Scotland Green Network. Participants provided their home postcode and a map detailing each location was created using Google Maps. Visual analysis of the mapped home locations illustrated spatial clustering of participants; 46 spatial groups of participants were identified. The spatial grouping of participants allowed for latent class analysis (Dymnicki and Henry, 2011; Carvalho et al., 2009). Consistent with previous research (Markevych et al., 2014; Kyttä et al., 2012), the distance considered acceptable for greenspace accessibility was 500 m. Thus, the greenspace available within a 500 m radius from the cluster group centre was calculated using ArcGIS (Esri, 2011). Where postcodes were spatially clustered, all participants attributed to a specific cluster fell within 50 m of the centroid. Where participants were remotely located (outside of a 50 m greenspace centroid), greenspace was calculated for their individual postcode.

A breakdown of greenspace (per m^2) types within each area was extracted. Greenspace was classified as all vegetated open space areas. Water areas (e.g. canals, rivers and ponds) were removed as they were not relevant to this study. The percentages of each greenspace

Table 1
Descriptive characteristics, Edinburgh, UK.

	All participants		Male		Female		Gender comparison
	N	Mean (SD) or % of *N*	*N*	Mean (SD) or % of *N*	*N*	Mean (SD) or % of *N*	Statistical analysis
Gender	276	–	122	44.4%	154	55.6%	
Age (years)	275	9.7 (.9)	122	9.8 (.9)	153	9.7 (.9)	$t(273) = 0.89$, $p = 0.38$
Siblings	274	–	122	–	152	–	$U = 9214.00$, $p = 0.93$
0	34	12.4%	10	8.2%	24	15.8%	
1	109	39.8%	56	45.9%	53	34.9%	
2	75	27.4%	34	27.9%	41	27.0%	
3	28	10.2%	12	9.8%	16	10.5%	
4	13	4.7%	4	3.3%	9	5.9%	
5	5	1.8%	2	1.6%	3	2.0%	
More than 5	10	3.6%	4	3.3%	6	3.9%	
Home type	275	–	122	–	153	–	$\chi^2(5) = 5.97$, $p = 0.42$
Cottage	2	0.7%	0	0.0%	2	1.3%	
Detached	39	14.2%	18	14.8%	21	13.7%	
Semi-detached	99	36.0%	43	35.2%	56	36.6%	
Terraced	49	17.8%	27	22.1%	22	14.4%	
Bungalow	4	1.5%	2	1.6%	2	1.3%	
Flat	82	29.8%	32	26.2%	50	32.7%	
Garden	276	–	122	–	154	–	$\chi^2(1) = 0.76$, $p = 0.38$
Yes	246	89.1%	111	91.0%	135	87.7%	
No	30	10.9%	11	9.0%	19	12.3%	
SIMD (decile)	263	6.0 (2.9)	114	6.2 (2.8)	149	5.8 (3.1)	$U = 7830.50$, $p = 0.27$
Total use of greenspace (days spent)	271	33.4 (19.2)	117	33.8 (18.2)	154	33.1 (19.9)	$t(269) = 0.30$, $p = 0.77$
Residential greenspace (decile)	254	5.4 (1.5)	111	5.4 (1.5)	143	5.4 (1.5)	$U = 7711.50$, $p = 0.69$
Total Kid-KINDL (/100)	260	66.9 (11.5)	115	67.1 (11.2)	145	66.8 (11.8)	$t(258) = 0.19$, $p = 0.85$
Physical (/100)	273	71.5 (17.6)	120	74.0 (17.2)	153	69.6 (17.6)	$t(271) = 2.06$, $p = 0.04$*
Emotional (/100)	274	78.1 (15.8)	120	77.4 (14.7)	154	78.6 (16.6)	$t(272) = -0.63$, $p = 0.53$
Self-esteem (/100)	270	50.2 (25.2)	120	52.9 (24.2)	150	48.1 (26.0)	$t(268) = 1.54$, $p = 0.13$
Family (/100)	269	74.7 (17.9)	118	73.9 (16.5)	151	75.2 (19.1)	$t(267) = -0.62$. $p = 0.54$
Friends (/100)	273	73.3 (18.3)	121	71.8 (18.6)	152	74.4 (18.1)	$t(271) = -1.15$, $p = 0.25$
School (/100)	276	55.0 (14.9)	122	54.5 (15.5)	154	55.4 (14.3)	$t(274) = -0.49$, $p = 0.67$

Note. Continuous variables are displayed as mean (±SD), categorical variables are displayed as percentage of variable total *N*.
* $p < 0.05$.

type, as well as the total amount of greenspace, within each area were then calculated.

