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Trends and inequalities in distance to and use of nearest natural space in the context of the 20-min neighbourhood: A 4-wave national repeat cross-sectional study, 2013 to 2019

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ABSTRACT

The 20-min neighbourhood is a policy priority for governments worldwide; a key feature of this policy is providing access to natural space (NS) within 800 m of home. The study aims were to (1) examine the association between distance to nearest NS and frequent use over time and (2) examine whether frequent use and changes in use were patterned by income and housing tenure over time. Bi-annual Scottish Household Survey data were obtained for 2013 to 2019 (n:42128 aged 16+). Adults were asked the walking distance to their nearest NS, the frequency of visits to this space and their housing tenure, as well as age, sex and income. We examined the association between distance from home of nearest NS, housing tenure, and the likelihood of frequent NS use (visited once a week or more). Two-way interaction terms were further applied to explore variation in the association between tenure and frequent NS use over time. We found that 87% of respondents lived within 10 min walk of a NS, meeting the policy specification for a 20-min neighbourhood. Greater proximity to NS was associated with increased use; individuals living a 6–10 min walk and over 10 min walk were respectively 53% and 78% less likely to report frequent NS use than those living within a 5 min walk. Housing tenure was an important predictor of frequent NS use; private renters and homeowners were more likely to report frequent NS use than social renters. Our findings provide evidence that proximity to NS is a strong predictor of frequent use. Our study provides important evidence that time-based access measures alone do not consider deep-rooted socioeconomic variation in use of NS. Policy makers should ensure a nuanced lens is applied to operationalising and monitoring the 20-min neighbourhood to safeguard against exacerbating existing inequalities.

1. Introduction

Designing healthier cities is at the forefront of urban planning (Barton and Grant, 2013) and creating healthy cities sits at the heart of the United Nations Sustainable Development Goals (World Health Organization, 2016). Urban areas have the potential to provide benefit for their residents through enabling access medical services, housing and health-related infrastructure, including parks, as well as economic and educational opportunities (Corburn, 2013). However, neither planning or public health systems are optimally organised to ensure cities are equitable and healthy, and new strategies are required (Corburn, 2013).

A range of international, national and local government policies have been developed with the aim of creating healthier urban environments, however, many of these have been suggested without baseline assessment of the current relationships between, and inequalities in, urban environment, health and related behaviour. This makes for difficulties in assessment of policy ideas and their evaluation once implemented.

The concept of a *20-min neighbourhood* is receiving renewed interest and strong policy support in governments worldwide. It is routed in the concept of changing urban design to improve public health (Victoria State Government, 2021, O'gorman and Dillon-Robinson, 2021). A key feature of the 20-min neighbourhood is providing access to publicly

Abbreviations: NS, Natural Space; SHS, Scottish Household Survey; UK, United Kingdom; OR, Odds ratio; m, meter.

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accessible open spaces, such as parks, municipal gardens and sports/-recreational facilities, within 800 m (m) of residents' home (O'gorman and Dillon-Robinson, 2021). The assumption is that proximity of natural space promotes and equalises use. The Scottish Government have committed in their *Government Programme for Scotland 2020–2021* and *National Planning Framework: position statement* to apply the concept of 20 min neighbourhoods in Scotland (Scottish Government, 2020b, Scottish Government, 2020a). However, without defining or operationalising the 20-min neighbourhood it will be difficult to implement, monitor and quantify the benefits of this policy (Thornton et al., 2022). Further understanding of individual level proximity to nearest natural spaces and use of existing natural space infrastructure within a 20-min neighbourhood in Scotland is required.

Urban natural spaces, such as parks, open and blue spaces, have been shown to be beneficial for human health. There is strong evidence that living or spending time in areas that are 'greener' is associated with many positive health outcomes, such as: higher birth weight; lower heart rate; increased physical activity and lower mortality rates (Fong et al., 2018, Kondo et al., 2018). Greater availability of blue space has been shown to be associated with lower antidepressant medication prevalence among older people (Mcdougall et al., 2021). The health benefits of living in areas with more natural space access are seen across socioeconomic groups and some evidence has highlighted that inequalities are narrower between socioeconomic groups for both mortality and mental health outcomes for those living in greener areas (Mitchell and Popham, 2008; Mitchell et al., 2015; Rigolon et al., 2021).

Evidence suggests that proximity to natural spaces can be associated with use (Ayala-Azcárraga et al., 2019; Seaman et al., 2010; Lin et al., 2014) and greater urban natural space access levels are associated with higher well-being levels (Sharifi et al., 2021). However, there are marked differences in *use* of these spaces between socioeconomic groups, with evidence showing that urban natural spaces in Europe are predominately used by more educated people (Peschardt et al., 2012) and those from lower socioeconomic groups are less likely to visit a natural space than those from higher socioeconomic groups (Burnett et al., 2021). The extent to which inequalities in use are determined by inequalities in access is not clear.

