

Exploring the user experience, quality, and provision of urban greenspace: A mixed-method approach

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ABSTRACT

Urban greenspace plays a crucial role in city design, offering residents various benefits for their health and wellbeing. With increasing urbanisation and human population growth, urban greenspace is becoming an even more significant resource. By implementing a mixed-method approach, we conducted a comprehensive assessment of urban greenspace based on public usage and perceptions, and quality, availability and accessibility in Derby, UK. Our methodology included an online questionnaire to investigate greenspace usage and perceptions, an in-situ assessment to assess greenspace quality, and Geographical Information Systems analysis to quantify greenspace provision based on Natural England's (2023) Accessible Greenspace Standards (AGS). We found that greenspace usage and perception vary according to demographic and socioeconomic aspects, with younger people and students showing lower engagement with greenspace. Positive engagement correlates with factors such as proximity, car access, employment, and education. We also found that moderately high levels of greenspace quality (69.47/100) are available in the city, with the most notable insufficiencies related to quietness/peacefulness, aesthetics, and naturalness. Finally, none of the AGS criteria are met at a city-wide scale given the lack of large greenspace sites (particularly over 100 ha) and inequalities in spatial distribution. Our study highlights the value of the use of different methodologies to assess greenspace-related factors and emphasises the significance of public engagement in evaluating greenspace quality. Additionally, we identified factors adversely affecting greenspace use, including parking fees and issues with facilities, amenities, and safety. We therefore recommend interventions to address these challenges and enhance greenspace experience and accessibility in the city.

1. Introduction

Nature has long been documented as crucial for human health and wellbeing. For example, Wilson's (1984) biophilia theory identifies the innate human need to connect with nature (Cutt et al., 2007). A range of benefits can be derived from nature such as improvement in cognitive function, decreased stress levels, reduced cardiovascular disease, and less occurrence of illness (Ekkel & de Vries, 2017; Keniger et al., 2013). In addition, interaction with nature can improve negative physiological effects of living with stressors found in urban environments, including traffic and crime (Keniger et al., 2013; Roe et al., 2017). In urban areas, greenspace is a key resource for maintaining contact with nature (Mahrous et al., 2018), promoting opportunities to engage in social interaction and recreational activities (Song et al., 2021), and reducing sedentary time (Arnberger & Eder, 2015).

The potential of urban greenspace to provide ecosystem services is well explored, including environmental benefits such as mitigation of urban heat islands, reduction of air pollution, noise reduction, and providing habitat for species (du Toit et al., 2018; Madureira et al., 2018). However, with the expansion of urbanisation, urban greenspace is becoming increasingly significant (Boulton et al., 2018; James et al., 2009), not only to reverse biodiversity loss but to connect people with nature (Turner et al., 2004). It is also likely that urban greenspace will become even more significant in the future, given the predicted increase in the proportion of the global population living in urban areas to 68 % by 2050 (United Nations, 2019). Thus, it is relevant to understand the different aspects that influence the experience and use of greenspace to better inform effective urban planning.

User perception must be considered when assessing the experience of greenspace (Kim et al., 2018; Ordóñez et al., 2022; Wright Wendel et al.,

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2012). Lackey and Kaczynski (2009) found that people’s perception of proximity to nearby greenspace vary from objectively measured proximity. Greenspace characteristics can also influence user perception. Cronin-de-Chavez et al. (2019) identified nine factors that influenced the decision to use greenspace for low-income and multi-ethnic families in the North of England. They found that some factors are associated with a positive attitude towards greenspace and encouraged use, whereas others, such as the built environment, lack of knowledge about greenspace, and fear (e.g., of crime and antisocial behaviour) acted as barriers (Cronin-de-Chavez et al., 2019). Perceptions of greenspace characteristics and the extent to which these can influence greenspace usage also vary between demographic groups. For example, women have a higher level of fear of crime (Mahrous et al., 2018), and elderly people, children, people without cars, and low-income residents have the greatest need for greenspace within walking distance (Boone et al., 2009). Therefore, it is important to consider socioeconomic and demographic groups to better understand usage and perception of greenspace.

Quality and perceptions of greenspace can be assessed using a combination of methods such as in-situ/expert assessments, questionnaires, and Geographical Information Systems (GIS) analysis (Stessens et al., 2020; Zhang et al., 2017). In-situ assessments are useful to investigate specific indicators related to these themes. Indicators are often grouped into categories, referred to as ‘domains’ (Table S1), which only focus on a specific area of quality or type of greenspace such as the ability of greenspace to enhance health/physical activity (Knobel et al., 2021), neighbourhood greenspace (Gidlow et al., 2012), or parks and playgrounds (Saelens et al., 2006). The use of GIS for assessing greenspace quality has been increasing recently (Baka & Mabon, 2022), particularly in studies over large areas where in-situ assessments are less appropriate (Stessens et al., 2020).

For residents to access the potential benefits of greenspace, it is imperative that they can use these spaces (Arnberger & Eder, 2015). However, many factors or barriers can discourage or prevent frequent use of urban greenspace (Fig. 1) by physically restricting the ability to access a greenspace or affecting the user’s perception (Biernacka et al., 2020). Biernacka & Kronenberg (2018) proposed availability, accessibility and attractiveness as factors to consider when assessing urban greenspace provision and access. For example, a greenspace is available if it exists, particularly within a suitable distance from people’s homes (Biernacka & Kronenberg, 2018). Time limits or travel distances are also references for determining levels of availability (Hoffmann et al., 2017). Greenspace availability can additionally be assessed based on guidelines of what ideal greenspace provision should resemble. A useful guideline is Natural England’s Accessible Natural Greenspace Standards in Towns and Cities (ANGSt), recently updated to the Accessible Greenspace Standards (AGS; English Nature, 2003; Natural England, 2023).

Given the importance of quality, availability, and accessibility in influencing the use of greenspace (Biernacka & Kronenberg, 2018), the aim of this study is to assess these key themes for greenspace in Derby, UK, a city with a long history of public greenspace. For that, we used a mixed-method approach as it not only allows the gathering of a wider range of data at different scales (Ivankova & Creswell, 2009) but a “deeper insight into a research problem” (Hoggart et al., 2002, p. 67). Particularly, we collected an overview of people’s use of greenspace and perceptions with the aim of comparing these across different socioeconomic/demographic groups. We also investigated greenspace quality by assessing factors such as facilities, maintenance, and safety. Finally, we investigated if there is adequate provision of accessible greenspace in the city. The use of different methods allows an in-depth understanding of the experience of greenspace, which is essential for local planning strategies and to better explore the links between the findings for the key themes of greenspace including perceptions and usage, quality, accessibility, and availability.

