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Wellbeing, Space and Society 6 (2024) 100203

Contents lists available at ScienceDirect

Wellbeing, Space and Society

journal homepage: www.sciencedirect.com/journal/wellbeing-space-and-society

Development and testing of the Perceived Wellbeing in Outdoor Shared Spaces (PWOSS) scale

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ARTICLE INFO

Keywords:
Wellbeing
Green space
Blue space
Nature
Scale development

ABSTRACT

Accessible and high quality shared outdoor open spaces, both built and natural, can be particularly beneficial for health and wellbeing. The design and quality of shared outdoor spaces are often modifiable and the health and wellbeing-promoting potential of such spaces can, therefore, be enhanced. However, optimal modification of shared outdoor spaces requires a greater understanding of perceptions and experiences. Citizen Science projects can be particularly valuable for capturing experiences of wellbeing in different environments and shared outdoor spaces, although suitable validated scales are lacking. This paper aims to develop and conduct psychometric testing on the Perceived Wellbeing in Shared Outdoor Spaces (PWOSS) Scale. The study involves three key phases of scale development and evaluation: (i) identifying suitable domains and generating initial items for the PWOSS Scale; (ii) pre-testing the PWOSS Scale and conducting item reduction analysis and factor extraction to refine the scale items using a sample of potential users from Edinburgh, Scotland ($n = 137$); and (iii) evaluating the PWOSS Scale by testing for dimensionality, reliability and validity. The final PWOSS Scale consisted of nine-items. The factor analysis indicated a two-factor solution (positive and negative wellbeing. The results of the three phases suggest the PWOSS Scale is a valid and reliable scale that can aid our understanding of the link between wellbeing and shared outdoor spaces and environments. The PWOSS Scale offers significant value to Citizen Science projects and to urban planning and public health practitioners interested in modifying and adapting shared outdoor spaces to increase wellbeing.

1. Introduction

Built and natural environments can positively and negatively impact human health and wellbeing (Duncan and Kawachi, 2018). Access to high quality shared outdoor spaces has been associated with a range of positive health outcomes (Francis et al., 2012). Accessible shared outdoor spaces are vital for encouraging physical activity across all age groups, which can lead to improved mental health and reduced risk of non-communicable diseases (NCDs) such as obesity, CVD, diabetes, stroke, hypertension and certain cancers (Mitchell, 2013; Papas et al., 2007; Lee et al., 2012). The provision of accessible and high quality outdoor shared spaces, therefore, provides an opportunity to promote and improve public health in urban areas (Villanueva et al., 2015).

In the last decade, the health-promoting potential of spending time in and around natural environments, such as green (e.g., parks and woodlands) and blue (e.g., lakes, rivers and seas) spaces has gained increasing recognition in policy and research (Gascon et al., 2017; Tester-Jones et al., 2020; Frumkin et al., 2017). Spending time in and around natural environments has been associated with improved mental wellbeing outcomes (White et al., 2021; McDougall et al., 2022). Furthermore, a meta-analysis of studies comparing natural and synthetic environment usage suggests exposure to natural environments is associated with benefits for mental health, including reduced sadness, anxiety and anger (Bowler et al., 2010). Consequently, the provision of accessible urban green and blue space is becoming an increasingly important consideration in urban planning and public health policies across the globe (Rutt and Gulsrud, 2016).

Although the provision of high quality built and natural outdoor spaces can provide public health benefits, a number of challenges exist in attaining such benefits for the population as a whole. Perceptions of shared outdoor spaces can vary substantially between individuals, depending on experience or knowledge of a particular place or

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https://doi.org/10.1016/j.wss.2024.100203
Received 27 February 2024; Received in revised form 3 May 2024; Accepted 15 May 2024
Available online 25 May 2024

environment (Phoenix et al., 2021). Furthermore, perceptions can be further impacted by personality, socio-demographics and situational and environmental factors (Birenboim, 2018) and differences in perceptions often lead to inequalities in access and usage (Phoenix et al., 2021). Such inequalities can lead to the underutilisation of outdoor shared spaces as health and wellbeing-promoting assets, which in turn may widen any pre-existing health inequalities.

The design and quality of shared outdoor spaces are often modifiable and the health and wellbeing-promoting potential of such spaces can, therefore, be enhanced. However, optimal modification of shared outdoor spaces requires a greater understanding of perceptions and experiences, particularly for historically disenfranchised citizens and in economically and socially deprived communities, who are often overlooked in urban planning processes (Kahila-Tani et al., 2019). Citizen engagement and a whole-of-society approach is increasingly acknowledged as necessary for tackling public health problems with increasing global recognition of the importance of a transparent political system that enables citizen involvement (Yang et al., 2018).