As the evidence base describing the benefits of natural space for health has grown rapidly over the past two decades, national and international policies, such as the World Health Organisation *Global Report on Urban Health (World Health Organization, 2016)*, have highlighted the requirement to improve the provision and use of natural spaces at a local level. There has also been increased promotion at a population level via public health organisations describing the health benefits of spending time in natural spaces (Van Den Bosch and Sang, 2017). In light of the increased evidence base and health promotion of natural space, it is important to explore change in its use over time.

Housing tenure is one facet of socioeconomic position that is related to income or wealth, and is influential in determining residential location within a city. Homeowners tend to be more affluent and more highly educated. Those more socially disadvantaged, with fewer financial resources, are more likely to be renting from a housing association or local authority (Szabo et al., 2019). Tenure is associated with health; those who rent have higher mortality rates and worse mental and physical outcomes compared to homeowners (Cairney and Boyle, 2004). Security of tenure is associated with good mental health (Li et al., 2022) and housing tenure has also been shown to moderate the effects of other socioeconomic characteristics on quality of life in older adults (Szabo et al., 2019).

Tenure is an important consideration in the context of 20-min neighbourhoods because it is closely associated with both location within a city and choice in location, and a smaller proportion of local authority or housing association renters have access to their own private outdoor space at home, compared to homeowners (Public Health Scotland 2022). Although housing tenure is a marker of socioeconomic deprivation, here we include this as an additional measure to explore the interactions between individual housing tenure, individual-level socioeconomic status and natural space use. This is due to existing research highlighting the importance of these factors in predicting greenspace use and the prominence of housing tenure in urban design policy.

The aims of this study were to (1) examine the association between subjectively measured distance to nearest natural space and frequent natural space use for a large nationally representative sample; (2) describe proximity to natural space and frequent use by socioeconomic status and housing tenure; and (3) explore whether there were changes in (1) and (2) over time.

2. Material and methods

2.1. Survey data

Bi-annual survey data from the Scottish Household Survey (SHS) for 2013, 2015, 2017 and 2019 were obtained from the UK Data Service (Ipsos Mori, 2020). The SHS is a nationally representative sample of the adult population in private households in Scotland. Across the four waves included in this study, a total of 42128 adults (2013: 10632, 2015: 10305, 2017: 10656, 2019: 10534) completed the survey via face-to-face interviews, the highest income householder was asked to complete the survey. Individual-level weighting is calculated by the Scottish Government to ensure that the sample in the SHS represents the population of Scotland as a whole. The weighting procedures for the SHS incorporate a selection weighting stage to address the unequal selection probabilities and calibration weighting to correct for non-response bias.

Data for 2019 were the most recent available at the time of analysis, our outcome measure of natural space use was introduced in 2013 and is included in the survey bi-annually.

2.1.1. Individual-level characteristics

Several individual-level variables were collected; this paper analysed age, sex, and income. Age (in years) was grouped into the following five categories for analysis: 16 to 24, 25 to 34, 35 to 44, 45 to 60 and 60 years and over. Individual level socioeconomic status was measured using annual household income and grouped into the following six categories for analysis: less than £15000, £15001 to £20000, £20001 to £25000, £25001 to £30000, £30001 to £40000 and £40001 and over. Two SHS questions regarding housing tenure and rental status were combined to create a single housing tenure variable for analysis, with subgroups specifying homeowner (owns with mortgage and owns outright), private renter, rents from local authority, rent from housing association, and other (that includes renting from an employer of a household member, from a relative or friend, from another household member or other).

2.1.2. Exposure: individual level distance to nearest natural space

Participants were asked "how far away from your home is the nearest public green/blue space – how long would it take me to walk there?" and instructed to exclude private garden space. Participants could select one of six responses indicating if the natural space was a 5 min or less walk, 6–10 min, 11–20 min, 21–30 min, more than 30 min, or 'don't know'. The 20-min neighbourhood specifically refers to facilities and amenities within a 10-min walk there and back from home and a 800m buffer of home is used to measure this (O'gorman and Dillon-Robinson, 2021), which is a commonly used measure and approximates a 10 min walk (Harrison et al., 2011). As we were interested in understanding proximity to spaces within a 20-min neighbourhood, we re-categorised and used the following groups in the final analysis: less than a 5 min walk, 6–10 min walk, more than 10 min walk. We included 'less than a 5 min walk' to allow us to examine whether natural spaces closer to home than specified within 20-min neighbourhoods were associated with frequency of use, as it also allowed us to assess our outcome in relation to Scotland's National Performance Framework indicator that measures the proportion of adults who live within a 5-min walk of their local green or blue space (Scottish Government, 2018).

