Assessing the feasibility of public engagement in a Smartphone app to improve wellbeing through nature connection

Running head: Feasibility of public engagement in a Smartphone app intervention for wellbeing

Kirsten McEwan[1]Miles Richardson[2]David Sheffield[2]Fiona J Ferguson[2], Paul Brindley[3]

[1]College of Health and Social Care, University of Derby; [2]College of Life and Natural Sciences, University of Derby, United Kingdom; [3]Department of Landscape, University of Sheffield, UK

Corresponding author:
Dr Kirsten McEwan
University of Derby
Kedleston Road
Derby
DE22 1GB
Email: k.mcewan@derby.ac.uk
Tel: 01332 592291

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Abstract

Aside from practical interventions such as providing green infrastructure to improve air quality or water contamination and reduce flooding, wellbeing interventions to increase engagement with the natural environment are one of the fastest growing ways of improving human and environmental health. This feasibility study assessed a novel Smartphone app wellbeing intervention. Over 30 days the app prompted adults, including those seeking help for a common mental health problem, to notice the good things about urban green or built spaces (control condition). Self-referral was successful with 885 people downloading the app, 435 supplying baseline data and 50 supplying post-intervention data. However, the low number of observations (M=6 per participant) indicates that 30 days is too long to remain engaged. There were significant improvements in wellbeing and nature connection, but no difference between green and built space conditions. Limitations, future recommendations regarding improving engagement and marketing to lower socio-economic status groups are discussed.

Key words: Health; Green space; Smartphone app; Nature connection; Wellbeing

Introduction

Rapidly increasing urbanisation means that 66% of people will be living in cities by 2050 (United Nations, 2014). Yet aside from the direct benefits of ecosystem services on human health (Summers, Smith, Case et al., 2012), it is increasingly recognised that exposure to the natural environment can improve human health and wellbeing (for reviews, see Bratman, Hamilton & Daily, 2012; Capaldi, Dopko & Zelenski, 2014). This is supported by Government policies (DEFRA 25 Year Environment Plan, 2018, UK; Wellbeing of Future Generations Act, 2015, Wales); and conservation NGO campaigns (RSPB; Wildlife Trust, UK); which are increasingly looking toward the natural environment as a means to improve health and wellbeing.

However, with increased urbanisation there are fewer opportunities for people to engage with as broad a variety of species and habitat types as found in more rural areas, and so interventions are needed to connect people with nearby or *urban nature* (Newman & Dale, 2013). Some studies have found that number, size and proximity to home of public green spaces correlated with wellbeing (Gascon, Triguero-Mas, Martínez, Dadvand, Forns et al., 2015; Twohig-Bennett & Jones, 2018; Wood, Hooper, Foster & Bull, 2017) and perceived physical health (Maas, Verheij, Groenewegen, Vries & Speeuwenberg, 2005). The effect size of regular visits to green spaces was similar to the effect size of life circumstances (such as marital status) on wellbeing (White, Pahl, Wheeler, Depledge & Fleming, 2017). A longitudinal study by Villeneuve, Jerrett, Su, Burnett, Chen et al. (2012) found associations between the presence of urban green spaces and lower levels of mortality at 22 year follow-up, demonstrating the potential value of urban green spaces to human health and wellbeing. From a public health perspective, there is a need for wellbeing interventions that are accessible regardless of socio-economic status, which can be built into day-to-day life and often in an urban environment (Burls, 2007; Lachowycz & Jones, 2013). However, a review into urban green space and health

(Lee & Maheswaran, 2011) warns that interventions may fail to address the underlying determinants of health, as the causal relationship is complex. Therefore, there is a need to go beyond correlational studies and explore the causal relationship between urban green space and wellbeing.