2. Methods

2.1. Study area

The study was conducted in Derby (Fig. 2), a city with around 261,400 residents (Office for National Statistics, 2022). Most identify as white (73.8 %), followed by Asian/Asian British/Asian Welsh (15.6 %) and Black/Black British/Black Welsh/Caribbean/African (4 %) (Derby City Council, 2021a). We selected this city given its long history with public greenspace and the limited research on this topic. Derby Arboretum was “the first specially designed, municipally owned, public park in Britain” (Elliott, 2001, p. 144). The importance of greenspace in Derby has been recognised through six parks being awarded the Green Flag Award (Derby City Council, 2021b). In addition, the largest urban rewilding project in the UK is currently being planned to be carried out in Allestree Park (Derby City Council, 2022).

2.2. Data collection and analysis

2.2.1. User perception

We developed a questionnaire to gather data on usage and perception of greenspace (Table 1) from a larger sample size compared to other methods such as interviews (Kitchin & Tate, 2013). We included close-ended questions (i.e., with responses provided to the respondent) such as multiple choice and Likert scale, and open-ended questions (i.e., with no responses provided to the respondent) (Parfitt, 2005). Open-ended questions allow respondents to have more freedom in their responses, and close-ended questions may encourage respondents to answer (McLafferty, 2016).

Previous studies have shown that online questionnaires can allow

Institutional Barriers	Cultural Factors
e.g., planning and management of greenspace	e.g., racial disparities, cultural norms
Perception of Greenspace	Physical Barriers
e.g., safety concerns, low quality greenspace, lack of place attachment to greenspace	e.g., fences, roads, entrance fees, lack of accessibility for disabled people
Lack of Knowledge	Demographic Factors
e.g., about greenspace location	e.g., health issues, income, disability

Fig. 1. A list of barriers that discourage or prevent access to urban greenspace. Adapted from Biernacka and Kronenberg (2018), Wolff et al. (2022) and Robinson et al. (2023).

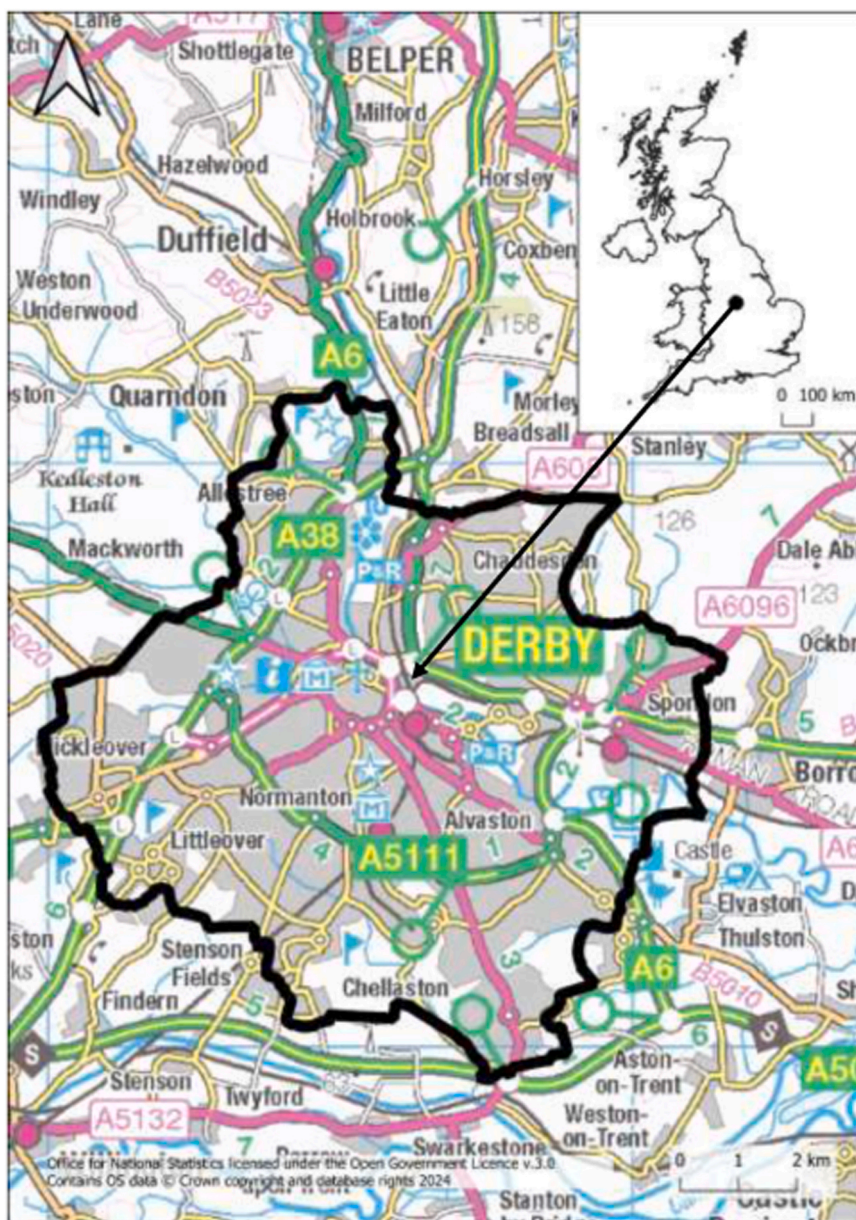


Fig. 2. Location of the study area (Derby Upper Tier Local Authority) outlined in black.

access to a higher number of respondents than other questionnaire distribution methods (Bethlehem, 2010). Thus, we first conducted a pilot study to test the questionnaire online and, after collecting a few responses ($n=10$) from a range of socioeconomic groups, including different age groups, gender, and employment status, we decided to distribute this questionnaire online through social media sites, including Twitter and Facebook, between December 2022 and February 2023. There were initially 329 responses, but 11 were excluded due to the respondent referring to greenspace outside of Derby or living far away from the city. Therefore, we included 318 responses in the analysis. We analysed responses using SPSS v27 (IBM Corp, 2020) for the close-ended questions, and NVIVO v12 (Lumivero, 2017) for the open-ended questions, and used emic coding for the analysis. We used Fisher's exact test and Chi-Square test to determine the relationship between the frequency of engagement with greenspace and demographic (ethnicity, gender, age) and socioeconomic factors (employment status, education level, access to a car, accommodation type). Moreover, we used Fisher's exact test to explore whether feeling unsafe when in or travelling to a greenspace site is related to gender, and Chi-Square test to determine whether

visit frequency is related to the proximity to home.