2.1.3. Outcome: frequency of natural space use

Participants were asked to record the frequency of their visits to their nearest green or open spaces. The SHS question was, "how often, if at all, do you use this space (green or open), even if just to pass through it?", participants could select one of the following eight responses: every day, several times a week, once a week, several times a month, once a month, less often, not at all, don't know. We created a binary outcome variable of ***frequent natural space use (once a week or more)*** (including green, blue and open space) that included the following categories: every day, several times a week and once a week. Natural space visits at least once a week has been very widely used as a measure of frequent natural space use (Natural England, 2019; Stewart and Eccleston, 2020; Fongar et al., 2019) and has been associated with positive health outcomes (Bloemsma et al., 2018), such as achieving recommended physical activity (Flowers et al., 2016).

2.2. Statistical analysis

Summary statistics described population characteristics in terms of sex, age, income, and housing tenure. Individual weighting was applied to all descriptive and statistical analysis to correct for unequal probabilities of selection and variations in response rates from different groups.

Natural space use: Frequent natural space use was modelled as the outcome variable for all analyses. Logistic regression models were performed to examine the association between distance from home of nearest natural space and the likelihood of frequent natural space use, adjusted for sex, age and income.

To explore whether frequent natural space use was associated with housing tenure, independently of the other individual characteristics, this variable was added separately and sequentially.

Change over time: The association between frequent natural space use and time was modelled to explore change in this outcome from 2013 to 2019. Two-way interaction terms were applied to explore within group variation in frequent natural space use over time and by housing tenure. Null hypothesis tests (Wald tests) evaluated significance of interaction terms. The results of the interactions that were significant at the alpha level were summarised and presented using the 'margins' commands in Stata. Stata/MP 17 (Statacorp., 2019) was used for all analyses.

3. Results

3.1. Participant characteristics

Participant characteristics are presented by year (2013, 2015, 2017 and 2019) in Table 1. Overall, the socio-demographic characteristics of the SHS participants did not vary considerably in each data collection wave over the time period, 58% of the 2013 sample were male and 58% in the 2019 sample. The large proportion of male respondents is likely due to the highest income householder asked to complete the survey. 37% of the sample were aged 60 years and over in 2019 and 29% aged 45–59 years (2013: 35% 60 years and over and 29% 45–59 years).

Reported housing tenure remained similar throughout the time periods, approximately 6 in 10 were homeowners, twelve percent were private renters, ten percent were renting from a local authority and ten percent were renting from a housing association.

The reported household income of participants was similar across the surveys, 33% reported an income of less than £15,000 in 2013 and 19% had an income of over £40,000. In 2019, a slightly lower proportion had an income of less than £15,000 (24%) and a greater proportion over £40,000 (27%).

3.2. Distance to nearest natural space and frequent natural space use

Two thirds of participants lived within a 5 min walk of their nearest natural space (2013: 67%, 2019: 66%; Table 1) and this was stable over time (no change ($p = 0.10$) between frequency of natural space use groups from 2013 to 2019). The reported frequency of natural space use remained stable over time for daily use (2013: 17%, 2019: 17%; Table 1), several times a week (2013: 18%, 2019: 18%; Table 1) and once a week or less (2013: 40%, 2019: 42%; Table 1).

The outcome variable, frequent natural space use, showed little variation over time; 47.1% and 47.2% of participants reported visiting their nearest natural space once of more a week in 2013 and 2019, respectively.

Table 1
Participant characteristics, distance to nearest natural space and frequent natural space use outcomes variables (weighted). N (%).