Covariates and additional information

Additional demographic information collected included: the participant's age; gender; number of siblings; type of home e.g. flat, bungalow, etc.; and whether or not the participant had a garden. The SIMD (Scottish Index of Multiple Deprivation, 2012) was used to assign a level of deprivation to each participant based on their postcode. Lower SIMD scores reflected areas of higher deprivation. Participants who indicated that they did not use a greenspace area within the week prior to the study were asked to explain why. Responses were provided via tick boxes from fixed options with further space for comment. All participants provided up to five motivational reasons for why they visited greenspace areas. These questions were sampled from the Plymouth City Council service questionnaire (Service questionnaire, 2016.), which was used to gain an understanding of the use of parks and open spaces in the city.

Statistical analysis

IBM SPSS Statistics version 22 (IBM Corp, 2013) was used to analyze the data. Demographic and greenspace data were normally distributed, meeting the requirements for regression analysis. For basic gender comparisons, continuous variables were compared using independent sample *t*-tests, ordinal data using Mann–Whitney *U* tests, and categorical variables using Pearson's chi-square. Pearson's bivariate correlations were used to explore linear relationships between the variables, and multiple linear regression analyses were used to determine whether residential greenspace and greenspace use were associated with total Kid-KINDL and sub-scale scores after accounting for covariates.

Results

The internal consistency for greenspace use was calculated using Cronbach's alpha (Cronbach, 1951), giving $\alpha = 0.56$ from the eight items assessed. Removal of streets and other hard surfaces led to an improvement in internal consistency ($\alpha = 0.70$). Furthermore, as 93.4% ($N = 251$) of the participants stated they did not or were unable to use allotment gardens, this item was also removed giving $\alpha = 0.71$ for the remaining six items used in analyses (public park/garden; own garden; playpark; outdoor sports facilities; woodland areas; and outdoor exercise).

Demographic statistics

Table 1 displays the socio-demographic characteristics of the participants, along with mean scores for total use of greenspace, percentage of residential greenspace within the 500 m radius, and Kid-KINDL. The participants were aged from 8 to 11 years ($M = 9.7$, SD = 0.9) and 44.4% ($N = 122$) were male. Most of the participants (36%, $N = 99$) lived in a semi-detached house and 89.1% ($N = 246$) had a garden.

The mean score for total use of greenspace was low, 33.4 (SD = 19.2) out of a maximum possible of 100. The largest proportion of participants (39%, $N = 99$) resided in areas of between 51% and 60% greenspace and the fewest number of participants (0.8%, $N = 2$) came from areas of 11%–20% greenspace. No participants resided in areas with less than 10% or more than 81% greenspace (Fig. 1).

The mean total Kid-KINDL score was 66.9 (SD = 11.5). Overall, participants scored highest on the emotional wellbeing sub-scale ($M =$

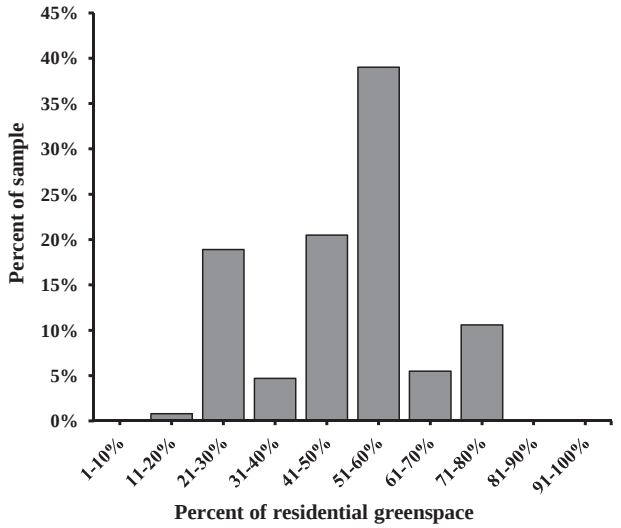

Fig. 1. The distribution of greenspace in residential areas.

78.1, SD = 15.8) and lowest on the self-esteem sub-scale ($M = 50.2$, SD = 25.2).

Gender comparison

Table 1 also displays results by gender. Only one significant difference was illustrated; males ($M = 74.0$, SD = 17.2) scored significantly higher than females ($M = 69.6$, SD = 17.6) on the physical wellbeing sub-scale of the Kid-KINDL ($t(271) = 2.06$, $p = 0.04$).

Reasons for greenspace use

Participants who indicated that they did not use greenspace also provided reasons why from a set of fixed responses (Fig. 2). The highest reported reason was that they were too busy (59.2%, $N = 155$), followed by the fact that they found greenspace boring (36.3%, $N = 95$).

All participants provided up to five motivational reasons for why they used greenspace (Fig. 3). The top reason was to play with friends (69.2%, $N = 191$), followed by to get fresh air (55.4%, $N = 153$). The least reported motivation was for an educational visit (2.5%, $N = 7$).