2.2.2. Quality of greenspace

We compiled a list of 89 indicators from a literature review of scientific papers (e.g., Alwah et al., 2021; Cavnar et al., 2004; Kaczynski et al., 2012; Mishra et al., 2020; Narh et al., 2020; Table S2) and classified them as objective or subjective across ten categories (Table 2) to develop a greenspace quality in-situ assessment tool. We assessed these indicators in six greenspace sites – Markeaton Park, Chester Green, Derby River Gardens, Rowditch Recreation Ground, Derby Arboretum, and Alvaston Park – given their different sizes and functions (e.g., acting as a regional greenspace with a wide catchment area or as a local greenspace (CABE, 2009)), and different locations which consequently cover areas with different socioeconomic characteristics (Fig. 3, Table S3). We first conducted a pilot study in two greenspaces to test the indicators and amended them where necessary (Table S3). We then visited all six greenspaces to undertake the quality in-situ assessment between December 2022 and February 2023 at weekends as these are popular times to visit (Wright Wendel et al., 2012).

Table 1
The main questionnaire sections and respective description used to assess the usage and perceptions of urban greenspace.

Questionnaire Section	Description
Demographic and Socioeconomic Section	This section included several questions relevant to the respondents' experience of greenspace, such as age and education level, given their association with greenspace usage (Elbakidze et al., 2022).
Usage of Greenspace	This section included questions related to the respondents' use of greenspace in general.
Most Frequently Visited Greenspace	This section was based on the assumption that respondents are more familiar with the greenspace they visit most often and thus can provide more accurate responses. We included questions about how locals travel to and use the greenspace, including which activities they undertake, how often they visit, as well as opinions about the greenspace.
Perceptions of Greenspace in General	Questions in this section assessed perceptions of greenspace including how far the respondent is willing to travel to greenspace if walking or by other modes of transport.
Non-users of greenspace	This section explored the reasons why respondents do not visit greenspace to identify any barriers to greenspace accessibility.

Table 2
The list of the categories and respective objective and subjective (*) quality indicators. These quality indicators were considered from a human health and wellbeing point of view.

Categories	Indicators
Naturalness	Water, (enhanced) biodiversity, allows people to feel closer to nature*
Quietness/Peacefulness	Feeling of tranquility*, disruptive noise*, noise level, outside noise*
Historical/Cultural/Educational value	Information of historical/cultural/educational value, historical/cultural features, events
Aesthetics	Decorative features, visual pollution, has lots of open space*, unpleasant smells*
Accessibility on site	Accessibility information, onsite parking, amount of onsite parking, car park fee, disabled parking, footpath quality and network, cycle path, accessibility, tactile paving, access points, access to greenspace features, crossings, busyness of roads surrounding greenspace, access to elsewhere, entry fee, opening hours, entrance sign, signs, map, directions, public transport stops near greenspace, pedestrian access/pavements
Safety/Amenities	Codes of conduct, staffed, safety devices, emergency information, presence of water safety equipment, presence of lighting, dog mess bins, litter bins, recycling bins, bike parking, CCTV, rules about dogs, land use around greenspace, visibility/hidden areas, roads through greenspace, dangerous objects, dangerous equipment/devices, dangerous natural features
Maintenance	... of hard surfaces, vegetation, buildings/infrastructure, other structures
Quality	Vandalism, alcohol/drug use, antisocial behaviour, dog mess, graffiti, glass, litter
Facilities	Presence of ... toilets, food outlets, benches, picnic tables, play area, sport field/courts, other Criteria – present, usability Combined usability score for facilities other than those listed above
Surrounding areas	Toilets – disabled toilet, baby changing, fee Graffiti, vandalism, vacant/dangerous buildings, lack of streetlights, litter, antisocial behaviour

For the objective indicators, we assessed these through observations and measured them using a unique scale for each individual indicator. We measured noise levels using a Voltcraft VC-4in1 sound level meter at five random locations generated using QGIS v3.28.7 (QGIS Development Team, 2022). We recorded noise levels at 30 second intervals for

five minutes before calculating a mean of these readings and ranking this mean value from loudest (0) to quietest (5) to incorporate into the objective quality indicators. For the subjective indicators, we developed a short questionnaire to allow more than one respondent to input their perception (Gidlow et al., 2018). We assessed these indicators using a five-point Likert scale and gathered five responses in each greenspace before calculating a mean score (rounded to the nearest integer) of the responses for each subjective indicator. Convenience sampling was used to obtain responses. These subjective indicator scores were then combined with the objective indicators to obtain a single overall quality score for each greenspace (Fig. 4). The scores ranged from 0 to 100, with 100 representing the highest possible quality score. We altered the scoring where certain indicators were not applicable to a greenspace to produce a fair score for each greenspace (e.g., the presence of disabled parking was not assessed where parking did not exist). For the facilities category (Table 2), we found that smaller greenspaces have a limited number of facilities compared to larger greenspaces, and therefore we only incorporated a limited number of common facilities and amenities (toilets, benches, picnic tables, play area, sports field/courts, food outlets) in the overall quality score for these greenspaces.

2.2.3. Availability/provision

We used the software QGIS v3.28.7 (QGIS Development Team, 2022) to assess the availability of accessible greenspace based on the six criteria of the AGS (Natural England, 2023) (Table 3). To map accessible greenspace sites, we first compiled data from the Ordnance Survey (OS) Open Greenspace data (Ordnance Survey, 2023). Based on satellite imagery, we then corrected geometries, added new sites, and excluded those not accessible to the public such as golf courses, churchyards, private gardens, allotments and agricultural land and those possessing certain characteristics (Table S4). Adjacent greenspace sites were combined into a single site unless clearly separated by a physical barrier (e.g., a fence or a road). We calculated the area of each greenspace and created buffers around each greenspace based on the distances provided by the AGS criteria. We also estimated the proportion of the city's total human population within each of the AGS criteria by first creating centroids of the 2011 Output Areas (OAs) (UK Data Service, 2018; Fig. S1) and then extracting the corresponding total 2020 OA population estimates (Office for National Statistics, 2020). Population estimates were calculated as a percentage of the city's total population (256,814) (Office for National Statistics, 2020) and investigated at the OA level as it is the smallest geographical area that census estimates are defined, making it useful for research involving demographic characteristics (Office for National Statistics, 2016).