(i) Participant characteristics		2013	2015	2017	2019
Sex	Male	6152 (57.9)	5892 (57.2)	6236 (58.5)	6073 (57.7)
	Female	4480 (42.1)	4412 (42.8)	4420 (41.5)	4460 (42.3)
Age	16 to 24	499 (4.7)	521 (5.1)	494 (4.6)	479 (4.6)
	25 to 34	1534 (14.4)	1521 (14.8)	1540 (14.5)	1557 (14.8)
	35 to 44	1825 (17.2)	1640 (15.9)	1696 (15.9)	1621 (15.4)
	45 to 59	3060 (28.8)	2949 (28.6)	3089 (29.0)	3023 (28.7)
	60 and over	3712 (34.9)	3672 (35.6)	3835 (36.0)	3852 (36.6)
Housing tenure	Homeowner (own outright or mortgage)	6387 (60.1)	6168 (59.9)	6458 (60.6)	6434 (61.1)
	Private Renter	1255 (11.8)	1359 (13.2)	1401 (13.2)	1294 (12.3)
	Rent from my Local Authority	1501 (14.1)	1430 (13.9)	1478 (13.9)	1482 (14.1)
	Rent from a housing association	1043 (9.8)	1080 (10.5)	998 (9.4)	1051 (10.0)
	Other	443 (4.2)	266 (2.6)	319 (3.0)	271 (2.6)
Household Income	£0–15000	3491 (32.8)	3111 (30.2)	2839 (26.6)	2518 (23.9)
	£15001–20000	1609 (15.1)	1527 (14.8)	1531 (14.4)	1536 (14.6)
	£20001–25000	1199 (11.3)	1170 (11.4)	1244 (11.7)	1205 (11.4)
	£25001–30000	973 (9.2)	922 (8.9)	954 (9.0)	929 (8.8)
	£30001–40000	1317 (12.4)	1418 (13.8)	1496 (14.0)	1495 (14.2)
	£40001+	2041 (19.2)	2155 (20.9)	2589 (24.3)	2849 (27.1)
(ii) Outcome or exposure variables		**2013**	**2015**	**2017**	**2019**
Distance to nearest natural space from home	within 5 min walk	6460 (66.9)	6077 (65.9)	6076 (63.6)	6210 (65.6)
	6–10 min walk	1915 (19.8)	1963 (21.3)	2020 (21.1)	1979 (20.9)
	More than 10 min	1279 (13.3)	1179 (12.8)	1461 (15.3)	1277 (13.5)
	Total	9656	9220	9558	9467
Frequency of natural space use	***Outcome: Frequent natural space use (once a week or more)***	4545 (47.1)	4432 (48.2)	4545 (47.6)	4461 (47.2)
	Less than once a week	3823 (39.6)	3660 (39.8)	3802 (39.8)	3928 (41.6)
	Never	2478 (25.7)	2327 (25.3)	2404 (25.2)	2257 (23.9)
	Total	9644	9205	9545	9449
Total		***10632***	***10305***	***10656***	***10534***

3.3. Frequent natural space use by distance to nearest natural space and individual factors

Table 2 presents the odds ratios (OR) from a model exploring frequent natural space use (outcome) by distance from home and individual characteristics. The model highlights variation in frequent natural space use by sex; females were less likely to use natural space frequently compared to males (OR: 0.93 95%CI: 0.89 to 0.98). Those aged 45 and over were less likely to visit natural spaces frequently compared to those aged 25–34 years. Those earning over £20,000 were more likely to report frequent natural space use compared to those earning less than £15,000, with likelihood increasing with income (Table 2).

Proximity to the nearest natural space was associated with frequent natural space use, those reporting their nearest natural space was a 6–10 min walk (OR: 0.47 95%CI: 0.44 to 0.50) and more than 10 min walk (OR: 0.22 95%CI: 0.20 to 0.24) from home were less likely to report frequent natural space use compared to those living within a 5 min walk to their nearest natural space (Table 2).

3.4. Frequent natural space use and housing tenure

In a model controlled for sex, age, income and distance to nearest natural space, private renters were more likely to report frequent natural space use compared to homeowners when combining the entire survey waves (OR: 1.09, 95% CI: 1.004 to 1.19) (Table 3). Those renting from a local authority or housing association visited natural space less frequently than homeowners, with a similar OR between the two housing tenure classifications. Full model presented in Supplementary Table 2, including housing tenure in the model did not provide any substantial change to other control variables presented in Table 2.

3.5. Change over time in frequent natural space use by distance and housing tenure

Table 4 presents the proportion of participants reporting frequent natural space use by housing tenure and year. A higher portion of homeowners reported frequent natural space use and this increased through the sample waves from 47% in 2013 to 50% in 2019 (Table 4). Frequent natural space use reported by private renters and those renting from local authorities both decreased over time: 54% in 2013 to 51% in 2019 for private renters and 43% in 2013 to 36% in 2019 for those renting from local authorities. There was little or no change in reported frequent natural space use for those renting from a housing association.

Table 2
Logistic regression model of frequent natural space use by distance to nearest natural space and individual factors.

Outcome: frequent natural space use	Odds ratio	P	LL 95% CI	UL 95% CI
Sex				
Male	Ref			
Female	0.93	0.01	0.89	0.98
Age Group				
25 to 34	Ref			
16 to 24	0.91	0.19	0.79	1.05
35 to 44	0.96	0.34	0.87	1.05
45 to 59	0.71	<0.001	0.65	0.77
60 plus	0.54	<0.001	0.50	0.58
Household Income				
£0–15000	Ref			
£15001–20k	0.99	0.89	0.92	1.07
£20001–25k	1.10	0.02	1.01	1.20
£25001–30k	1.16	<0.001	1.06	1.27
£30001–40k	1.27	<0.001	1.17	1.38
Over £40k	1.35	<0.001	1.26	1.45
Distance to nearest natural space from home				
within 5 min walk	Ref			
6–10 min walk	0.47	<0.001	0.44	0.50
More than a 10 min walk	0.22	<0.001	0.20	0.24

Table 3
Logistic regression model of frequent natural space use by housing tenure.