Citizen science, which we define as the collection and analysis of data by members of the general public, offers potential to collect real-time data and increase citizen involvement in public health and environmental and urban planning. However, the potential of citizen science as a means of engaging the public and collecting data at a national level has so far been underutilised in public health and social science research, particularly in relation to increasing societal wellbeing (Barrie et al., 2019). This is despite wellbeing becoming increasingly recognised as an important indicator of societal performance in many countries (Das et al., 2020). Crucially, citizen science approaches can be highly effective for engaging different socioeconomic and demographic groups in urban planning processes and research (Rydenstam et al., 2020).

Taking a citizen science approach to gather data on health and wellbeing related perceptions of outdoor shared spaces could have huge implications for utilising these environments to promote wellbeing and address society-wide public health problems. However, care needs to be taken when selecting suitable data collection measures / scales to ensure they are robust, replicable and practical. Indeed, there remains significant debate on how best to measure wellbeing (Diener et al., 2018; VanderWeele et al., 2020) and how best to assess the suitability of different places and environments in promoting wellbeing. The wellbeing promoting potential of different environments can be determined by collecting wellbeing data ex-situ via validated measurement tools and combine wellbeing scores with place-related behaviours (e.g., visiting green and blue spaces) (e.g., McDougall et al., 2022; White et al., 2021) or objectively and subjectively measured attributes of place e.g. perceptions of housing and neighbourhood environments (Bond et al., 2012). However, such approaches often require complex statistical analysis and are, therefore, unsuitable for citizen science projects.

Measuring wellbeing in-situ can be particularly useful for capturing contextual effects and fluctuations in wellbeing (Beute and Kort, 2018) and to reduce biases associated with recalled accounts of wellbeing (Su et al., 2022). A number of studies have utilised smart-phone applications to quantify momentary wellbeing (happiness) and used geo-location technology to link wellbeing values with different outdoor environments (De Vries et al., 2021; MacKerron and Mourato, 2013). However, these approaches tend to focus on broad land-use classifications, rather than specific places and, therefore, have limited value in local contexts. Furthermore, a range of scales exist which measure elements of wellbeing related to place, such as the Restorative Outcome Scale (ROS; Korpela et al., 2008) or the Wellbeing in Place Perceptions Scale (WIPPS; Pennington et al., 2021), which are used to quantify restoration and perceptions of wellbeing in different settings, respectively. Other scales focus on the connection between wellbeing and certain attributes of outdoor spaces, including the presence of biodiversity (Irvine et al., 2023).

The PWOSS Scale, which is outlined in this paper, measures perceptions of wellbeing in shared outdoor spaces. It allows perceptions of wellbeing in any outdoor shared space to be quantified, the characterisation of different shared outdoor spaces in relation to their wellbeing promoting potential, as well as monitoring changes in these values over time (for example if adaptations have been made to the space). The PWOSS Scale was developed to be used as part of the Our Outdoors Citizen Science project (www.spotteron.com/ouroutdoors/info). Our Outdoors aims to engage citizens and policymakers to characterise and, where necessary, suggest improvements to the outdoor shared spaces in their local area via a dedicated smartphone application. Although, the PWOSS Scale was designed to be used as part of Our Outdoors smartphone application, it can be used as a standalone measure. Despite an availability of broadly relevant methodologies and scales, it was deemed appropriate to develop a new scale for the Our Outdoors project as existing scales tend to focus specifically on certain elements of wellbeing, certain environmental attributes, do not consider both positive and negative perceptions of wellbeing related to outdoor shared spaces and are often unsuitable for citizen science projects due to their length and complexity.

This paper outlines the development and psychometric testing of the Perceived Wellbeing in Shared Outdoor Spaces (PWOSS). The specific objectives are (i) to identify suitable domains and generate initial items for the PWOSS Scale; (ii) to pre-test the PWOSS Scale and conduct item reduction analysis and factor extraction to refine the scale items; and (iii) evaluate the PWOSS Scale by testing for dimensionality, reliability and validity.

2. Methodology

2.1. Overview

The PWOSS Scale was developed in accordance with best practice for developing and validating scales for health, social and behavioural research (Boateng et al., 2018; Streiner et al., 2015) and the principles of citizen science (Robinson et al., 2018). The following phases were followed to develop and validate the PWOSS Scale; (i) item development; (ii) scale development; and (iii) scale evaluation. The study protocol was approved by the Usher Research Ethics Committee at the University of Edinburgh, 2015.

2.2. Phase 1: item development

Phase 1 aimed to identify suitable domains and generate initial items for the PWOSS Scale.

2.2.1. Identification of domains and item generation

Wellbeing is often conceptualised as a multi-dimensional construct (Linton et al., 2016). Therefore, a tripartite model was adopted as the basis for the PWOSS Scale, taking into account physical, mental and social domains in alignment previous research and the three domains outlined in the World Health Organisation (WHO) definition of health: 'Health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity' (WHO, 1946). Furthermore, it is widely recognised that spending time in outdoor environments can result in changes to physical, mental and social wellbeing (Kondo et al., 2018). It was not assumed that these domains contribute equally to wellbeing. In accordance with best practice, an initial item pool for each wellbeing domain was generated by combining deductive and inductive methods (Boateng et al., 2018). Deductive methods involved consulting literature of existing wellbeing measures (e.g., Linton et al., 2016) and existing wellbeing scales to (i) identify themes often assessed within each of the three domains; (ii) examine the specific item content of existing health and wellbeing measures; and (iii) establish which specific aspects of wellbeing are thought to be influenced by outdoor environments. Items were then selected to reflect aspects of wellbeing that are expected to be influenced by outdoor environments.