With widespread use of Smartphones in the UK (81% own a Smartphone - Deloitte, 2016), it is clear that Smartphone apps can be utilised in research to obtain repeated measurements in day-to-day settings and offer a unique opportunity for behaviour-change interventions (Howells, Ivtzan & Eiroa-Orosa, 2016). Apps such as Mappiness (MacKerron & Mourato, 2013) and Urban Mind (Bakolis, Hammoud, Smythe, Gibbons, Davidson, Tognin & Mechelli, 2018) have been used to collect data on wellbeing in urban spaces. Data from both apps found that greater wellbeing was associated with spending time in the natural environment. However, prompts were random and MacKerron and Mourato (2013) found their average participant spent a minority of their time outdoors (7.48% each day), thus there was limited data collected on time spent in the natural environment compared with the urban environment. In a previous paper we describe the development of an app called Shmapped (Sheffield mapped), which builds on previous app designs by using intelligent prompts linked to geofenced green spaces (McEwan, Richardson, Brindley, Sheffield, Tait et al et al, 2019), thus capturing data on the time people spend in green spaces. This paper focuses on the feasibility of engaging people with the app.

The app was created to act as an intervention to increase nature connection and wellbeing by prompting people to notice the good things in green spaces (for example, hearing bird song, appreciating Autumn colours) every day, over 30 days. The intervention aspect of the app is based on Positive Psychotherapy (Seligman, Rashid & Parks, 2006; Sin & Lyubomirsky, 2009) which aims to increase positive emotions, engagement and meaning in the long-term, rather than directly targeting a reduction of current negative emotions. Namely,

the app was based on brief gratitude interventions which ask people to notice 'three good things' daily (Seligman, Steen, Park & Peterson, 2005). The mechanisms by which gratitude may increase wellbeing are suggested to include schematic biases, coping, positive affect, and broaden-and-build principles (Fredrickson, 2011; Wood, Froh & Geraghty, 2010). Fredrickson's (2011) broaden and build theory of positive affect states that daily increases in positive emotions broaden awareness and encourage exploration which builds skills, resources and psychological resilience over time, leading to sustained wellbeing benefits. This could be effective in natural or semi-natural urban settings whereby a daily focus on gratitude for ones surroundings might increase positive emotions, broaden awareness and positively bias attention and memory. In addition, there are mechanisms accounting for the benefits of exposure to nature and these are Kaplan's (1995) Attention Restoration Theory (ART) which proposes that observing nature allows the brain to recover from mental fatigue and restore attentional focus; and Ulrich's (1979) Stress Reduction Theory (SRT) which proposes that observing nature can benefit wellbeing through its stress reducing properties.

Practising gratitude in controlled psychological intervention settings has been shown to have lasting effects on dispositional gratitude, psychological wellbeing (Seligman et al., 2005) and happiness (Mongrain & Anselmo-Matthews, 2012). These interventions can work as a diary pen and paper exercise but have also been shown to work as an app. For example, an app which prompted participants every 2 hours to express gratitude saw an increase in gratitude and wellbeing compared with a control group (Ghandeharioun, Azaria, Taylor, & Picard, 2016). This 'three good things' approach was adapted to writing about the good things in *nature* and resulted in increased nature connection and wellbeing (Richardson, Hallam, & Lumber,, 2015). Online nature connection campaigns such as the Wildlife Trusts '30 Days Wild' have been shown to increase people's nature connection and wellbeing (Richardson,

Cormack, McRobert, & Underhill , 2016), but with adults living in increasingly urbanised environments, there is a need to deliver these interventions in urban settings.

This feasibility study aimed to assess whether adults were willing to 'self-refer' to the app and engage with it for 30 days. It also assessed whether health professionals and NGOs were willing to refer adults with common mental health problems to the app, to test its feasibility as a social prescription (referral to local non-clinical services to benefit health and wellbeing). A second aim of the study was to examine the effectiveness of the app in improving wellbeing, to inform a larger trial. Understanding who remains engaged in using the app and who benefits in terms of wellbeing, could help identify the mechanisms through which the intervention is effective, hence a third aim was to assess for whom the intervention was effective.