Associations between greenspace and quality of life

There were small but significant positive associations between greenspace use and total Kid-KINDL score ($r = 0.17$, $p < 0.01$), as well as the self-esteem ($r = 0.27$, $p < 0.01$) and friends sub-scale scores ($r = 0.14$, $p < 0.05$). Participants with greater greenspace use reported higher health-related quality of life. Apart from the association between physical wellbeing and school, which was not statistically significant ($r = 0.09$, $p = 0.14$), the Kid-KINDL sub-scales were all significantly positively associated with each other (Table 2).

The percentage of residential greenspace was significantly negatively associated with scores on the Kid-KINDL family sub-scale ($r = -0.13$, $p < 0.05$), suggesting that participants from areas with more greenspace had poorer family relationships. A small but significant positive association between residential greenspace and greenspace use ($r = 0.15$, $p < 0.05$) suggested that participants who resided in areas with more greenspace also used greenspace more frequently; and a significant positive association between residential greenspace and SIMD ($r = 0.28$, $p < 0.01$) suggested that less deprived areas had more greenspace.

Predicting health-related quality of life

Multiple linear regression analyses developed predictive models for total Kid-KINDL and sub-scale scores (Table 3). Age, gender, siblings, SIMD, garden, use of greenspace and residential greenspace were entered into the model as predictor variables.

A regression analysis to predict total Kid-KINDL scores produced a significant model (Adj. $R^2 = 0.03$, $F(7224) = 2.07$, $p < 0.05$), accounting for 3% of the variance. The results suggested that increased greenspace use ($\beta = 0.21$, $p < 0.01$) and having fewer siblings ($\beta = -.16$, $p < 0.01$) significantly contributed to the variance accounted for.

Six further regression analyses examined which variables accounted for variance in each of the Kid-KINDL sub-scales (Table 3). A significant model, accounting for 7% of the variance, emerged for the self-esteem sub-scale (Adj. $R^2 = 0.07$, $F(7,233) = 3.41$, $p < 0.01$). Greenspace use ($\beta = 0.28$, $p < 0.01$) was the only variable significantly contributing to

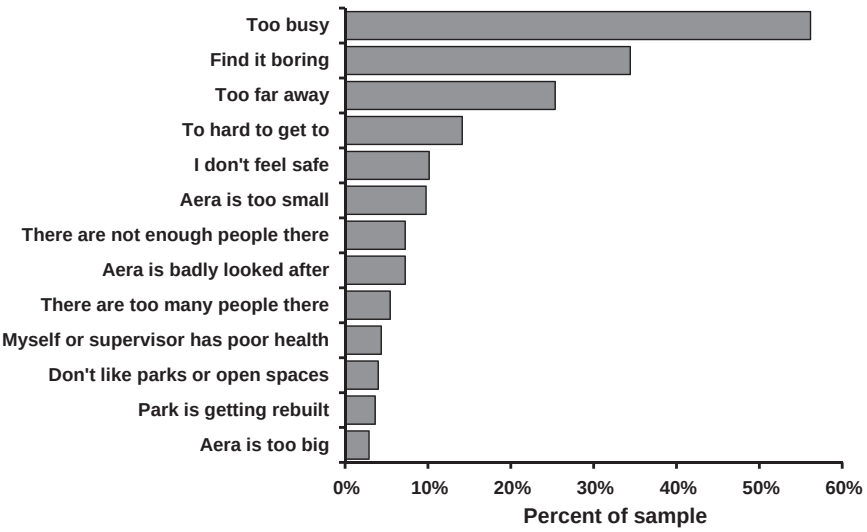

Fig. 2. Reported reasons for not using greenspace.

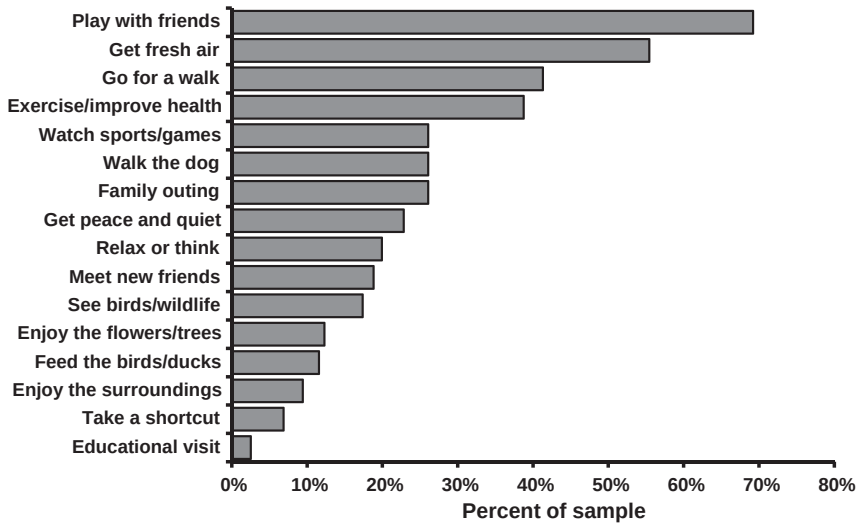

Fig. 3. Motivational reasons for greenspace use.

the variance, indicating that greater greenspace use was associated with higher self-esteem.