Deductive methods involved a series of participatory workshops ($n = 3$). Participatory approaches have been shown encourage a range of socioeconomic and demographic groups to engage in research (Rydenstam et al., 2020). The participatory workshops involved 36 Edinburgh community members from a range of different socioeconomic and demographic backgrounds to represent potential users of the PWOSS Scale. Participants were recruited via established partnerships between The University of Edinburgh and community organisations. Each workshop sought to establish what elements of outdoor spaces aligned with positive and negative wellbeing impacts. Participants were given opportunities to describe a range of feelings in relation to their local environments using participatory approaches. The participatory approaches included a *Graffiti Board* where participants were encouraged to draw pictures and write text outlining the emotions, thoughts and feelings they experienced in different environments. Responses were then clustered into key themes by the research team. The findings aligned closely with the findings that were yielded from the literature and the triangulation of these findings was used to construct a long-list version of the PWOSS Scale.

2.2.2. Content validity

Content validity checks were conducted to ensure items appropriately measured the three domains of interest (Streiner et al., 2015). The appropriateness of an initial list of items within each domain (physical, mental and social wellbeing) was firstly evaluated by five experts in public health and wellbeing (independent from the authorship team) from the Scottish Collaboration for Public Health Research and Policy (SCPHRP). Each item was assessed for suitability based on whether the item could theoretically connect outdoor space to wellbeing. Unsuitable items, which were not agreed by a majority of experts (3/5) were removed (Cai et al., 2017). Item inclusion was also discussed with the potential users during the participatory workshops. The content validity check ensured each domain and the associated items were refined to ensure consistent interpretation, minimise ambiguity and remove any items that were deemed to be irrelevant.

2.3. Phase 2: scale development

Phase 2 aimed to pre-test the PWOSS Scale and conduct item reduction analysis and factor extraction (Boateng et al., 2018). All statistical analysis was conducted in Stata v17.0.

2.3.1. Pre-testing and survey administration

Pre-testing was conducted among the target population to refine the scale items (Carpenter, 2018). Surveys including the PWOSS Scale were conducted over three days in 2018/19 in three outdoor shared spaces in Edinburgh, Scotland via the Our Outdoors smartphone application. Additional perceptions of outdoor spaces, which have been associated with impacts on perceptions of place quality and wellbeing, including crime, litter, pleasantness and access. The survey concluded with socioeconomic and demographic questions including age, ethnicity, sex and socioeconomic status which was collected via the Scottish Index of Multiple Deprivation (SIMD) zone associated with a participant's postcode. Approximately ten respondents per scale item were surveyed in accordance with best practice (Boateng et al., 2018). The three study sites represented a variety of different outdoor shared spaces and are described below. Members of the public were approached by researchers at each study site and were asked to complete the PWOSS Scale while spending time in the surrounding outdoor spaces. All members of the public (over the age of 18) were eligible and participants included individuals commuting through each study site, cyclists, dog walkers, families, local residents and those generally passing through the area. This broad criterion was adopted to represent the broad target population of the PWOSS Scale (Streiner et al., 2015). Participants were able to complete paper or smartphone-based versions of the survey and PWOSS Scale.

The first study site was located within a socioeconomically diverse area of North Edinburgh. Data was collected from participant's travelling through a section of waterfront, which falls within 20 % of the most socioeconomically deprived areas in Scotland, towards an area that is ranked as one of the least deprived areas. The waterfront site includes sections of pedestrian footpaths and some sections were also used as a cycleway. The second study site focussed on a section of the North Edinburgh Cycleway. The area falls within 20–30 % of the most socioeconomically deprived areas in Scotland. A number of the cycleway routes run through a park, which was used as the base to collect data for pre-testing. The third study site included the Meadows green space and a range of green spaces on the University of Edinburgh campus. The Meadows is one of the most popular greenspaces in the city and is frequently used by members of the public, residents, local school and university students for commuting and leisure. Cycleways provide access to wider areas of the city and links to other cycle paths. The study site also contained a nearby gated green space area (George Square) and an open plan grey space area (Bristo Square). Although the additional spaces are located within the University of Edinburgh campus, they are open to members of the public and are regularly used by students, staff and the public for leisure and pedestrian travel.