Method

Participants

Based on a power calculation, the study targeted 500 Sheffield residents who were over 18 years old and owned a Smartphone. Based on the Recovering Quality of life scale (ReQoL) as a primary outcome measure, a sample of 500 participants was determined to be sufficient to detect a small difference (r=.1) between groups, based on a power of .95 and an alpha of .05, and assuming 50% attrition. To test the feasibility of using the app as a social prescription, the study also targeted 100 residents with a common mental health difficulty (mild to moderate anxiety &/or depression) through health professional referrals. A total of 885 people downloaded the app, 576 (50.99%) supplied baseline data, of these 435 (75.52%) were eligible to participate (aged over 18 years and living in Sheffield as denoted by their postcode), 50 (11.49%) completed post-intervention measures and 10 (1.13%) completed follow-up measures at three months. Those who completed the study took part between June and

November 2017. Participants who completed the post-intervention measures were entered into a prize draw to win vouchers.

In an attempt not to just target people who already necessarily had a nature connection, the name of the app (Shmapped) and the advertising around it were phrased as noticing the good things about Sheffield, rather than specifically about nature. The main strategy for promoting the app was through social media (Twitter & Facebook). This was successful with 108 Facebook, 123 Instagram and 443 Twitter followers and 177.7k impressions on Twitter recorded. Other strategies included: promotion through the Sheffield and Rotherham Wildlife Trust (emails and social media, stalls at events and guided walks demonstrating the app); distributing posters and leaflets; an appearance on local radio; contacting NGOs, Council staff, large local employers, health professionals and social prescription organisations; and joint promotion with other apps of a similar theme (Move More & Go Jauntly).

Measures

Primary outcome measures included: source of referral, attrition rates and engagement with the app. Secondary measures included: the 10-item Recovering Quality of life scale-ReQoL, (Brazier, Connell, Papaioannou, Mukuria, Mulhern, et al., 2014), example item: 'I found it difficult to get started with everyday tasks', rated on a five-point Likert scale 'none of the time' to 'most or all of the time'; the 18-item Types of Positive affect scale-TPAS (Gilbert, McEwan, Mitra, Richter, Franks, et al., 2009), example item 'Secure', rated on a five-point Likert scale 'not characteristic of me' to 'very characteristic of me'; the 6-item short form Nature Relatedness scale (Nisbet & Zelenski 2013), example item 'My ideal vacation spot would be a remote, wilderness area', rated on a five-point Likert scale 'disagree' to 'agree strongly'; the 4-item Engagement with Natural Beauty scale (Diessner, Parsons, Solom, Frost & Davidson, 2008), example item: 'I notice beauty in one or more aspects of nature', rated on

a seven-point Likert scale ‘very unlike me’ to ‘very much like me’; and the single item Inclusion of Nature with Self scale-INS (Schultz, 2001) where participants select between graphics of five overlapping circles (like a Venn diagram) representing self and nature with lower scores for the least overlap between circles (least overlap between self and nature) and higher scores for the greatest overlap between circles (complete overlap between self and nature). Table 2 displays the correlations and reliability for all study variables.

[Insert Table 2 around here]

The ReQoL was selected as, like other measures of quality of life (QoL), it allows for health economic analysis (presented in another paper), but focuses specifically on the mental wellbeing aspect of QoL rather than just physical health. It also has an established minimum important difference allowing for analysis of clinical significance (ReQoL Scoring, reqol.org.uk). The TPAS was selected as unlike other unidimensional measures of positive affect, the TPAS distinguishes between calm and activated positive affect types which may both be stimulated to different degrees by spending time in nature. The Nature Relatedness scale and INS scales are commonly used brief measures of nature connection and have been used in large cohorts, for example the Wildlife Trusts 30 Days Wild campaign (Richardson, Cormack, McRobert, & Underhill 2016). Finally, the Engagement with Natural Beauty scale was used as it was previously shown to mediate the relationship between nature connectedness and wellbeing (Capaldi et al., 2017) and its use allowed us to look further at mechanisms of intervention effectiveness. Three items measured previous exposure to nature growing up, previous exposure to nature in the last year and whether participants had access to a garden. It took participants an average of 3 minutes to complete these questions.