2.3. Ethics statement

This research was approved by the Research Ethics Committee of the University of Derby (ETH2122-3599). Respondents consented to take part in the study by completing the questionnaires after reading the participation information sheet. Respondents were able to withdraw from the study anytime.

3. Results

3.1. Greenspace use

Most respondents (91.2 %) visit greenspaces, particularly Markeaton Park (21.7 %) and Darley Park (19.0 %). Women (68.2 %) and people of white ethnicity (93.1 %) are overrepresented in the questionnaire. We found that ethnicity is associated with visits to greenspace (two tailed, $p = 0.019$) but this is not the case for gender ($\chi^2 = 9.89, p = 0.129$, Cramer's $V = 0.177$). Our results suggest that respondents identifying as a minority ethnicity have a lower rate of engagement with greenspace (73.7 %) compared to those identifying as white (92.2 %). The median age group of respondents is 30–49, and the frequency of greenspace

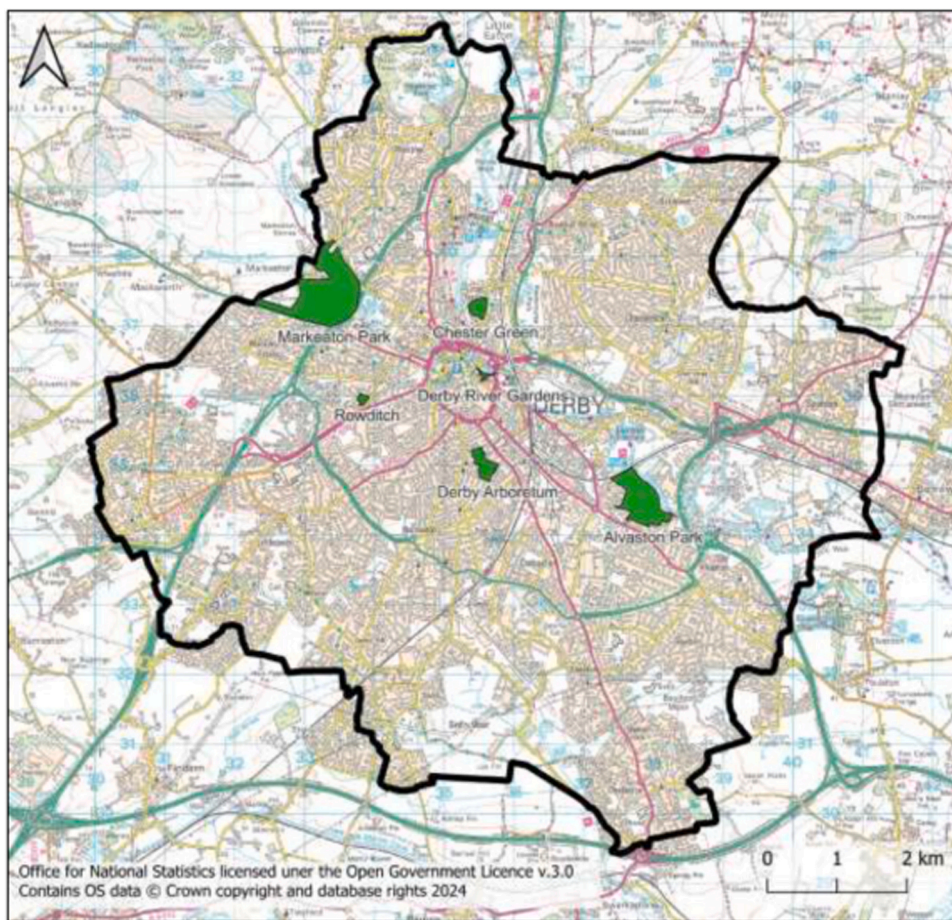


Fig. 3. The greenspace sites (in green) selected for the assessment of the quality indicators.

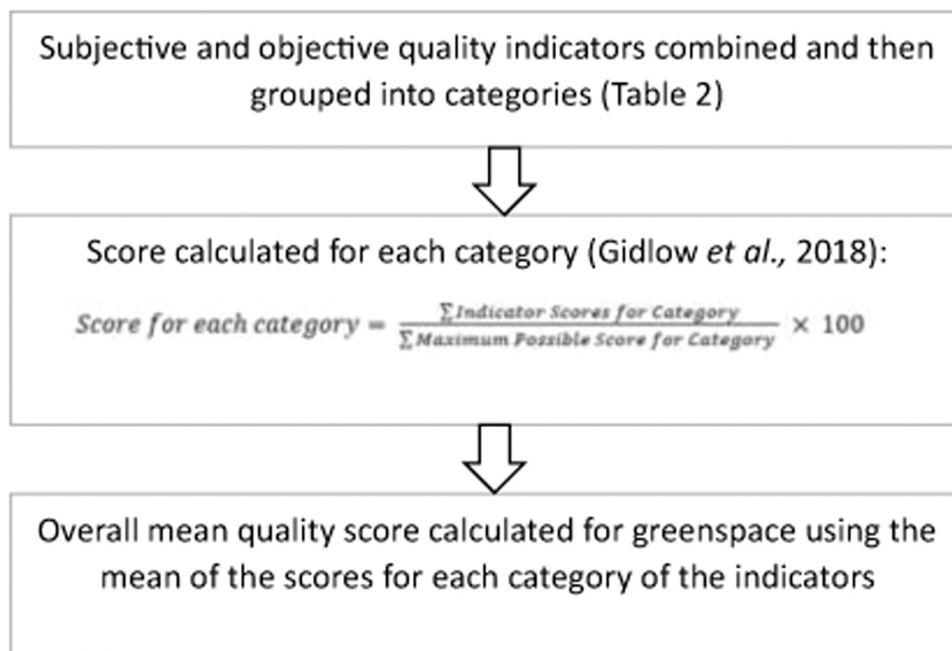


Fig. 4. The method used to calculate an overall score for each quality indicator in each greenspace site.

visits is associated with age ($\chi^2 = 62.11, p < 0.001$, Cramer's $V = 0.256$), with fewer respondents aged 18–29 visiting once a week or more frequently than expected and more never visiting greenspace than based

on random expectations. However, for those aged 30–65+, the opposite was generally the case, with more respondents visiting at least once a week.