2.3.2. Item reduction and extraction of factors

Descriptive statistical approaches including cross-tabulation and tests for normality were conducted on the PWOSS Scale data. Correlation coefficients between wellbeing items were assessed to identify items to remove or retain to improve the performance and parsimoniousness of the PWOSS Scale. Items with particularly low (<0.30) or high (>0.80) correlation coefficients were removed (Boateng et al., 2018). The correlation matrix of wellbeing items, along with Bartlett's test of sphericity, and Kaiser-Meyer-Olkin (KMO) were used to establish whether factor analysis could be applied to the data. To evaluate the presence of a latent structure exploratory factor analysis was conducted using Principal Axis Factoring and Varimax rotation and scree plots were generated. The optimal number of factors was established by reviewing eigenvalues, with <1.0 adopted as the eigenvalue threshold (Choukas-Bradley et al., 2020).

2.4. Phase 3: scale evaluation

Phase 3 aimed to evaluate the PWOSS Scale by testing for dimensionality, reliability and validity (Boateng et al., 2018).

2.4.1. Dimensionality, reliability and validity

Confirmatory factor analysis was conducted to verify the factor structure which emerged from the exploratory factor analysis. A threshold of factor loadings of <0.3 was selected to remove poorly performing items (Boateng et al., 2018). This analysis was also used to assess potential score weightings in the PWOSS Scale. Testing reliability of the PWOSS Scale was challenging as identical conditions of outdoor spaces and wellbeing are almost impossible to replicate. Cronbach's Alpha was calculated to assess the internal consistency of the PWOSS Scale.

2.4.2. Validity

Content validity checks were conducted to ensure items appropriately measured the three domains of interest (physical, mental and social wellbeing), as outlined in Section 2.2.2. Internal validity was calculated via Cronbach's Alpha and exceeded the commonly accepted threshold of 0.7 was adopted (Taber, 2018). We were unable to conduct concurrent validity testing of the PWOSS Scale as similar instruments do not exist for comparison.

3. Results

3.1. Phase 1: item development

Based on the literature review of wellbeing and outdoor spaces and community workshops an initial long-list of 17 items, covering three domains of wellbeing (mental, social and physical) was generated for the PWOSS Scale. Table 1 provides a summary of the 17-item long list and the status of each item. The community drop-in event suggested a range of emotions and perceptions of wellbeing that participants experienced in outdoor spaces they enjoyed and outdoor spaces they did not enjoy spending time in. Common perceptions of positive wellbeing outdoors spaces included feelings of relaxation, calmness, reflection, inspiration, stimulation, excitement, connectedness and belonging. Common perceptions of negative wellbeing in outdoor spaces included anger, frustration, discomfort, loneliness, fear and stress.

Six items were to be removed from the PWOSS Scale based on feedback during community workshops and content validation by experts, leaving 11 items to be assessed and retained for phase two. Item 17 (*There are opportunities here for me to be active if I want*) was removed as both experts and participants perceived the question to focus on attributes of an outdoor shared space rather than feelings of wellbeing within that space. Furthermore, a range of appropriate tools already exist to measure self-reported or objective physical activity in outdoor spaces (Strain et al., 2020). Two items were also removed from the social domain. Items 13 (*I am interested in my surroundings here*) and 14 (*There are opportunities to socialise with people if I want*) were also removed due to a focus on attributes of a place, rather than measuring an individual's feelings of wellbeing within that place. Three items (3, 8 and 10) were removed from the mental domain. Evaluation from potential users during community workshops suggested items 3 (*I feel energised here*) and 10 (*I feel alert here*) were challenging to understand. Item 8 (*I feel peaceful here*) was removed as community workshops suggested item 8 overlapped significantly with items 2 and 4, causing confusion among participants.

3.2. Scale development

A total of 137 completed surveys were collected for analysis from Study Site 1 ($n = 35$), Study Site 2 ($n = 41$), Study Site 3 ($n = 35$) and in other/unknown locations ($n = 26$). This sample size aligned with recommendations of at least ten responses per survey item. Descriptive statistics for the sample and each item are included in Tables 2 and 3. Item 1 (*I feel happy here*) received the highest score of the items considered in the analysis (4.23 SD: 1.58).

A correlation matrix of all items in Phase 2 is presented in Table 4. The correlation matrix suggests generally acceptable correlations between items with the exception of high correlations (>0.8) between Item 1 (*I feel happy here*) and item 2 (*I feel relaxed here*) and between item 6 (I feel anxious here) and item 7 (*I feel stressed here*). Consequently, items 2 and 7 were removed from the PWOSS Scale. No items exhibited significant correlations ($p < 0.01$) less than 0.3 and no further items required removal from the scale.

The next stage of phase two involved exploratory factor analysis on the remaining nine items of the PWOSS Scale. The correlation matrix of wellbeing items, along with Bartlett's test of sphericity, and Kaiser-Meyer-Olkin (KMO) were used to establish whether factor analysis could be applied to the data. Table 6 illustrates the presence of multiple bivariate correlations greater than 0.3 and in conjunction with Bartlett's Test of Sphericity $p < 0.001$ and a KMO value of 0.841 (greater than the generally accepted threshold of 0.6) support suitability for an exploratory factor analysis.