A significant model also emerged for the friends sub-scale (Adj. $R^2 = 0.04$, $F(7,237) = 2.51$, $p < 0.05$), accounting for 4% of the variance. Increased greenspace use ($\beta = 0.23$, $p < 0.01$) and having fewer siblings ($\beta = -0.13$, $p < 0.05$) were the only variables contributing to the model. No significant models emerged for the remaining Kid-KINDL sub-scales.

Regression analyses were also conducted including the individual types of residential greenspace (Appendix A). A significant model, accounting for 7% of the variance, emerged for the self-esteem sub-scale (Adj. $R^2 = 0.07$, $F(27,212) = 1.62$, $p < 0.05$). Greenspace use ($\beta = 0.25$,

Table 2
Bivariate correlations of demographic characteristics, greenspace use, residential greenspace and Kid-KINDL scores.

	Gender	Age	Siblings	Garden (yes/no)	SIMD	Use of greenspace	Residential greenspace	Physical wellbeing sub-scale score	Emotional wellbeing sub-scale score	Self-esteem sub-scale score	Family sub-scale score	Friends sub-scale score	School sub-scale score	Total Kid-KINDL score
Gender	–													
Age	0.05	–												
Siblings	−0.02	−0.04	–											
Garden (yes/no)	0.05	0.09	0.01	–										
SIMD	0.06	−0.04	−0.19**	0.30**	–									
Use of greenspace	0.02	−0.09	0.07	0.20**	0.12	–								
Residential greenspace	0.01	0.07	−0.02	0.31**	0.28**	0.15*	–							
Physical wellbeing sub-scale score	0.12*	−0.03	−0.10	0.13	−0.01	0.08	0.12	–						
Emotional wellbeing sub-scale score	−0.04	0.01	−0.14*	0.06	0.08	0.02	−0.05	0.49**	–					
Self-esteem sub-scale score	0.09	−0.03	−0.04	−0.03	0.03	0.27**	−0.03	0.24**	0.26**	–				
Family sub-scale score	−0.04	0.04	−0.15*	−0.09	0.02	−0.08	−0.13*	0.25**	0.42**	0.22**	–			
Friends sub-scale score	−0.07	0.07	−0.11	0.00	0.00	0.14*	0.01	0.16*	0.37**	0.32**	0.35**	–		
School sub-scale score	−0.03	−0.03	−0.00	0.08	−0.02	0.09	−0.02	0.09	0.15*	0.18**	0.25**	0.16**	–	
Total Kid-KINDL score	0.01	−0.00	−0.16*	0.02	0.04	0.17**	−0.02	0.60**	0.71**	0.67**	0.65**	0.63**	0.47**	–

Note: Sub-scales are from the Kid-KINDL questionnaire.
* $p < 0.05$.
** $p < 0.01$.

Table 3
Multiple regression analysis of Kid-KINDL and sub-scale scores.