Design

The design was a repeated measures design, with self-reported measures completed in the app at three time-points: baseline, post-intervention and three months follow-up. This design was used to allow comparison of questionnaire scores between baseline, post-intervention and longer term follow-up. Three months was selected as suggested by the end-user testers as the follow-up period to allow monitoring of longer term changes to questionnaire scores but within a time-frame where it seemed likely that participants would still have the app on their phone and feel motivated to participate. GPS location data was tagged every 20 seconds but only in publicly accessible green and open spaces between the hours of 8am and 8pm. These were identified using data provided by Sheffield City Council. When GPS recorded participants as being within a green space, the app prompted them to enter a good thing they had noticed. The location data will be reported in another paper.

Procedure

The 'three good things' procedure from Seligman et al. (2005), a literature review of wellbeing apps and a review of commercially available health and wellness-based apps, informed the development of the app storyboard. The storyboard was modified in an iterative process through discussions between the researchers, the app development team and an end-user testing group. The aim was to produce an app that would: prompt users once a day to notice the good things about green or built spaces (depending on randomisation by the app); allow users to write brief notes about the good things about green or built spaces, answer questions about their experience of that place, and record data on wellbeing and nature connection at baseline and follow-up. The app did not depend on Wi-Fi or use of mobile data: this was to allow participants to record good things in remote areas with poor coverage (a

limitation identified by MacKerron during a Skype discussion) and also to not act as a barrier to engagement with the app by usage of mobile data. A full description of the app as a data collection tool and intervention can be found in McEwan, Richardson, Brindley, Sheffield, Tait et al., (2019).

There was a desire to learn about the intervention (green space condition) and to maximise power, so more participants were randomised to receive it (Dumville, Hahn, Miles & Torgerson, 2006). After giving consent, 70% of participants were randomised to the intervention condition (noticing the good things about green spaces), whilst 30% of participants were randomised to the control condition (noticing the good things about built spaces). Participants were asked to complete questionnaires within the app.

Participants were then instructed to notice the good things about either green or built spaces over the next 30 days and were given examples of good things to notice, such as 'newly emerging flowers in Spring' (green space condition) or 'the colours of stain glass windows' (built space condition). The examples were derived from previous studies where participants were asked to write about the good things in nature (Richardson, Hallam, & Lumber 2015). When participants were prompted by the app to enter their daily notes about green or built spaces, 4 single item contextual measures asked about the variety of wildlife or how built-up the area was, how that place made them feel, who they were with, and what they were doing. Given that adults using similar apps were found to only spend an average of 7.48% of their time outside (MacKerron & Mourato 2013), green space prompts were designed to be intelligent and prompted the user whilst they were in a green space. Built space prompts were random but usually occurred around midday. If participants chose to 'snooze' their response, they would be reminded later that day usually around 8pm. Participants completed the same questionnaire measures at post-intervention and three months follow-up.

Ethics Statement

Upon downloading the app, participants were informed of the study aims and asked to read brief information before providing consent by tapping 'yes, I agree' in the app. Of the 885 participants who downloaded the app, 674 consented to participate, whilst 211 did not consent to participate and progressed no further. Users could revisit the information sheet at any time in the app. The information sheet and Privacy Impact Assessment (PIA) were also available on the study website in case people wanted to read them before downloading the app. The study was approved by the Human Sciences Research Ethics Committee at the University of Derby (ref: 08-1617-KMp) and the West Midlands Research Ethics Committee (ref: 222700).

Data analysis

Data were screened for normality using skewness (.005 to -1.380) and kurtosis (.061 to 1.980) and found to be within acceptable ranges. It was not possible to move forward in the app until all questions in the questionnaires had been answered, hence any missing data is due to participants not providing any data at baseline and/or post-intervention. A *t*-test was conducted on baseline scores comparing green and built space participant responses and no significant difference was found. To address the first aim of assessing the feasibility of recruitment and engagement, frequency analyses were conducted on referral route and participants referred through a health professional were screened for their mean scores on the Recovering Quality of Life scale (ReQoL). Engagement was assessed through descriptive analysis of the number of observations recorded by participants of good things, and descriptive analysis of participants responses to a Mobile App Rating Scale (MARS- Stoyanov, Hides, Kavanagh, Zelenko, Tiondronegoro & Mani, 2015). Attrition data were explored with frequency analysis and a *t*-test was conducted to assess the characteristics of participants who withdrew versus participants who completed the study. Representativeness of the sample was

also checked by comparing the frequency of demographics with those reported by census data for the city. Fidelity was checked through qualitative analysis of the observations reported by participants.