The results of an exploratory factor analysis (Rotation: Varimax with Kaiser Normalization) are displayed in Table 5 and associated scree plot in Fig. 1. The scree plot and eigenvalues obtained from the exploratory factor analysis indicates a two-factor solution as only two factors have greater eigenvalues than the 1.0 threshold. Factor 1 was responsible for 38 % of variance and Factor 2 was responsible for 30 % of variance. On review of factor loadings, Factor 1 was predominantly items which indicated feelings of positive wellbeing in an outdoor space (e.g., happiness, calmness and feelings of belonging, safety and activeness).

Table 1
Initial PWOSS Scale item long-list.

Item	Domain	Items	Status
1	Mental	I feel happy here	Retained
2	Mental	I feel relaxed here	Removed (Phase 2)
3	Mental	I feel energised here	Removed (Phase 1)
4	Mental	I feel calm here	Retained
5	Mental	I feel frustrated here	Retained
6	Mental	I feel anxious here	Retained
7	Mental	I feel stressed here	Removed (Phase 2)
8	Mental	I feel peaceful here	Removed (Phase 1)
9	Mental	I feel uneasy here	Retained
10	Mental	I feel alert here	Removed (Phase 1)
11	Social	I feel I belong here	Retained
12	Social	I feel safe here	Retained
13	Social	I am interested in my surroundings here	Removed (Phase 1)
14	Social	There are opportunities to socialise here	Removed (Phase 1)
15	Social	I feel lonely here	Retained
16	Physical	I feel like being active or exercising here	Retained
17	Physical	There are opportunities here for me to be active	Removed (Phase 1)

Table 2
Sample demographic statistics.

Variable	% / mean ($n = 137$)	SD
Sex		
Male (%)	39.1	
Female (%)	59.8	
Prefer not to say (%)	1.1	
Age	42.3	16.6
<20 (%)	1.7	
21 - 30 (%)	30.4	
31 - 40 (%)	20.9	
41 - 50 (%)	12.2	
51 - 60 (%)	13.0	
61 - 71 (%)	15.8	
>71 (%)	6.1	
SIMD (quintile)	3.9	1.4
1 (%)	8.8	
2 (%)	22.0	
3 (%)	9.9	
4 (%)	9.9	
5 (%)	49.5	
Ethnicity		
Other Asian background (%)	0.9	
Other White background (%)	18.4	
Mixed ethnic background (%)	3.5	
British (%)	9.7	
Chinese (%)	4.4	
English (%)	7.9	
Indian (%)	1.8	
Irish (%)	3.5	
Northern Irish (%)	1.8	
Prefer not to say (%)	0.9	
Scottish (%)	45.6	
Welsh (%)	0.9	
White and black African (%)	0.9	

Table 3
Summary of PWOSS Scale item responses.

Item	n	Mean	SD
I feel happy here	137	4.23	1.58
I feel relaxed here	137	4.09	1.23
I feel calm here	137	3.98	1.28
I feel frustrated here	137	1.61	1.11
I feel anxious here	137	1.53	0.97
I feel stressed here	137	1.51	1.02
I feel uneasy here	137	1.60	1.03
I feel I belong here	137	3.60	1.23
I feel safe here	137	3.85	1.23
I feel lonely here	137	1.71	0.99
I feel like being active or exercising here	137	3.91	1.16

Factor 2 was predominantly items which indicated negative feelings of wellbeing in an outdoor space e.g. (anxiety, frustration and feelings of unease and loneliness). Sufficient factor loadings >0.3 meant no further items were removed from the PWOSS Scale.

3.3. Phase 3: scale evaluation

Confirmatory factor analysis was conducted to test the two-factor solution proposed. The results of the goodness-of-fit of the confirmatory factor model are displayed in Table 6. Goodness-of-fit indicated appropriate dimensionality based on the Root Mean Squared Error of Approximation, Tucker-Lewis Index, Comparative Fit Index and Standardised Root Mean Square Residual. Given the broad similarities of loading factors, weighting scale items was not considered necessary. The PWOSS Scale can be regarded as sufficiently reliable given the testing conducted. Internal validity was calculated via Cronbach's Alpha and generated an alpha value of 0.7629 which exceeded the commonly accepted threshold of 0.7 (Taber, 2018). We were unable to conduct concurrent validity testing of the PWOSS Scale as similar instruments do not exist for comparison.

3.4. Final PWOSS scale

The final PWOSS Scale consisted of nine items and is outlined in Table 7. The PWOSS Scale is now included within the Our Outdoors smartphone application. Our Outdoors participants are given an option to upload a photograph of an outdoor shared the space via the Our Outdoors smartphone application. Respondents are then presented with the final nine-item PWOSS Scale and asked: *How do you feel in the space right now?* Responses for each statement are presented on a 5-point Likert scale (1 = not at all, 5 = extremely). Negative items are reversed scored, and final nine-item PWOSS Scale has a maximum score of 45 and a minimum score of 9.