Outcome: frequent natural space use	Odds ratio	P	LL 95% CI	UL 95% CI
(i) Housing tenure				
Homeowner (own outright or mortgage)	REF			
Private Renter	1.09	0.04	1.004	1.19
Rent from my local authority	0.80	<0.001	0.74	0.86
Rent from a housing association	0.82	<0.001	0.76	0.90
Other	1.09	0.26	0.94	1.26

Interaction effect models were performed for distance from home and frequent natural space use over time and showed that there was no change in the reporting of frequent natural space use and distance from home between distance groups over time (x2 (6) = 11.33, p = 0.787).

The interaction effect models between housing tenure and frequency natural space use over time were significant (x2 (12) = 42.38, p > 0.001) and showed evidence of change in private renter's frequent natural space use relative to homeowners (Supplementary Table 2). Fig. 1 presents the predicted marginal means of frequent natural space use from 2013 to 2019 by housing tenure. The pattern in linear predictions vary by housing tenure over time, for homeowners there was a 6% increase in the predicted marginal means of frequent natural space use from 2013 to 2019 (Full table shown in Supplementary Table 2). Private renters, those renting from a local authority and 'other' housing tenures all displayed decreasing predictive marginal means of frequent natural space use (private renters: −6.4%, renting from local authority: −17.5%, other: −11.1%), although private renters had higher values initially and the 2019 value was similar to homeowners during the same year.

4. Discussion

The primary aim of this study was to explore frequent natural space use within the context of a 20-min neighbourhood. We found that 87% of respondents lived within a 10 min walk to their nearest natural space, meeting the requirement of a 20-min neighbourhood, and two-thirds reported they lived within a 5 min walk. Individuals living less than a 5 min walk to their nearest natural space were 53% more likely to use that natural space once a week or more compared to those living 6–10 min walk, and 78% more likely than those more than 10 min walk. The results suggest that subjective distance to nearest natural space is associated with frequent natural space use; those who lived within a 5 min walk to their nearest natural space had greater use than those living further away. Thus, providing supporting evidence for 20-min neighbourhoods by showing that having a natural space within a reasonable walk of home is an important predictor of frequent natural space use. There were no changes during the time period 2013 to 2019 in the association between proximity to natural space and frequent use of that space.

Household income was associated with frequent natural space use, those earning £20,000 or more were more likely to visit natural spaces frequently compared to households earning £15,000 or less. As household income increased, as did the likelihood of frequent natural space use. Housing tenure was shown to be an important predictor of frequent natural space use. Overall, those renting from a housing association or local authority were less likely than homeowners to be frequent users. Private renters were most likely to be frequent users, although this was a small association compared to homeowners and showed a decreasing trend over time. There was a change from 2013 to 2019 in frequent natural space use by housing tenure and different temporal patterns by tenure groups were present; frequent natural space use by homeowners remained relatively stable with a small increase over time. Private

Table 4
Frequent natural space use by housing tenure over time.

Proportion reporting frequent natural space use	2013		2015		2017		2019		Total	
	N (total)	%	N (total)	%	N (total)	%	N (total)	%	N	%
Homeowner (own outright or mortgage)	2745 (5809)	47.3	2674 (5539)	48.3	2786 (5807)	48.0	2882 (5783)	49.8	11087 (22938)	48.3
Private Renter	606 (1114)	54.3	656 (1190)	55.1	686 (1251)	54.9	593 (1174)	50.5	**2541 (4729)**	**53.7**
Rent from my Local Authority	585 (1360)	43.0	585 (1285)	45.5	535 (1300)	41.2	482 (1330)	36.2	**2186 (5274)**	**41.5**
Rent from a housing association	398 (951)	41.9	387 (966)	41.2	373 (901)	41.4	392 (927)	42.3	**1562 (3745)**	**41.7**
Other	212 (410)	51.7	120 (225)	53.3	165 (286)	57.6	112 (236)	47.3	**608 (1157)**	**52.5**