To address the second aim and provide an early indication of effectiveness and to inform a further full trial, data were analysed using a repeated measures Multivariate Analysis of Variance (MANOVA) with questionnaire scores (at baseline and post-intervention) as the within-subjects variables, and condition (noticing good things about green or built spaces) as the between-subjects variable. Multivariate statistics could not be calculated to include follow-up data due to the small sample size (n=10).

To address the third aim of assessing which participants benefit the most from the app, demographic variables and baseline variables were considered as covariates. *T*-tests and Chi-square were used to compare change in wellbeing and nature connection scores to assess for whom the app was least or most effective.

Results

The feasibility of recruitment and engagement with the app

Participants who downloaded the app were asked where they heard about it (see Table 1 for referral route). Of those who provided a response (n=716), 'other' and social media were the two most common referral routes. Only 34 participants reported being referred by a health professional.

[Insert Table 1 about here]

The feasibility of the app as a social prescription

Of the 34 participants self-reporting being referred by a health professional, only 5 of these met the reference range criteria (baseline score of <=24) for being classed as a clinical population according to the ReQoL. In terms of the total sample supplying baseline data (n=435), according to the ReQoL reference range criteria, 79 would be classed as clinical and 372 would be classed as non-clinical populations. These low referral rates by health professionals and low incidences of participants who could be classed as clinical according to the ReQoL criteria mean that the app has very limited application as a social prescription.

Representativeness of sample

We aimed for geographical spread across Sheffield. Maps of location data were reviewed every two weeks to inform the recruitment team about where to focus their efforts. We also aimed to recruit a representative Black Asian Minority Ethnicity (BAME) population, as previous research found that fewer BAME participants engaged with nature (Natural England, 2016). The predominant demographics in our sample were white (86.8%), female (62.6%), aged 30-44 years old (20%), and living in the upper two quartiles of the index of multiple deprivation (68.89%). A Chi-square comparison of demographic data from the app with 2011 census data for Sheffield showed no significant differences (*ps*>.05), indicating the demographic profile of the app was no different to census data.

Attrition

50.99% of participants who downloaded the app provided baseline data, of these 11.49% completed post-intervention data. Of the 79 participants classed as a clinical sample who provided baseline data, 12 (17.91%) completed the study, compared with 42 of the 372 (12.73%) classed as non-clinical. Table 3 shows the participants demographics throughout the study.

[Insert Table 3 about here]

A *t*-test was conducted, with attrition after completing baseline measures (n=435) and retention to post-intervention measures (n=50) as the groups. Those who made a greater number of observations (t= -4.94, df=90.63, p=.000) and spent less time outside as a child were more likely to complete post-intervention measures (t= 2.33, df=433, p=.020). Those who reported walking (t= -2.07, df=484, p=.039) or relaxing (t= -2.02, df=484, p=.044) or being in the company of friends, family or a partner (t= -5.28, df=484, p=.000), at the time of making observations were also more likely to complete the study.

Condition (green or built), gender, ethnicity, socio-economic status, garden access and how participants heard about the study were all entered into a Chi-square test comparing those who remained in the study with those who did not. None of these variables had a statistically significant impact on attrition rates.

Engagement

Engagement with the app as defined by the number of observations made over 30 days was not optimal. Our target was for participants to make observations 50% of the time (i.e. 15 days out of 30), the same target used by Bakolis et al. (2018). A total of 83 (19.08%) out of 435 participants achieved this target. In total, 4,617 observations were made. The number of observations of 'good things' by users ranged from 0-22 (M=6.25, SD=7.15). Some participants (n=89) failed to make any observations. We calculated percentiles of observations which resulted in three groups: low engagement (0-1 observations, n=172); moderate engagement (2-6 observations, n=156); and high engagement (7-22 observations, n=158).