4. Discussion

This study aimed to provide an overview of the development of the PWOSS Scale and conduct initial pilot testing of the scale to evaluate its psychometric properties. The PWOSS Scale was developed and evaluated in alignment with recommendations of best practice across three key phases; (i) item selection; (ii) scale development and; (iii) scale evaluation (Boateng et al., 2018). The development and evaluation process resulted in a nine-item scale from an initial 17 item long-list, which was established from both inductive (literature review) and deductive (community workshops and drop-in events) item generation approaches. Six items were removed from the PWOSS Scale in Phase 1 due to items focusing on attributes of an outdoor shared space opposed to a perception of wellbeing ($n = 3$), being challenging for potential users to understand ($n = 2$) and due to theoretical overlap with another item ($n = 1$). A further two items were removed from the PWOSS Scale in Phase 2 due to highly positive correlations between items. No items were removed during factor analysis and a two-factor solution, which was defined as positive and negative wellbeing, was identified.

The PWOSS Scale offers a number of key strengths. Firstly, the scale is reinforced by theoretical foundations and conceptualises wellbeing as a multi-dimensional construct and includes domains of physical, social and mental wellbeing (Linton et al., 2016). These domains are not

Table 5
Summary of factor loading (two-factor solution).

Variable	Factor 1 positive wellbeing	Factor 2 negative wellbeing	Uniqueness
happy	**0.894**	0.048	0.199
safe	**0.855**	−0.166	0.241
calm	**0.845**	−0.017	0.285
belong	**0.819**	0.020	0.329
active	**0.707**	0.115	0.488
anxious	−0.058	**0.906**	0.176
frustrated	−0.050	**0.859**	0.260
uneasy	0.038	**0.847**	0.281
lonely	0.066	**0.607**	0.628

Table 4
Correlation matrix of PWOSS Scale items.

variable	happy	relaxed	calm	frustrated	anxious	stressed	lonely	uneasy	belong	safe	active
happy	1.000										
relaxed	**0.809**	1.000									
	0.000										
calm	**0.753**	**0.752**	1.000								
	0.000	0.000									
frustrated	−0.004	−0.088	−0.035	1.000							
	0.967	0.306	0.683								
anxious	−0.007	−0.112	−0.076	**0.742**	1.000						
	0.937	0.192	0.377	0.000							
stressed	0.017	−0.112	−0.062	**0.766**	**0.864**	1.000					
	0.848	0.191	0.470	0.000	0.000						
lonely	0.147	0.140	0.049	**0.325**	**0.450**	**0.347**	1.000				
	0.087	0.104	0.573	0.000	0.000	0.000					
uneasy	0.022	−0.007	0.023	**0.645**	**0.691**	**0.678**	**0.368**	1.000			
	0.797	0.932	0.785	0.000	0.000	0.000	0.000				
belong	**0.647**	**0.608**	**0.547**	−0.032	0.017	−0.008	−0.014	0.062	1.000		
	0.000	0.000	0.000	0.713	0.844	0.924	0.870	0.472			
safe	**0.703**	**0.685**	**0.680**	−0.166	**−0.185**	−0.163	−0.052	−0.069	**0.672**	1.000	
	0.000	0.000	0.000	0.053	0.031	0.057	0.548	0.425	0.000		
active	**0.550**	**0.497**	**0.480**	0.063	0.028	0.064	0.069	0.106	**0.521**	**0.446**	1.000
	0.000	0.000	0.000	0.466	0.745	0.458	0.424	0.216	0.000	0.000	