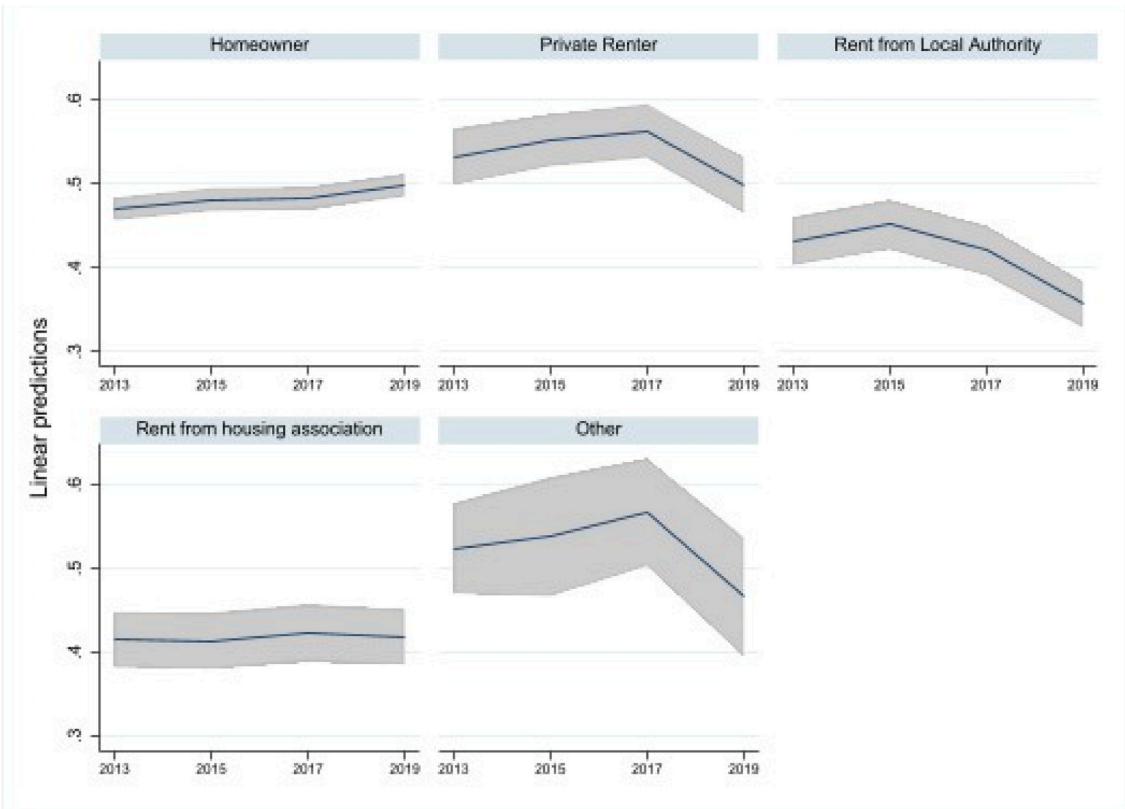

Fig. 1. Predicted marginal means of frequent natural space use from 2013 to 2019 by housing tenure.

renters, who overall had the highest reported frequent use, showed a decrease over time and in the most recent survey wave. Those renting from a local authority showed a decrease in frequent natural space use over time and those renting from a housing association showed little change over time, but had the lowest proportion of frequent natural space use across all survey waves.

4.1. Comparison with other literature

We found that almost 9 in 10 individuals reported they lived within a 10 min walk of their nearest natural space and two thirds within a 5 min walk (approximately 400m). In Sheffield, a Northern English city, 74% of individuals resided within 300m of a publicly accessible greenspace (Mears et al., 2019). Thornton et al. (2022) examined access to each 20-min neighbourhood domain for two Australian cities; Melbourne and Adelaide. The study found that 73.2% (Melbourne) and 76.1% (Adelaide) of households were located within 400m of open space, equating 400 m to a 5 min walk (Thornton et al., 2022). Both the Australian and UK studies show greater proximity to nearest natural spaces than in our study, where we found two thirds of our sample reported living within a 5 min walk to their nearest natural space. There were differences in the study design; we included a Scotland-wide population, as opposed to only urban areas, and we used a subjective measure of proximity to nearest natural space compared to an objective measure of access to open spaces in the other UK and Australian studies.

There is mixed evidence about the relationship between proximity to natural space and use of that space. Many studies suggest that greater opportunities to experience natural spaces will lead to increased use (Galea and Vlahov, 2005). However, an Australian study examined patterns of greenspace use for 1479 individuals in Brisbane and found that whilst those who used a park had greater access, individual level nature orientation was a stronger predictor of greenspace visitation (Lin et al., 2014). For Scottish adults (n:19441), models showed that having a greenspace within a 5 min walk from home was associated with greater recreational use of the outdoors on at least a weekly basis. The study also found that there were other contextual factors associated with use of the outdoors on at least a weekly basis, including rating one's neighbourhood as a very good place to live and high neighbourhood social capital scores, however the authors noted the explanatory power of the models was low (Colley and Irvine, 2018). Both factors may be associated with individual-level housing tenure. Residents in Scotland's most deprived areas were least likely to report frequent use, despite studies in the UK revealing that individuals living in more deprived areas often have better access to public natural spaces than those from more affluent