These were entered into a one-way ANOVA along with age, time spent outdoors as a child and in the last year, and all baseline variables. This revealed significant effects of older age [$F(2, 463) = 4.08$, $p = .017$], higher scores of baseline nature connection [$F(2, 457) = 4.70$, $p = .010$], and higher baseline scores of appreciation of nature's beauty [$F(2, 455) = 6.22$, $p = .002$] on number of observations made.

Categorical variables (condition, gender, ethnicity, socio-economic status, garden access and how participants heard about the study) were entered into a Chi-square comparing the percentiles of observations. There was a significant effect of socio-economic status, with more observations made by participants living in deprived areas (according to index of multiple deprivation) (Chi-square=13.18, *df*=6, *p*=.040), and condition, with more observations in the green space condition (Chi-square=7.32, *df*=2, *p*=.026) but no other significant effects.

Ratings of engagement

Engagement was formally assessed using the Mobile app rating scale (MARS-Stoyanov et al 2015). The MARS is a 29 item scale with Likert responses 1-5. A total of 100 participants (50 participants who completed the study and a random sample of 50 participants who did not complete the study) were invited to complete the MARS scale online, 25 participants completed the MARS. Responses indicated that users found the app moderately engaging (M=3.42, SD=.59), very functional (M=4.38, SD=.53), aesthetically pleasing (M=3.93, SD=.61), moderately informative (M=3.32, SD=.62), reasonable quality (M=2.78, SD=.67), and showing moderate promise of having an impact on knowledge, attitudes, intentions and behaviours (M=3.44, SD=.88). Owing to the app being part of a research study, the primary aim was for the app to be functional, these scores indicate that we were successful in achieving this aim.

Fidelity

Those in the green space condition predominantly reported good things they had seen in nature, with only two (0.63%) mentions of built spaces. In the built condition there were 40 (24.10%) mentions of parks or planting around built spaces, indicating less fidelity (i.e. not noticing the good things about built spaces but instead noticing green spaces and features). Further analysis of qualitative data from this study will be reported in another paper.

The effectiveness of the app

There was a statistically significant difference between scores at baseline and post [$F(7, 35) = 2.58$, $p = .030$, $\eta_p^2 = .340$]. However there were no significant between-subjects or interaction effects [$F(7, 35) = .575$, $p = .771$, $\eta_p^2 = .103$]. Univariate tests revealed significant effects for scores on the ReQoL, INS and positive affect variables (safeness, relaxation and activation). Mean scores across variables revealed improvements and can be seen in Table 4. Higher scores on variables indicate good wellbeing.

[Insert Table 4 about here]

Who benefits from the app

When included as covariates, there were no significant effects of age, number of observations, time spent outside as a child or in the last year, garden access, socio-economic status, or baseline nature connection (*ps*=>.05), on the effectiveness of the app as an intervention to improve wellbeing and nature connection.

When clinical caseness according to the ReQoL was included as a covariate there was a significant main effect [$F(7, 33) = 9.80$, $p = .000$, $\eta_p^2 = .675$] and two-way (time x caseness)

[$F(7, 33) = 3.05$, $p = .014$, $\eta_p^2 = .393$] and three-way (time x condition x caseness) [$F(7, 33) = 2.73$, $p = .024$, $\eta_p^2 = .367$] interactions.

These effects were explored further using a *t*-test where participants were grouped according to caseness (n=12) or non-caseness (n=38). In both the green (t= -2.05, df =31, p=.049) and built (t= -3.68, df =19, p=.002) conditions, participants who were classed as cases showed significantly greater improvements in the ReQoL than participants classed as non-cases. In the built condition this difference in scores exceeded the minimum important difference of 5 points (change score =7.25) (ReQoL Scoring, reqol.org.uk). In the green condition, participants classed as non-cases showed significantly greater improvements in nature connection than those classed as cases (t= -2.36, df =24, p=.027).

Discussion

The feasibility of recruitment and engagement with the app

Self-referral to the app through social media was successful with 885 downloads (our target was 500). This sample showed good representation of the population when compared with census data. Referral through health professionals was less successful, with only 34 referrals (our target was 100). This suggests that application of the app as a social prescription would not be feasible. Known barriers to referrals were: i) lack of time during consultation and other competing interventions; ii) the app is not currently an NHS approved app and was seen by some as a patient-safety risk. There was no evidence of adverse effects during this pilot, or previous studies where participants were asked to notice the good things about nature (Richardson, Hallam, & Lumber 2015).