Table 3

The criteria and respective greenspace size and distance defined by the Accessible Greenspace Standards (Natural England, 2023).

Criterion	Minimum Size (ha)	Distance
Doorstep Greenspace	0.5	200 m
Local Natural Greenspace	2	300 m
Neighbourhood Natural Greenspace	10	1 km
Wider Neighbourhood Natural Greenspace	20	2 km
District Natural Greenspace	100	5 km
Sub-regional Natural Greenspace	500	10 km

We found that full time employment is the mode employment type. Employment status is related to visit frequency ($\chi^2 = 68.50, p < 0.001$, Cramer’s $V = 0.276$), with the majority (75.9 %) of retired respondents visiting at least once a week and the majority of students (65.4 %) visiting less often than weekly or not visiting at all. Unemployment status was not assessed due to lack of data. We further found that visit frequency is significantly contingent on the respondents’ highest education level ($\chi^2 = 38.58, p = 0.008$, Cramer’s $V = 0.176$), with respondents with university level qualifications generally visiting greenspaces more frequently than those with school level qualifications. Those with no qualifications were not assessed due to lack of data. We also found that visit frequency is not influenced by mobility issues ($\chi^2 = 9.30, p = 0.098$, Cramer’s $V = 0.172$), and accommodation type ($\chi^2 = 6.15, p = 0.909$, Cramer’s $V = 0.101$). The mode accommodation type for respondents is semi-detached housing.

We found a significant association between the frequency of visits to the most frequently visited greenspace and proximity to home ($\chi^2 = 35.78, p < 0.001$, Cramer’s $V = 0.351$). For more than half of the respondents (57.6 %), their most frequently visited greenspace is closest to their home, with the majority (69.5 %) visiting it at least once a week, whereas for those whose most frequently visit greenspace is not the closest to their home one-third (35.8 %) visit at least once a week. Access to a car is also associated with whether respondents visit greenspace (two-tailed, $p < 0.001$). Of the respondents with access to a car (91.8 %) more than expected visit greenspace and less than expected do not visit, whereas the opposite is the case for those without access to a car. We further found that over half (51.7 %) prefer to walk to their most frequently visited greenspace, followed by travelling by car (43.4 %) and public transport (2.8 %). The mode time taken to travel to the greenspaces is 5–10 minutes, with the mean maximum time respondents are willing to walk being 23 minutes and drive 32 minutes. The most common visit duration at the most frequently visited greenspace is between 30 minutes and 1 hour, and the most common frequency for visiting is more than once a week. Despite the majority (95.6 %) of respondents having access to a garden space (whether private, shared or not at the respondents’ property), this is not associated with respondents’ visits to greenspace (two-tailed, $p = 0.115$). Out of a range of twenty activity types, the most popular is individual exercise (73.1 %), followed by dog walking (25.9 %). The most popular individual exercise

Table 4

Results of the overall scores of the quality indicators for each criterion in each greenspace site. For more details about each category see Table 2.

Categories	Markeaton Park	Chester Green	Arboretum	Alvaston	Rowditch Recreation Ground	Derby River Gardens	Mean
Naturalness	85.71	42.86	57.14	57.14	28.57	57.14	54.76
Quietness/Peacefulness	47.06	47.06	58.82	41.18	64.71	17.65	46.08
Historical/Cultural/Educational Value	80.00	60.00	100.00	80.00	00.00	40.00	60.00
Aesthetics	71.43	57.14	71.43	50.00	35.71	35.71	53.57
Accessibility on Site	80.95	76.32	83.33	85.71	68.18	60.53	75.84
Safety/Amenities	72.34	62.22	68.89	68.09	68.89	70.21	68.44
Maintenance	100.00	100.00	87.50	75.00	83.33	100.00	90.97
Quality	82.14	89.29	82.14	75.00	82.14	82.14	82.14
Facilities	95.83	66.67	90.00	87.50	75.00	37.50	75.42
Surrounding Areas	100.00	87.50	75.00	95.83	70.83	95.83	87.50
Mean	81.55	68.90	77.43	71.55	57.74	59.67	69.47

activities are walking, running, and jogging.

3.2. Quality and perceptions

The mean quality score across greenspaces is 69.47 out of 100. The larger greenspaces tended to have higher quality scores, with Markeaton Park obtaining the highest quality score (81.6), whereas the smallest greenspaces Derby River Gardens and Rowditch Recreation Ground have the lowest scores (59.7 and 57.7, respectively). The highest scoring quality category across all greenspaces is maintenance (91.0) and the lowest scoring is quietness/peacefulness (46.1) (Table 4, Text S1).

Most (70.1 %) respondents mentioned an adequate availability of greenspace in their neighbourhood and reported a mean satisfaction score of 7.42. The most popular reasons for visiting the most frequent greenspace are related to proximity, aesthetics, and spaciousness. Proximity to places such as home, workplace or other specific areas, incentivises respondents to walk to greenspace sites:

Within walking distance of home (Respondent 142)

It’s near the Museum of Making which we visit and the river which we like to walk along. (Respondent 292)

Favourite greenspace characteristics include nature- and water-related aspects as well as aspects related to size and sense of peacefulness and tranquility:

Quite well enclosed by trees and vegetation in such a way to feel like you’re in the countryside rather than in the suburbs and next to busy dual carriageways (Respondent 89)

The physical shape of the landscape, the hills, views, streams and wild-flower meadows and the lake (Respondent 219)

Another popular aspect is the diversity of features, including a variety of facilities and amenities, landscapes, habitats, and activities:

The fact that it has different areas for different needs, some days I want the playground, some days I want to sit alone and read my book (Respondent 244)

The variety of woodland, streams, open areas, and recreational and family facilities (Respondent 293)