	t	*p*	β	*F*	*df*	*p*	Adj. R^2
Total Kid-KINDL score (overall model)				2.07	7, 224	0.05*	0.03
Gender	0.25	0.81	0.02				
Age (years)	0.10	0.93	0.01				
Siblings	−2.36	0.02*	−0.16				
SIMD	0.17	0.87	0.01				
Garden (yes/no)	−0.16	0.87	−0.01				
Use of greenspace	3.09	0.00**	0.21				
Residential greenspace	−0.72	0.47	−0.05				
Physical wellbeing sub-scale (overall model)				2.00	7, 236	0.06	0.03
Gender	1.75	0.08	0.11				
Age (years)	−0.89	0.37	−0.06				
Siblings	−1.79	0.08	−0.12				
SIMD	−1.30	0.20	−0.09				
Garden (yes/no)	1.44	0.15	0.10				
Use of greenspace	0.89	0.38	0.06				
Residential greenspace	1.48	0.14	0.10				
Emotional wellbeing sub-scale (overall model)				0.94	7, 237	0.48	0.00
Gender	−0.51	0.61	−0.03				
Age (years)	0.09	0.93	0.01				
Siblings	−1.64	0.10	−.11				
SIMD	0.40	0.69	0.03				
Garden (yes/no)	1.16	0.25	0.08				
Use of greenspace	0.70	0.48	0.05				
Residential greenspace	−1.52	0.13	−0.11				
Self-esteem sub-scale (overall model)				3.41	7, 233	0.00**	0.07
Gender	1.68	0.10	0.11				
Age (years)	0.05	0.96	0.00				
Siblings	−1.00	0.32	−0.06				
SIMD	0.53	0.60	0.04				
Garden (yes/no)	−1.83	0.07	−0.13				
Use of greenspace	4.25	0.00**	0.28				
Residential greenspace	−0.39	0.70	−0.03				
Family sub-scale (overall model)				1.40	7, 233	0.21	0.01
Gender	−0.81	0.42	−0.05				
Age (years)	0.25	0.80	0.02				
Siblings	−1.82	0.07	−0.12				
SIMD	1.19	0.24	0.08				
Garden (yes/no)	−0.73	0.46	−0.05				
Use of greenspace	0.05	0.96	0.00				
Residential greenspace	−1.77	0.08	−0.12				
Friends sub-scale (overall model)				2.51	7, 237	0.00**	0.04
Gender	−1.09	0.28	−0.07				
Age (years)	1.54	0.13	0.10				
Siblings	−2.06	0.04*	−0.13				
SIMD	−.44	0.66	−0.03				
Garden (yes/no)	−.19	0.85	−0.01				
Use of greenspace	3.55	0.00**	023				
Residential greenspace	−.35	0.73	−0.02				
School sub-scale (overall model)				0.69	7, 239	0.68	−0.01
Gender	−0.62	0.54	−0.04				
Age (years)	−0.65	0.51	−0.04				
Siblings	−0.20	0.84	−0.01				
SIMD	−0.44	0.66	−0.03				
Garden (yes/no)	1.52	0.13	0.11				
Use of greenspace	1.07	0.28	0.07				
Residential greenspace	−0.89	0.38	−0.06				

* $p < 0.05$.
** $p < 0.01$.

$p < 0.01$) was the only variable significantly contributing to the variance, further indicating that greater use was associated with higher self-esteem, rather than the proportion of greenspace in the residential area.

Discussion

In this study, having fewer siblings and greater greenspace use were associated with better health-related quality of life of children from urban areas. The percentage of residential greenspace was not identified as a significant contributor. The current findings suggest that it is the frequency of use that may be important for the health-related quality of life of city dwelling children.

When analyses were conducted for each of the Kid-KINDL subscales, only greenspace use, along with having fewer siblings, emerged as significant variables in predicting scores on the friends

sub-scale, and greenspace use in predicting scores for self-esteem. Previous research suggests that urban greenspace provides a place for people to meet and socialize (Sugiyama et al., 2008), and that children who use greenspace areas more frequently have fewer issues with their friends (Flouri et al., 2014). When the participants were asked what motivated them to use greenspace, the highest reported reason was to play with friends. Children with fewer siblings may use greenspace areas more often to socialize with other children, which could reduce their feelings of loneliness (Maas et al., 2009) and improve friendships. Furthermore, research has suggested that by using greenspace as a form of education, children can be given a level of responsibility which can improve their confidence and self-esteem (Understanding the Contribution Parks and Green Spaces can make to Improving People's Lives, 2016). While a plausible reason for this finding, specific activities undertaken when using greenspace were not assessed in this study, so this cannot be concluded with certainty.

The fact that there was no significant association between use of greenspace and the family sub-scale is interesting, as previous research suggests that activities undertaken in greenspace can benefit family bonds (Understanding the Contribution Parks and Green Spaces can make to Improving People's Lives, 2016). As specific activities undertaken when using greenspace were not assessed in this study, it would not be possible to speculate further on this finding.

No associations were found between deprivation and greenspace use or Kid-KINDL scores. This contrasts with previous research findings suggesting that children living at increasing distances from greenspace, and who came from homes with higher deprivation, reported more psychological and general health problems than children from less deprived areas with more greenspace (Aggio et al., 2015). Differences across studies may arise from the standard of greenspace in deprived neighborhoods as a proportion of the children indicated that this was an important reason why they did not use greenspace. Alternatively, while the SIMD scale used in this analysis was the most up-to-date available, it was from 2012 which may have affected the results. Furthermore, while the participants were grouped from most to least deprived, the full range of deprivation was not available; restriction in range may therefore have limited the utility of the deprivation measure.