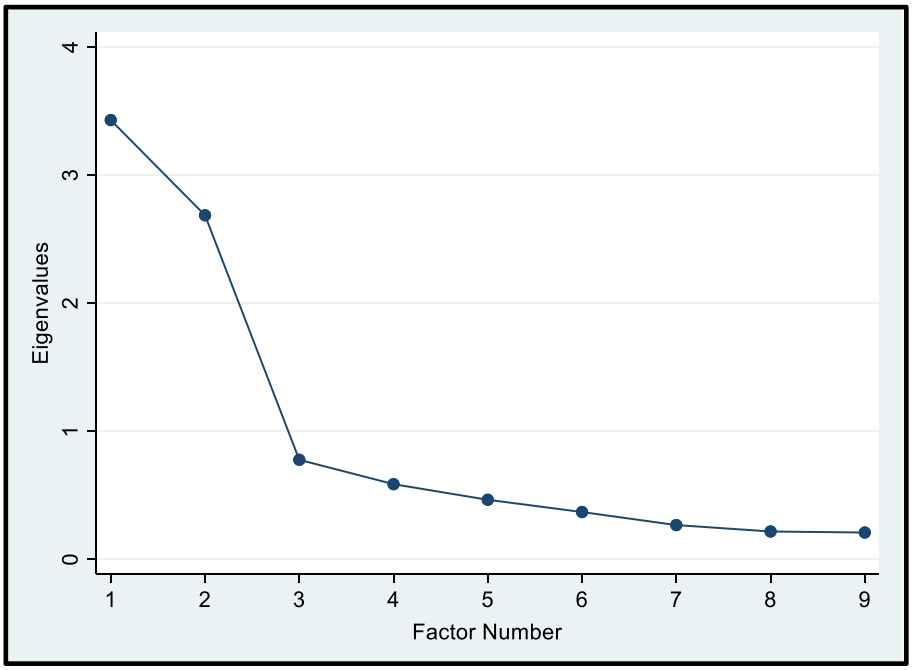

Fig. 1. Scree plot - exploratory factor analysis.

Table 6
Summary of fit statistics for PWOSS Scale evaluation.

Fit statistic	Value	Threshold	Citation
Root Mean Squared Error of Approximation	0.076	<0.1	Boateng et al., 2018
Tucker-Lewis Index	0.954	>0.95	
Comparative Fit Index	0.967	>0.95	
Standardised Root Mean Square Residual	0.058	<0.08	

Table 7
Final PWOSS Scale.

Item	Response option	Reverse scoring
I feel happy here	1 (not at all) - 5 (extremely)	No
I feel calm here	1 (not at all) - 5 (extremely)	No
I feel frustrated here	1 (not at all) - 5 (extremely)	Yes
I feel anxious here	1 (not at all) - 5 (extremely)	Yes
I feel uneasy here	1 (not at all) - 5 (extremely)	Yes
I feel I belong here	1 (not at all) - 5 (extremely)	No
I feel safe here	1 (not at all) - 5 (extremely)	No
I feel lonely here	1 (not at all) - 5 (extremely)	Yes
I feel like being active or exercising here	1 (not at all) - 5 (extremely)	No

equally represented in the PWOSS Scale as the items within the mental wellbeing domain represent a majority. The dominant mental wellbeing domain is somewhat expected given the focus on perceptions of wellbeing and close connections between wellbeing and positive mental health. Secondly, the PWOSS Scale considers both positive and negative perceptions of wellbeing in outdoor shared spaces. Previous research often focuses on positive perceptions of built and natural environments and focuses on identifying health and wellbeing benefits opposed to considering positive and negative wellbeing impacts. Thirdly, the PWOSS Scale was developed in consultation with potential users and communities (Boateng et al., 2018), which is particularly important given the scale is likely to be used primarily in citizen science projects. Inductive approaches for initial item selection involved a series of workshops with potential users and detailed pre-testing allowed for evaluation of the scale in alignment with best practice.

Despite several strengths in the initial development and evaluation, a number of limitations and associated opportunities for improved evaluation are apparent. Although the pre-testing sample was representative of the Scottish population in terms of socioeconomic status, age and gender, the vast majority of participants were of white ethnicity and all respondents were fluent English speakers. Further evaluation of the PWOSS Scale with a wide variety of ethnic populations, therefore, offers a valuable area for future research. This is particularly important given that perceptions of natural environments can differ substantially between demographic groups (Dlamini et al., 2021). Similarly, further testing in international settings with varying language, climate and culture related to outdoor shared spaces is a future priority. Another opportunity for further evaluation, and potentially development, of the scale relates to seasonality, weather and daylight. For logistical reasons, pre-testing was undertaken in daylight hours, during summer months on days with no rainfall. Ideally, sampling would include a variation of daylight, weather and seasonality as these factors can impact wellbeing in and perceptions of built and natural environments (White et al., 2020, 2010). However, the logistics of such sampling exceeded the resource and capacity of this study. Finally, validity and replicability evaluations of the PWOSS Scale where somewhat challenging as wellbeing often fluctuates due to a wide variety of individual and environmental factors and capturing or replicating exact conditions is not possible. Furthermore, there is an absence of suitable instruments for traditional validity checks. Despite some limitations, deviations from scale development and evaluation best practice are due to the complex and ever-changing nature of the phenomena being measured by the PWOSS Scale. Health scale development and evaluation is often inconsistent and lacks theoretical foundation (Boateng et al., 2018). However, the PWOSS Scale has been developed and evaluated in alignment with recommendations of best practice where possible.

The primary purpose of the PWOSS Scale is to provide an outcome measure of wellbeing in outdoor shared space for the Our Outdoors citizen science project and associated smartphone application. The Our Outdoors smartphone application collects a variety of data on specific visits to an outdoor shared space including activities undertaken, characteristics of the space and if the visit was completed alone or in a group.