Over one-quarter (29.0 %) of respondents stated that they have felt unsafe in a greenspace and/or when travelling to a greenspace site, which was related to gender (two-tailed, $p = 0.007$) with women feeling more unsafe than men (33.8 % and 18.2 %, respectively). Among the respondents who mentioned a least favourite aspect, we found that the majority relate to other users’ behaviour, dogs’ presence, and lack of management of these issues causing a threat to the safety of other users:

Too many people who don’t control their dogs! (Respondent 27)

Mindless vandalism. The throwing into of the river of the stone balustrades broke my heart. (Respondent 47)

Drug consumption / fears over personal safety (Respondent 88)

Many respondents commented on how their least favourite aspect led them to change their usual behaviour:

I was attacked by an American XL bully dog not on a lead. Consequently I no longer feel safe walking my dog in the park (Respondent 119)

Paying for parking is also off putting and sometimes prevents me from

going to this park (Respondent 296)

We identified improvements in facilities and amenities, maintenance, or other users' behaviour as the most popular suggestions. With regards to improvements to facilities and amenities, these largely related to improvements of existing ones and/or the addition of new ones including food-related facilities, waste disposal facilities, and toilets:

Additional WC/ cafe/ restaurant facilities (Respondent 24)

More dog bins scattered around the park, greater access to toilets (Respondent 214)

It would be nice if there more options for food - as it's such a large site - a few more catering options including halal should be offered (Respondent 296)

Some respondents commented that it would encourage and allow them to spend more time in greenspace if the suggested improvements are implemented:

Toilet facilities improved, so that longer/whole day visits are possible (Respondent 335)

Of a small number of respondents (8.8 %) who do not visit greenspace, the most common reasons are due to respondents' preferences of undertaking other activities, having access to greenspace at their home, not having enough time to visit, having health/mobility issues, and lack of knowledge of the location of their closest greenspace. Some respondents also prefer greenspace in the countryside rather than urban

greenspace:

Green spaces in cities are usually too maintained and artificial - I prefer wild woodlands and natural outdoor spaces to get in touch with nature and get fresh air (Respondent 44)

I prefer to walk in the countryside where there are less people and better views (Respondent 50)

One-third (32.1 %) of non-users mentioned that there is nothing or that they are not sure if anything would encourage them to visit greenspaces. More activities/events suited to different age groups including "for older people", "for adults and not just focused on children" and "young adults", improved transport services such as "more public transport" and "free car parking" would encourage them to visit greenspace. Other factors include an increased awareness of greenspace, "more advertisement" or "information", and encouragement from family or friends.

3.3. Availability/provision

We identified 310 greenspace sites covered by 1010.52 ha, which represents approximately one-tenth of the total area (12.9 %) in Derby. Most greenspace (n=173) have an area below the lowest area considered in the AGS (0.5 ha). Half of the city's population lives within the Doorstep (52.8 %) and Local Natural Greenspace criteria (52.9 %).

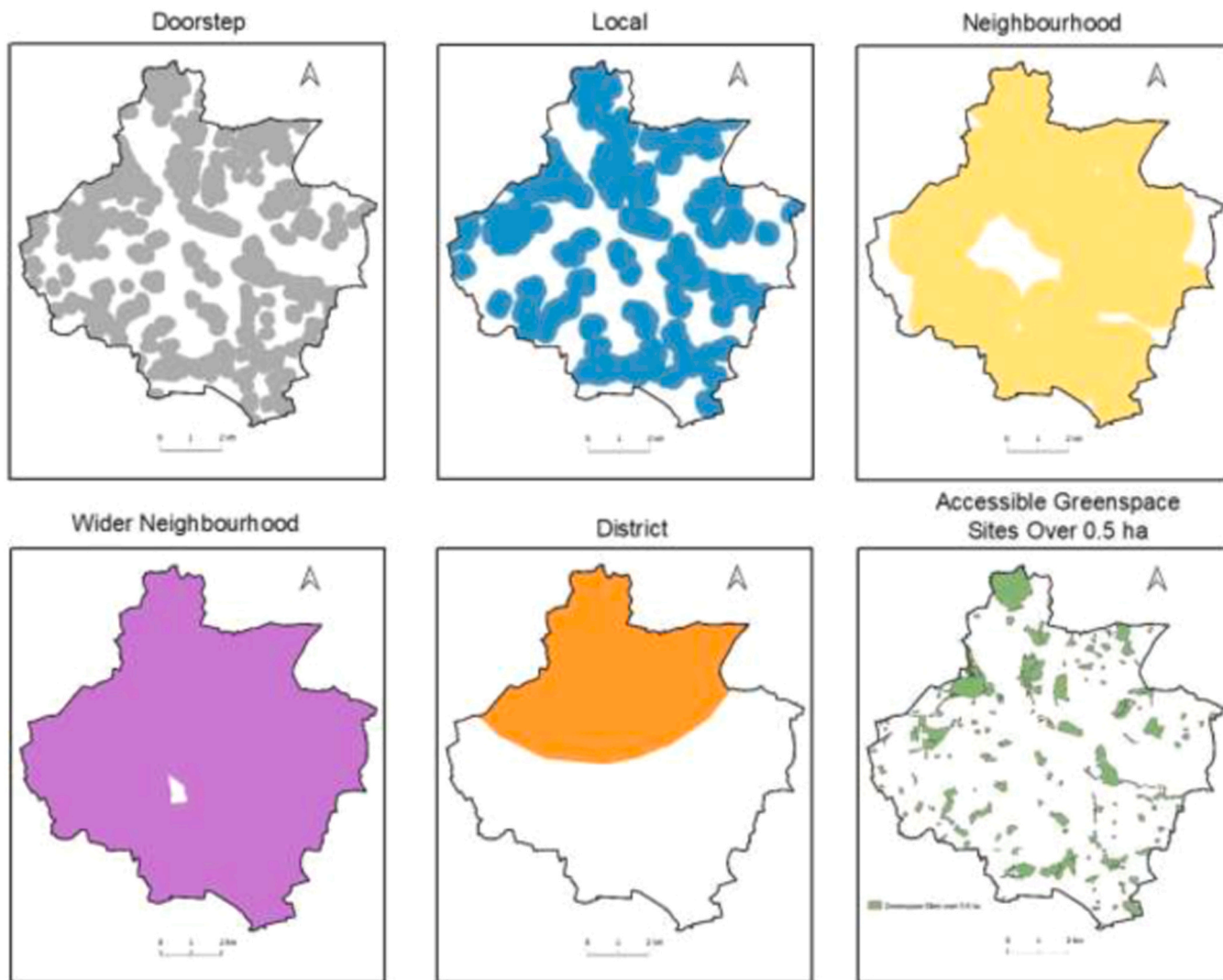


Fig. 5. Maps showing the results of each AGS Criteria (Doorstep, Local, Neighbourhood, Wider Neighbourhood, and District) and the location of the greenspace sites over 0.5 ha in Derby. For more details about each criterion see Table 3. Contains OS data © Crown copyright and database right (2024).