Overall findings from this study suggest that incorporating greenspace use into children's daily life in urban communities may have a small but significant beneficial impact on their health-related quality of life. Many inner-city schools currently have playgrounds which are predominantly concrete, with little greenspace for children to use. As primary schools may potentially be a child's only opportunity to use greenspace, it is suggested that through Biophilic Design (Kellert et al., 2011) the layout of urban buildings relevant to children should include greenspace. Parents/guardians should also be made aware of the potential health benefits of increasing greenspace use. If they are able to encourage this interaction at a young age, they could teach children habits which may benefit their health throughout their life. It is known that using greenspace as a child is associated with using greenspace as an adult (Ward-Thompson et al., 2008), and that using greenspace as an adult has a multitude of health benefits (Ulrich, 1984; Kaplan and Kaplan, 1989). This study suggests this association may be observable at a younger age; however, longitudinal studies of this association are necessary to fully explore the links between greenspace use and exposure, health behaviors and health outcomes through childhood into adulthood.

Strengths and limitations

The self-report survey was undertaken from late-autumn into early-winter due to constraints on access to the sample population. Diminished daylight hours and cold/wet outdoor conditions in Edinburgh during these seasons may result in lower greenspace use than during summer months, for example, though would be less likely to influence greenspace availability. It is acknowledged that positive outlook decreases during the winter months in northern localities due to the decreased sunlight hours. As a result, the findings regarding the influence of greenspace on child health and wellbeing require replication across other regions and seasons.

Increased use of greenspace was significantly positively associated with total Kid-KINDL, and two of the sub-scale scores; however, although these associations were significant, they were small. While family level data on socio-economic status was not available in the current sample, the deprivation measure included was perhaps both more detailed and more objective than traditional occupation-based approaches; the SIMD combines postcode-level information on access to important resources such as schools and medical services, educational attainment within a given area and crime figures, for example. Future studies might benefit from inclusion of both objective and self-reported family level socio-economic data. It is also important to note that causality cannot be inferred from the current findings. Both longer term studies following the same individuals across multiple seasons and/or years, or specific intervention studies, would allow an examination of whether the seasons affect children's greenspace use and in-turn, their quality of life.

This study also relied on self-report measures. Although advantageous, allowing for a personal account of perceived health and greenspace use, it is possible that some of the children over- or under-reported their results. It is also acknowledged that the use of individual postcode spatial analysis for all participants might increase the level of detail and that while participant location datasets were highly clustered (and only considered as such if within 50 m of a given centroid), some loss of resolution might be expected. Future research may benefit from analysing postcodes on an even more fine-grained, individual basis, and focusing on greenspace areas which are accessible to all children. This could improve our understanding about whether or not the quantity of available public urban residential greenspace is a significant factor in predicting the health-related quality of life of children.

Conclusions

In exploring how both use of, and proximity to, greenspace were associated with health-related quality of life in children from urban areas, the current findings suggest that higher use of greenspace was associated with better quality of life (overall, and in terms of friends and self-esteem sub-scales). This indicates that increasing children's greenspace use in urban areas might have a small but positive impact on their health-related quality of life, though future longitudinal and intervention studies are required to confirm such causal assumptions.

Conflict of interest statement

The authors declare that there are no conflicts of interest.

Transparency document

The Transparency document associated with this article can be found, in the online version.

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Appendix A. Multiple regression analysis of Kid-KINDL and sub-scale scores (residential greenspace breakdown)