areas (Mears et al., 2019, Office For National Statistics, 2020). Here, we found that greater proximity was associated with more frequent use. As this was a subjective measure of distance to natural space, it could be likely that those who used natural spaces less frequently may not be aware of their proximity to other local natural spaces or that those spaces were '*not for them*'. Qualitative research exploring reasons why urban residents choose to use natural space highlight that other factors beyond proximity are important predictors of use, such as perceptions of social cohesion at a community level and the level of integration and inclusion in their communities felt by individuals (Seaman et al., 2010). Both subjective and objective environmental measures of the environment have been shown to be linked to health; with mental health affected more by subjective measures (Zhang et al., 2019). Few studies have explored the potential of response bias in reporting proximity to natural spaces. Nguyen et al. (2021) in their review of greenspace and health found that subjective perceptions of natural spaces did not always correspond with objective spatial measures. Highlighting further research is required to understand whether individuals are likely to over or underestimate their proximity to greenspace and what influences these perceptions.

In England, the People and Nature Survey showed an increase in adults spending time outdoors at least once a week from 54% in 2009/10 to 65% in 2018/19 (Natural England, 2019). Similarly, Scotland's People and Nature Survey showed increases in adults spending time outdoors at least once a week from 44% in 2006 to 63% in 2019/20 (Stewart and Eccleston, 2020). Both these surveys reported a larger proportion of individuals spending time outdoors than in our study and that this proportion increased over time. These differences may be due to those studies using a broader definition of 'spending time outdoors' rather than focusing solely on visits to nearest natural space, as we did here.

We found differences in frequent natural space use by housing tenure classifications and it is important to consider the residential context of people and place that sit within the previously defined residential context of health (Hartig and Lawrence, 2003). Hartig and Lawrence (2003) suggested that people with varying cognitions and attachment to their homes may also have different structural features of the dwelling and the physical and social attributes of its surroundings. These contextual factors may contribute to the association between housing tenure and likelihood of natural space use. Similarly, research in Germany found that cultural contexts and individual perspectives influenced natural space use, highlighting that it may be likely that housing tenure classification is an indicator of the cultural contexts and individual perspectives of their tenants (Kabisch and Haase, 2014). Cross-sectional survey data collected in Scotland during May 2021 found that 66% of all respondents reported they had visited a green or open space in the previous 4 weeks but also found there was a steep reduction in visits by housing tenure; those who rented from a local authority (51%) or a housing association (50%) (Public Health Scotland 2022).

National mapping data for the UK estimated that 12% of households in the UK did not have access to a private garden (Office For National Statistics, 2020), highlighting the importance of natural spaces for those who do not have a garden at their home. Provision of natural spaces is often greater for those living in the most deprived areas of the UK, however individuals residing in the most deprived areas often report worse perceptions of natural spaces, citing concerns such as overcrowding, particularly for those living in flats (Shoari et al., 2020). Similarly, access to greenspaces in northern England was greater for those residing within deprived areas but these spaces were found to be smaller and poorer quality (Mears et al., 2019). Research exploring barriers to using natural spaces include using a space at their own home instead, being too busy, poor weather and that natural spaces are too busy (Olsen and Mitchell, 2021). Further research is required to understand barriers to using a natural space temporally by housing tenure, particularly for private renters where our findings show decreasing use of natural spaces.

4.2. Implications for 20-min neighbourhood policy

The findings presented here have important implications for the operationalising and monitoring of the 20-min neighbourhood policy in Scotland. We highlight that for a key domain, access to open and natural spaces, almost 90% report living within a 10 min walk to their nearest natural space and two-thirds within a 5 min walk, suggesting this indicator is currently well met within Scotland but can be improved. Efforts in Scotland in relation to this indicator and the 20-min neighbourhood should be focused on creating natural spaces for the 10% who currently do not have access within a reasonable walk from their home. Proximity to natural space was important for greater frequent use and our findings support and endorse policies that suggest increased access to natural space is associated with increased use of those spaces. It may be more ambitious to move in line with Scotland's National Performance Framework, which recommends local planning should aim to ensure individuals live within a 5 min walk to their nearest natural space (Scottish Government, 2018).

A key outcome of our study is that the monitoring and evaluation of the 20-min neighbourhood policy must focus on differences in proximity to and use of these natural spaces by socioeconomic groups, including those defined by income and housing tenure. These were both associated with the likelihood of frequent natural space use; housing tenure classifications showed both differing overall levels and temporal patterns of frequent natural space use over time; private and social renters showing recent decreases in natural space use. Qualitative research has highlighted that access alone may not encourage use of these spaces and factors such as social cohesion and feelings that the space is for them are also important (Seaman et al., 2010), these factors were found to be most pertinent for lower income individuals. Urban policies should seek to use novel approaches to promote and encourage use of existing natural spaces and encourage community integration. Public Health England in their policy *improving access to greenspace* recommend that the planning system requires a green infrastructure network from a micro-level (i.e. garden) to macro-level (parks and semi-rural natural spaces) to both increase provision and equitable access to greenspace (Public Health England, 2020). There are inconclusive conclusions for equitable interventions to increase use of natural spaces, largely due to the heterogeneous and under-evaluated evidence base (Hunter et al., 2019).