Attrition rates were high with 50.99% of participants providing baseline data but only 11.49% of participants completing post-intervention data. Studies of similar apps recording time and experience in green and built space have reported similar rates (14%) of engagement (McKerron & Mourato, 2013). A fair proportion (19.08%) of participants showed good fidelity

412 of engagement with the app and recorded observations of good things a minimum of every
413 other day. In general though, numbers of observations were quite low with an average of 6.25
414 observations made over 30 days per participant. This indicates that 30 days may be too long a
415 period of engagement and hence in the full trial a 7 day version of the app will be used.
416 Participants rated the app as moderately engaging on the Mobile App Rating scale (MARS).
417 Participants were more likely to remain engaged in the study if they were older, had spent less
418 time outdoors as a child, had lower socio-economic status (according to index of multiple
419 deprivation), if they were in the green space condition, and if they had greater baseline scores
420 on nature connection and appreciation of nature's beauty. Participants were also more likely
421 to remain engaged in the study if they were walking or relaxing and were in the company of
422 others when prompted by the app.
423
424 **The effectiveness of the intervention**
425 Across the green and built conditions there were statistically significant improvements
426 for scores on the recovering quality of life scale (ReQoL), nature connection scale (INS) and
427 positive affect variables (safeness, relaxation and activation). There were no significant
428 differences between conditions (green or built), which is not entirely unexpected, as noticing
429 the good things about ones' surroundings is not dissimilar to previous gratitude-based
430 interventions (Seligman et al., 2005) which have been shown to improve wellbeing. It may be
431 that the gratitude element of the intervention (Seligman et al., 2005) and the increased positive
432 emotions and broader awareness resulting from it (Fredrickson, 2011), could be the mechanism
433 behind improved wellbeing scores.
434 The qualitative findings relating to the observations participants made will be reported
435 in full in another paper. However, three key themes emerged from thematic analysis: i) wonder
436 at encountering wildlife in day-to-day urban settings; ii) appreciation of street trees; and iii)

awe at colourful, expansive, dramatic skies and views. This might suggest that positive emotions of wonder, awe and gratitude generated by noticing nature, may be an active mechanism in improving nature connection and wellbeing.

Who benefits from the app

Improvements in wellbeing and nature connection were more observable in those who were classed as clinical cases (*n*=79 based on ReQoL reference ranges) at baseline. Participants with lower scores in wellbeing at baseline are likely to have a greater margin for improvement with interventions and hence could benefit more from interventions such as the app. However, due to attrition rates post-intervention data was limited to 12 participants meeting the ReQoL criteria for being a clinical case, so these findings should be interpreted with caution.

Limitations

This research is not without limitations. Although a large number of users began the study, the attrition rate was high and engagement was poor with participants recording an average of 6.25 good things over the 30 days. The attrition rate meant that the study failed to recruit its targeted sample size based on a power calculation of 500 participants and this has implications for power. Although a systematic review (Walters et al. 2017) suggests that few RCTs achieve target, many (97%) reach 80% of their target. The current study reaches 87% of its target. The attrition rate was surprising given that entry to a prize draw was offered. Although we had no feedback to suggest this, one could speculate that some participants, particularly marginalized populations, may have found notifications to "report good things" inadvertently frustrating. There were very few referrals from health professionals, indicating that application of the app as a social prescription is not feasible.