	t	*p*	*β*	*F*	*df*	*p*	Adj. R^2
Total Kid-KINDL score (*overall model*)				1.35	27, 203	0.12	0.04
Gender	0.36	0.72	0.02				
Age (years)	−0.03	0.98	0.00				
Number of siblings	−1.43	0.16	−0.10				
SIMD decile rating	−0.90	0.37	−0.08				
Garden (yes/no)	0.19	0.85	0.02				
Total outdoor use percent	2.49	0.01**	0.18				
Allotment & community growing area	−0.53	0.60	−0.05				
Amenity — business	−0.69	0.49	−0.08				
Amenity — residential	−1.48	0.14	−0.15				
Amenity — transport	−0.56	0.57	−0.05				
Bowling greens	0.29	0.77	0.03				
Cemetery	−0.17	0.86	−0.02				
Churchyard	1.01	0.32	0.11				
Civic space	−0.34	0.74	−0.04				
Golf courses	0.74	0.46	0.09				
Green access routes	−0.49	0.63	−0.05				
Institutional grounds	0.80	0.42	0.09				
Open semi-natural	0.51	0.61	0.06				
Playing fields	1.85	0.07	0.13				
Other sports	−0.68	0.50	−0.07				
Playspace	1.05	0.30	0.09				
Private gardens	−0.80	0.43	−0.10				
Public park and garden	−0.83	0.41	−0.08				
School grounds	0.84	0.40	0.08				
Tennis courts	−0.24	0.81	−0.03				
Other functional greenspace, e.g. caravan park	0.31	0.76	0.02				
Woodland	0.22	0.83	0.02				
Physical wellbeing sub-scale (*overall model*)							
Gender	1.72	0.09	0.12	1.15	27, 215	0.29	0.02
Age (years)	−0.92	0.36	−0.06				
Number of siblings	−1.41	0.16	−0.10				
SIMD decile rating	−2.17	0.03*	−0.19				
Garden (yes/no)	1.82	0.07	0.14				
Total outdoor use percent	0.48	0.63	0.03				
Allotment & community growing area	1.26	0.21	0.11				
Amenity — business	0.80	0.42	0.09				
Amenity — residential	−0.21	0.83	−0.02				
Amenity — transport	−0.27	0.79	−0.03				
Bowling greens	1.30	0.20	0.11				
Cemetery	−0.05	0.96	−0.01				
Churchyard	1.47	0.14	0.16				
Civic space	−1.00	0.32	−0.11				
Golf courses	1.94	0.05*	0.23				
Green access routes	0.13	0.90	0.01				
Institutional grounds	0.39	0.70	0.04				
Open semi-natural	−0.16	0.87	−0.02				
Playing fields	1.50	0.14	0.10				
Other sports	0.68	0.50	0.07				
Playspace	0.66	0.51	0.05				
Private gardens	−0.32	0.75	−0.04				
Public park and garden	−0.97	0.33	−0.08				
School grounds	1.33	0.19	0.12				
Tennis courts	−0.45	0.65	−0.06				
Other functional greenspace, e.g. caravan park	0.55	0.58	0.04				
Woodland	0.62	0.53	0.06				
Emotional wellbeing sub-scale (*overall model*)				0.89	27, 216	0.62	−0.01
Gender	−0.64	0.52	−0.04				
Age (years)	0.21	0.84	0.01				
Number of siblings	−1.00	0.32	−0.07				
SIMD decile rating	0.07	0.94	0.01				
Garden (yes/no)	1.18	0.24	0.09				
Total outdoor use percent	0.41	0.68	0.03				
Allotment & community growing area	−1.75	0.08	−0.16				
Amenity — business	−1.63	0.11	−0.18				
Amenity — residential	−0.86	0.39	−0.09				
Amenity — transport	−0.21	0.83	−0.02				
Bowling greens	−0.56	0.58	−0.05				
Cemetery	0.58	0.56	0.07				
Churchyard	0.92	0.36	0.10				
Civic space	−0.84	0.40	−0.10				
Golf courses	−0.70	0.48	−0.08				
Green access routes	−0.13	0.90	−0.01				
Institutional grounds	−0.19	0.85	−0.02				

Appendix A (*continued*)

	t	*p*	*β*	*F*	*df*	*p*	Adj.R^2
Open semi-natural	1.73	0.08	0.21				
Playing fields	0.76	0.45	0.05				
Other sports	−0.66	0.51	−0.07				
Playspace	0.90	0.37	0.07				
Private gardens	−1.37	0.17	−0.17				
Public park and garden	−0.41	0.68	−0.04				
School grounds	−0.43	0.67	−0.04				
Tennis courts	−0.27	0.79	−0.04				
Other functional greenspace, e.g. caravan park	−0.77	0.44	−0.06				
Woodland	−0.34	0.73	−0.03				
Self-esteem sub-scale (*overall model*)				1.62	27, 212	0.03*	0.07
Gender	1.89	0.06	0.12				
Age (years)	0.06	0.95	0.00				
Number of siblings	−0.29	0.77	−0.02				
SIMD decile rating	0.41	0.68	0.04				
Garden (yes/no)	−1.58	0.12	−0.12				
Total outdoor use percent	3.67	0.00	0.00**	0.25			
Allotment & community growing area	−1.16	0.25	−0.10				
Amenity — business	−1.40	0.16	−0.15				
Amenity — residential	−1.00	0.32	−0.10				
Amenity — transport	0.23	0.82	0.02				
Bowling greens	−1.01	0.31	−0.08				
Cemetery	0.28	0.78	0.03				
Churchyard	−0.15	0.88	−0.02				
Civic space	0.79	0.43	0.09				
Golf courses	0.15	0.88	0.02				
Green access routes	0.21	0.84	0.02				
Institutional grounds	0.73	0.47	0.08				
Open semi-natural	0.65	0.52	0.08				
Playing fields	1.23	0.22	0.08				
Other sports	−1.34	0.18	−0.14				
Playspace	0.65	0.52	0.05				
Private gardens	−0.20	0.84	−0.02				
Public park and garden	−1.12	0.27	−0.09				
School grounds	0.28	0.78	0.02				
Tennis courts	0.37	0.71	0.05				
Other functional greenspace, e.g. caravan park	−0.25	0.81	−0.02				
Woodland	−0.11	0.91	−0.01				
Family sub-scale (*overall model*)				0.98	27, 212	0.50	−0.00
Gender	−0.64	0.52	−0.04				
Age (years)	0.06	0.96	0.00				
Number of siblings	−1.06	0.29	−0.08				
SIMD decile rating	0.04	0.97	0.00				
Garden (yes/no)	−0.42	0.67	−0.03				
Total outdoor use percent	0.09	0.93	0.01				
Allotment & community growing area	−0.59	0.56	−0.05				
Amenity — business	−0.85	0.39	−0.10				
Amenity — residential	−2.00	>0.05*	−0.21				
Amenity — transport	−1.40	0.16	−0.13				
Bowling greens	0.74	0.46	0.07				
Cemetery	−0.70	0.49	−0.09				
Churchyard	−0.30	0.76	−0.03				
Civic space	−0.47	0.64	−0.06				
Golf courses	−0.29	0.78	−0.03				
Green access routes	−0.75	0.45	−0.07				
Institutional grounds	0.70	0.49	0.07				
Open semi-natural	0.86	0.39	0.10				
Playing fields	0.95	0.35	0.07				
Other sports	−0.70	0.49	−0.07				
Playspace	0.49	0.62	0.04				
Private gardens	−0.83	0.41	−0.11				
Public park and garden	−0.15	0.88	−0.01				
School grounds	0.67	0.51	0.06				
Tennis courts	0.06	0.96	0.01				
Other functional greenspace, e.g. caravan park	0.27	0.79	0.02				
Woodland	0.01	0.99	0.00				
Friends sub-scale (*overall model*)				0.92	27, 216	0.51	−0.00
Gender	−0.88	0.38	−0.06				
Age (years)	1.29	0.20	0.09				
Number of siblings	−1.68	0.09	−0.12				
SIMD decile rating	−0.72	0.47	−0.06				
Garden (yes/no)	0.00	1.00	0.00				