Almost the entire population (97.7 %) lives within the Wider Neighbourhood Natural Greenspace criterion, and about three-quarters (78.9 %) within the Neighbourhood Natural Greenspace criterion (Fig. 5, Table 3). There is only one site of accessible greenspace of at least 100 ha available - Allestree Park - that reaches two-fifths of the human population (40.3 %) according to the District Natural Greenspace criterion. There are no accessible greenspace sites of at least 500 ha within the city, meaning that the Sub-regional Natural Greenspace criterion could not be assessed.

4. Discussion

Our findings show that greenspace use can vary across socioeconomic/demographic groups. Younger people and students visit greenspace less often than older and retired people. People with access to a car are more likely to visit greenspace despite walkability and proximity being factors highly valued by the respondents. Most respondents walk to greenspace, and individual exercise is the most popular activity. We quantify, on average, a moderately high level of greenspace quality (69.47/100), with the most notable insufficiencies relating to quietness/peacefulness, aesthetics, and naturalness. This is supported by the respondents' high degree of satisfaction of the quality in their neighbourhood (7.4/10). In terms of provision, the AGS's Wider Neighbourhood Natural Greenspace criterion was the best achieved (minimum 20 ha within 2 km; with 97.7 % of the population living within this criterion) in contrast to the Sub-regional Natural Greenspace criterion as no 500 ha sites are located within the city boundary.

4.1. Use, perception, and quality of greenspace

Despite conducting a pilot study and sharing the questionnaire in different online community social media groups in attempt to gather responses from different areas of the city, our study revealed that most respondents identify as white and consequently a high number of people of white ethnicity were found to engage more with greenspace. However, our results need to be interpreted with caution given the low response rate for those identifying as a minority ethnicity. Questionnaires distributed online allow efficient collection of a large number of responses, but a large limitation is that they can result in bias in which socioeconomic groups respond (Bethlehem, 2010). The same issue can also be found when conducting questionnaires onsite as an over-representation of some demographic groups is often expected (Wood et al., 2018). This demonstrates the complexity of equally representing all demographic groups when conducting questionnaires.

The greenspace sample showed a relatively high level of quality, which is essential in increasing good perceptions of greenspace (Zhang et al., 2017). This corroborates with the respondents' relatively high rating of satisfaction of greenspace in their neighbourhood (7.4/10). The most popular greenspaces to visit among sampled greenspace sites – Markeaton Park, Alvaston Park, and Arboretum – also had the highest quality levels as assessed through the indicators (Table 4). It is therefore possible that respondents recognise high levels of quality and adapt their use of greenspace accordingly (which is also complemented by the respondents' views of how they alter their behaviour to reflect certain greenspace factors). However, further research including assessing the quality of a larger number of greenspace sites is needed to confirm this. This also suggests that larger greenspaces are more popular due to the higher level of quality related to facilities/amenities as these greenspaces were the highest scoring for this category. People tend to prefer greenspace where key facilities such as toilets are available (Arnberger et al., 2017). This also reinforces the idea that it is difficult to assess all types of greenspaces based on a single methodology given the different characteristics that influence people's expectations, and therefore a variety in user perceptions (Gidlow et al., 2012).

Respondents expressed that proximity of greenspace to places of significance to them was important and allows them to walk instead of

using other modes of transport. Closer proximity to greenspace has been documented to result in more frequent greenspace visits (Van Herzele & Wiedemann, 2003) and greenspace use has been shown to decrease significantly beyond a 100–300 m distance (Nielsen & Hansen, 2007). However, there is a possibility that, despite respondents considering proximity to greenspace as the most important reason, other underlying factors also influence users' decision making. Ekkel and de Vries (2017) suggested that, despite proximity to greenspace being an important determinant of greenspace visit behaviour, visits to greenspaces at further distances are influenced by unique recreational opportunities. This is supported by our findings as respondents value a variety of facilities/amenities and a large proportion suggest that these could be improved.

Our study also suggests that the maximum time (average 23 minutes) respondents are willing to walk to a greenspace site is longer than previously reported walking guidelines (e.g., 10–15 minutes (Kovacs-Györi et al., 2018) or 5 minutes (Wright Wendel et al., 2012)). Given that the most popular activities undertaken in greenspace are individual exercise (predominantly walking) and dog walking and the majority of respondents walk to greenspace sites, it is possible that the respondents view the travel to the greenspace site as an extension of the activity they undertake when visiting a greenspace. Our finding that individual exercise is the most popular activity corroborates with previous studies (Gidlow et al., 2012).

Quietness/peacefulness, aesthetics, and naturalness were identified in the quality indicators as potential aspects to improve (Table 4). This is not surprising given that greenspace mitigates the effects of urban noise on health (Cohen et al., 2014). The favourite aspect of greenspace identified by the respondents is related to nature, which is consistent with previous studies (Schroeder, 1982; Ward et al., 2023) and supports the idea that greenspace is valued by urban residents as an outlet for withdrawing from the stressors of the urban area and spending time in nature (Schroeder, 1982). This aspect was recently assessed by Ward et al. (2023) who identified that respondents recognise the contrast between noise (or lack of noise) in greenspace sites compared to other areas of the city.