The adoption of the PWOSS Scale alongside the Our Outdoors smartphone application offers opportunities to understand how different visit characteristics influence PWOSS Scale scores. Furthermore, by using the PWOSS Scale within a citizen science context there is potential to generate large datasets related to wellbeing and shared outdoor spaces which could be vital for policy making as urban planning and public health policymakers are increasingly utilising big data in policy and decision-making (Cappa et al., 2021; Hashem et al., 2016). Indeed, citizen science (which PWOSS has been specifically designed for) can help empower communities who use outdoor shared spaces to have a say on how they could be developed in the future (Ottaviano et al., 2019).

There are also a number of opportunities to utilise the PWOSS Scale beyond the Citizen Science context to assist in addressing key knowledge gaps in research and policy. Although there is a growing understanding of how different natural and built environments impact health and wellbeing (Gascon et al., 2017; Tester-Jones et al., 2020), several critical gaps in knowledge exist. These require increased research attention and the adoption of novel methodological approaches (Frumkin et al., 2017). Crucially, cross sectional studies often generalise observations of health impacts across large populations to determine if a space is health-promoting or health-reducing. Such approaches often fail to account for the views of minority communities and can be subject to intersectionality, where groups of marginalised socioeconomic and demographic status intersect and overlap, creating greater marginalisation (Triguero-Mas et al., 2021).

Similarly, health-promoting environments, such as green and blue spaces, are not always viewed positively and are not always health-promoting. Outdoor spaces may be unsuited to wellbeing promotion due to a lack of access and quality of the space itself or the socioeconomic (e.g., crime rate) and environmental (e.g., noise pollution) conditions surrounding the space (Pitt, 2018). Indeed, negative perceptions and experience or the historical context of a shared outdoor space can lead to variations in perceptions and wellbeing (Phoenix et al., 2021). Perceptions can be further impacted by personality, socio-demographics and situational and environmental factors (Birenboim, 2018). For example, sex has consistently been identified as a factor associated with perceptions of reduced safety in shared outdoor spaces, with females generally more likely to rate spaces as less safe than males (Arnberger et al., 2010; Polko and Kimic, 2022). By developing an improved understanding of the varied experiences of wellbeing in shared outdoor spaces, which can be achieved via the PWOSS Scale, opportunities arise for more inclusive research and policy. Furthermore, the PWOSS Scale can support improved wellbeing focused design and decision making by providing access to more diverse and often overlooked experiences of shared outdoor spaces. Such support is of critical importance as promoting wellbeing is becoming increasingly recognised as valuable public health strategy (Trudel-Fitzgerald et al., 2019).

5. Conclusion

Understanding perceptions of wellbeing in outdoor shared spaces can play an important role in understanding how best to improve, adapt and design urban environments to promote health and wellbeing. This study reports the development and evaluation of the Perceived Wellbeing in Outdoor Shares Spaces (PWOSS) Scale. The development and evaluation process followed best practice guidance and consisted of three key phases; (i) Item development; (ii) Scale development; and (iii) Scale evaluation. The evaluation conducted suggests the PWOSS Scale is a suitable and parsimonious measurement tool for assessing wellbeing in shared outdoor spaces. The data in this study indicates the PWOSS Scale performs well in internal and convergent validity testing. The PWOSS Scale is primarily intended for use alongside the Our Outdoors Citizen Science smartphone application. However, wider usage offers opportunities to represent a wide variety of perspectives in urban planning decisions and improve the wellbeing-promoting potential and inclusivity of outdoor shared spaces.

Ethics statement

The study protocol was approved by the Usher Research Ethics Committee at the University of Edinburgh - 2015.

CRediT authorship contribution statement

Craig W. McDougall: Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Methodology, Investigation, Data curation, Conceptualization. **Stephen Malden:** Writing – review & editing, Validation, Supervision, Formal analysis, Data curation, Conceptualization. **Kathleen Morrison:** Writing – review & editing, Methodology, Formal analysis, Data curation, Conceptualization. **Sammy Mason:** Writing – review & editing, Investigation. **Andrew J. Williams:** Writing – review & editing, Validation, Supervision, Conceptualization. **Ruth Jepson:** Writing – review & editing, Validation, Supervision, Resources, Project administration, Methodology, Funding acquisition, 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.

Acknowledgements

Work on the study was undertaken when the Scottish Collaboration for Public Health Research and Policy was funded by the Medical Research Council (MR/KO 023209/1) and the Chief Scientist Office (CSO). The CSO funded part of the work through The 'Our Outdoors' Citizen Science Project: Further Development Of An App Based Platform And Citizen Science Approaches To Data Collection (CGA/19/51) 2019–2020. This work was also supported by the UK Prevention Research Partnership (MR/V049704/1), which is funded by the British Heart Foundation, Cancer Research UK, Chief Scientist Office of the Scottish Government Health and Social Care Directorates, Engineering and Physical Sciences Research Council, Economic and Social Research Council, Health and Social Care Research and Development Division (Welsh Government), Medical Research Council, National Institute for Health Research, Natural Environment Research Council, Public Health Agency (Northern Ireland), The Health Foundation and Wellcome.

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