(*continued on next page*)

Appendix A (*continued*)

	t	*p*	*β*	*F*	*df*	*p*	Adj.R^2
Total outdoor use percent	3.14	0.00**	0.22				
Allotment & community growing area	−0.31	0.76	−0.03				
Amenity — business	0.42	0.68	0.05				
Amenity — residential	−1.35	0.18	−0.13				
Amenity — transport	0.02	0.98	0.00				
Bowling greens	0.87	0.39	0.07				
Cemetery	−0.85	0.39	−0.11				
Churchyard	0.06	0.96	0.01				
Civic space	0.36	0.72	0.04				
Golf courses	−0.22	0.82	−0.03				
Green access routes	0.42	0.68	0.04				
Institutional grounds	1.29	0.20	0.14				
Open semi-natural	−0.24	0.81	−0.03				
Playing fields	0.89	0.38	0.06				
Other sports	−0.96	0.34	−0.10				
Playspace	0.23	0.82	0.02				
Private gardens	0.10	0.92	0.01				
Public park and garden	0.03	0.98	0.00				
School grounds	0.28	0.78	0.02				
Tennis courts	0.27	0.79	0.04				
Other functional greenspace, e.g. caravan park	1.11	0.27	0.09				
Woodland	0.50	0.62	0.05				
school sub-scale (*overall model*)				0.18	27, 218	0.73	−0.02
Gender	−0.52	0.60	−0.04				
Age (years)	−0.81	0.42	−0.06				
Number of siblings	0.31	0.76	0.02				
SIMD decile rating	−0.79	0.43	−0.07				
Garden (yes/no)	1.76	0.08	0.14				
Total outdoor use percent	0.43	0.67	0.03				
Allotment & community growing area	0.08	0.94	0.01				
Amenity — business	0.40	0.69	0.05				
Amenity — residential	−0.12	0.90	−0.01				
Amenity — transport	0.14	0.89	0.01				
Bowling greens	0.25	0.80	0.02				
Cemetery	−0.36	0.72	−0.05				
Churchyard	1.61	0.11	0.17				
Civic space	0.32	0.75	0.04				
Golf courses	0.70	0.49	0.08				
Green access routes	−1.38	0.17	−0.13				
Institutional grounds	−0.25	0.81	−0.03				
Open semi-natural	−1.11	0.27	−0.13				
Playing fields	1.48	0.14	0.10				
Other sports	0.01	0.99	0.00				
Playspace	0.65	0.52	0.05				
Private gardens	−0.73	0.47	−0.09				
Public park and garden	0.60	0.55	0.05				
School grounds	0.12	0.90	0.01				
Tennis courts	−0.58	0.56	−0.08				
Other functional greenspace, e.g. caravan park	0.23	0.82	0.02				
Woodland	0.04	0.97	0.00				

* $p < 0.05$.
** $p < 0.01$.

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