Another aspect identified in the questionnaire, but less prominent in the quality indicators, was related to concerns of safety. Respondents highlighted concerns related to the behaviour of other users and the control of dogs, whereas for the quality indicators, safety had a relatively high average score (68.44). Dogs off the lead have been shown as a threat to public safety, causing issues such as injury and disease (Rahim et al., 2018). Improvements to safety regarding dogs could be achieved by implementing features such as signage reminding people of rules related to dogs or off-lead areas (Cutt et al., 2007). The quality indicators confirmed that these features are often missing in greenspace sites. However, interventions should be carefully planned to not discourage dog owners from visiting greenspace as dog ownership increases the frequency of undertaking exercise (Schipperijn et al., 2010). There are several reasons for the differences in respondents' perceptions of greenspace safety and safety assessed through our quality indicators. Firstly, the indicators were only assessed in the daytime and greenspace is often perceived as more unsafe at night (Ugolini et al., 2022; Wright Wendel et al., 2012). Secondly, it is likely that residents have better knowledge of their local greenspace and are therefore more likely to identify issues. This pattern is also suggested by Ugolini et al. (2022), who found that professional opinion of greenspace can vary from the public's perception. Finally, it is possible that respondents have different perceptions and demands of greenspace to meet their needs or may consider different indicators of safety that are not reflected in the quality indicators used in our study and may differ between demographic and socioeconomic groups. This is illustrated by the fact that women were more likely to report feeling unsafe when in and/or traveling to a greenspace site, which agrees with previous studies (Sanesi & Chiarello, 2006). Our results also highlighted specific demands and perceptions of certain groups such as the availability of halal food and accessible

toilets, which is a common theme in the literature (Chen et al., 2022; Seeland & Nicolè, 2006). These findings support the importance of consulting the public in the creation process/analysis of quality indicators (Gidlow et al., 2012; Stessens et al., 2017).

4.2. Accessibility and provision

None of the AGS criteria were achieved at a city-wide level. Among all criteria, the Wider Neighbourhood Greenspace performed best, with only 2.35 % of the city's population living beyond 2 km of a 20 ha accessible greenspace site. In contrast, the Sub-regional Natural Greenspace criterion obtained the worst result as there are no sites of at least 500 ha within the city boundary (Fig. 5). Only one site within the city boundary - Allestree Park - is over 100 ha, and therefore the city performed poorly in the District Natural Greenspace criterion. As this greenspace is in the north of Derby, this reveals the disparity between the northern and southern areas in meeting this standard. Expanding the study area beyond the city boundary may allow the city to reach these criteria especially since there is a greenspace of approximately 130 ha in size at the southeast edge of the city (Derbyshire County Council, 2023) which was only partially included. Despite the fact that only around half of the city's population live within the two most local AGS criteria (Doorstep - 52.8 % and Local Natural - 52.9 %), the majority of respondents felt that there are adequate amounts of greenspace in their neighbourhood. This suggests that objectively assessed greenspace availability may differ from the respondents' perceived greenspace availability, although further investigation of this would be needed to explore reasons for variations in perceived greenspace availability. Comber et al. (2008) found that there is no greenspace of at least 500 ha in Leicester, East Midlands, using the ANGSt, and, of the criteria that can be compared between the former ANGSt recommendations and the AGS criteria used here, Derby has a higher proportion of the population living within 300 m of a greenspace of at least 2 ha as well as within 2 km of a site of at least 20 ha. This suggests that Derby has a higher level of greenspace provision compared to other local cities.

However, there are some limitations in our approach. Although using buffering is an efficient method of assessing greenspace availability, it does not consider certain factors such as physical barriers or user behaviour that may limit the accessibility of greenspace (So, 2016). In addition, the use of centroids of OAs in estimating human population relies on the assumption that the majority of the population of each OA is located in the centre. This means that the figures provided for the population estimates may be overestimates or underestimates. Despite this, it is important to highlight the importance of adequate provision of greenspace in the city, especially since walkability and proximity were shown to be important factors to visit greenspace.

5. Conclusions and future directions

This study gathered an in-depth overview of the experience of greenspace within an urban area using a mixed-method approach that included questionnaires, in-situ assessments and GIS analysis, which allowed us to explore key themes of greenspace availability, accessibility, and quality, as well as perceptions and usage of greenspace. Firstly, usage of greenspace was shown to vary among socioeconomic and demographic groups. For example, younger people and students are less likely to visit greenspace regularly. In addition, women are more likely to feel unsafe when travelling to or in a greenspace. We also found a moderately high level of greenspace quality in the city, with larger greenspace sites showing higher levels of quality. Aspects of greenspace indicative of lower quality were low levels of quietness and peacefulness, safety concerns, and low aesthetic quality. Finally, the spatial distribution of accessible greenspace sites is inadequate regarding the Natural England's AGS as none of the criteria included in these standards are met at a city-wide scale. This can be explained by the lack of large greenspaces which could attract visitors from a larger catchment

area and a spatially unequal distribution of accessible sites. Despite this, Derby shows a more adequate level of greenspace provision in comparison to a local city, Leicester (Comber et al., 2008).

Using a mixed-method approach, we were able to identify some similarities and differences between greenspace characteristics through quantitative methods (in-situ assessments and GIS analysis) and perceptions of greenspace through questionnaires. For example, most respondents mentioned in the questionnaire that there is enough greenspace in their neighbourhood, despite only around 50 % of residents living within the two most local AGS criteria. This supports the importance of integrating different methods when assessing perceived and objective proximity to greenspace. However, a limitation of our approach is that it did not explore one particular aspect in-depth (e.g., focusing solely on greenspace accessibility or perceptions). This could be explored in more detail by comparing objective indicators and perceptions of different aspects of greenspace quality (e.g., safety, accessibility). Quality assessments of a higher number of greenspace sites could also be useful to obtain a more accurate quality assessment at a city-wide scale and to make comparisons between quality assessed through different methods. In addition, due to the limitations in using buffering as a method of assessing the AGS, a more in-depth assessment of AGS criteria in the city is recommended by considering physical and mental barriers that may influence the ability of the residents to access their closest accessible greenspace. Considering factors that may limit the benefits of greenspace when assessing availability avoids overestimates of how much greenspace is available (Yao et al., 2014). Importantly, our findings confirmed the importance of considering certain aspects in future research:

- Tailoring indicators to specific types of greenspaces e.g., neighbourhood greenspace and regional greenspace to more accurately quantify quality (Gidlow et al., 2012).
- Including less biased demographic and socioeconomic groups in decision making when assessing quality to better distinguish between perceived and objective quality.

CRediT authorship contribution statement

Joana Silva Carvalho: Writing – review & editing, Validation, Supervision, Resources, Methodology, Investigation. **Charlotte Creed:** Writing – review & editing, Writing – original draft, Methodology, Investigation, Formal analysis, Data curation, Conceptualization.

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.

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Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at [doi:10.1016/j.ufug.2024.128470](https://doi.org/10.1016/j.ufug.2024.128470).

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