Further research is required in Scotland to define and describe accessibility of the other 20-min neighbourhood domains: healthy food; recreational resources; community resources; health services; and public transport. Australian studies have highlighted that access to these domains within 20-min neighbourhoods is poor when compared to green and open spaces (Thornton et al., 2022).

4.3. Strengths and limitations

Our study had a number of strengths, we were able to measure perceived distance to and access of natural space at an individual level, which is important to prevent misclassifications and masked associations using aggregated data (Houlden et al., 2019). We included a large sample with nationally representative data on the composition, characteristics, attitudes and behaviour of private households and individuals across Scotland (Scottish Government, 2017) with multiple outcomes and exposure measures over time.

However, our study used a subjective measure of distance to nearest natural space, individuals were asked to report the walking distance within pre-specified groups, and this may be subject to usual biases, including recall and confirmation bias. Studies have shown that there may be differences between subjective proximity to natural space and objective measures; objective measures provide greater accuracy in describing spatial measures of the home environment that do not always

correspond with subjective perceptions. Although objective measures provide greater accuracy, subjective measures are important for understanding what residents perceived is available to them and can have a greater association with mental health (Zhang et al., 2019). The study was also repeat cross-sectional rather than a panel. The changes we observed and explored were therefore at a population or group level, not within individuals. We were unable to include other key predictors of frequent natural space use, such as the quality of that space, delve deeper into any urban-rural differences, or what individuals were doing in natural spaces and how that might contribute to physical or mental health. The frequent natural space use survey question asks individuals to record that they visited a natural space even if they just passed through it. We were unable to describe the length of time an individual spent in natural space or the purpose of their visit, in terms of intentional or passive use via an active transit route. As the SHS asked the highest income householder to complete the survey, this resulted in a gender bias in our analysis where almost 60% of responders were male.

A limitation of our outcome variable *frequent natural space use* was we were unable to separate green and blue space within our analysis. Scottish studies exploring proximity to blue and green space separately showed variation in residents reporting living within a 10-min walk of these spaces (greenspace: 76%; blue space - lake: 11%; canal 10%; sea 14%; and river: 30%) as well as reported use of those spaces (Mcdougall et al., 2022). Research has also highlighted that the benefits of the use of blue space for health are inconclusive, partly due to research in this area being in its infancy (Triguero-Mas et al., 2015; Mcdougall et al., 2022). This highlights the importance for future studies and national surveys to question proximity to and use of green and blue spaces separately.

5. Conclusions

We found that 9 out of 10 Scottish residents reported that they lived within a 10 min walk of their nearest natural space, using subjectively recorded natural space proximity data from a nationally representative survey. Greater proximity to nearest natural space was strongly associated with frequent use, those living less than 5 min more likely to report greater use. Housing tenure was shown to be an important predictor of frequent natural space use, those renting from a housing association or local authority were less likely than homeowners or private renters to be frequent users.

We found overall that there was no change in frequent use of nearest natural spaces from 2013 to 2019 in Scotland, however there was variation by housing tenure; small increases were observed for homeowners and decreases for those renting from a local authority and private renters.

Our study provides important findings for population level policies that aim to improve access to local facilities and amenities, such as natural spaces, in Scotland and other similar geographical contexts. The findings providing evidence that proximity to natural space is an predictor of frequent use and natural space provision is in-line with the 20-min neighbourhood policy. The results suggesting that operationalising and monitoring of the 20-min neighbourhood policy must focus on improving access and use of these spaces for people living in social housing and of lower income.

Credit author statement

Jonathan Olsen: Conceptualization, Methodology, Formal analysis, Writing – original draft.; **Natalie Nicholls**: Methodology, Formal analysis, Writing – review & editing.; **Jenna Panter**: Conceptualization, Methodology, Writing – review & editing.; **Hannah Burnett**: Writing – review & editing.; **Michael Tornow**: Writing – review & editing.; **Richard Mitchell**: Conceptualization, Methodology, Writing – review & editing.

Ethical approval

Ethical approval was not required for this study as it used secondary data from the Scottish Household Survey via the UK Data Service.

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Data sharing statement

Data are available in a public, open access repository. The data underlying this article are freely available to bona fide researchers via the UK Data Service (http://ukdataservice.ac.uk).

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.envres.2022.113610.

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