Some of the qualitative data obtained through participants notes about ‘good things’ indicated that 24.10% of participants in the built space condition noticed green features within built spaces such as planters and street trees. This brings to question how meaningful it is to draw distinctions between 'green' and 'built' environments and the use of ‘built space’ as a control condition in studies investigating the benefits of access, contact and connection with nature. Indeed, calls to focus research and interventions on ‘urban nature’ (e.g. Newman & Dale, 2013) acknowledge that nature permeates urban areas, even densely built-up urban areas. In addition, by giving people examples of 'good' things to notice, there was potential to reproduce culturally engrained notions of what constitutes 'good' or 'bad' nature, which may have been alienating for people with alternative values/priorities. The examples given were taken from public notes about good things in nature from the 30 Days Wild campaign, hence the intention was to take examples from the general public, but again the representativeness of participants in the campaign may not correlate with census data. We acknowledge that the prompting between the green and built control group were not directly comparable which may have affected results. It should be noted, however, that this pilot found no significance difference between output from the two groups.

Future directions

To improve the study ready for a full trial, a new 7 day version of the app will be produced in an effort to increase engagement and reduce attrition. In their 7 day app, Bakolis et al. (2018) achieved an engagement rate of 59.26%, hence 7 days intervention duration seems likely to result in better engagement. We will also offer a £20 voucher to all participants who complete the study as a systematic review found that participant remuneration has been found to encourage completion of follow-up data (Robinson, Dennison, Wayman, Pronovost & Needham, 2007). For the purpose of research there are questionnaires included to address the

research questions, however if the app were to be used mostly as an intervention, then the number of questions could be reduced or omitted to make the app more user-friendly for participants with busy lives. On the advice of our stakeholders, including a group of GPs working in the most deprived areas of Sheffield, to improve demographic representation we will distribute 3,000 study leaflets to lower socio-economic status areas in Sheffield, target food banks, community centres, job centres, large employers, local sports team forums, Mumsnet, places of religious worship and libraries. One of the known barriers to gaining referrals from health professionals and utilising the app as a social prescription was concern about the app not being NHS approved. Therefore early application to the NHS Digital approved apps department is recommended for researchers developing and evaluating similar wellbeing apps.

Conclusion

With increasing development and urbanisation (United Nations, 2014), there is an urgent need to develop wellbeing interventions that can be effective in urban settings. This pilot study of a novel Smartphone wellbeing intervention indicated that whilst it was feasible to initially engage large numbers with the intervention, participants did not remain engaged over the 30 days of the intervention. For a future evaluation, the limitations in sample size will be addressed by shortening intervention duration to 7 days (in line with Bakolis et al., 2018). Nonetheless, initial data on effectiveness indicated that the app has promise in terms of improving wellbeing and nature connection as a result of noticing good things in green and built spaces within an urban environment. The finding that noticing good things in both green and built spaces improves wellbeing scores and the finding that some participants in the built space condition noticed natural features of the built environment does bring to question how useful this distinction between green and built space is. It is possible that the gratitude-based-

ntervention (Seligman et al., 2005) on which the app was based and gratitude in general for ones surroundings may be the mechanism behind improved wellbeing scores. Delivering wellbeing interventions through Smartphone apps has the potential to offer a mode of intervention delivery that is accessible and cost-effective (cost-effectiveness data will be reported in a separate paper), and if promoted more widely as a social prescription, may reduce the burden on health and social services.

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682 **Tables**

683 1. Table 1: How participants who downloaded the app heard about the study

684 2. Table 2. Correlations and reliability for all study variables

685 3. Table 3: Participant demographics at baseline, post and follow-up

686 4. Table 4. Baseline and post-intervention means and standard deviations for the

687 outcome measures

688

689 **Table 1: How participants who downloaded the app heard about the study**

How heard	N
Other	258
Social media	234
Wildlife Trust	87
Charitable organisation	58
Poster/leaflet	42
Health professional	34
TV/radio	3
Total	716

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693 **Table 2. Correlations and reliability for all study variables**

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	ReQoL	Safe	Relaxed	Activated	Nature Connection	INS	Natures Beauty
ReQol	-						
Safe	.53**						
Relaxed	.46**	.66**					
Activated	.44**	.62**	.81**				
Nature connection	.07	.17**	.19**	.23**			
INS	.13**	.14**	.23**	.22**	.62**		
Natures Beauty	.05	.09	.22**	.22**	.62**	.42**	-
Reliability	.87	.67	.67	.75	.83	-	.80

695 ** Correlation is significant at 0.01

696

Table 3: Participant demographics at baseline, post and follow-up

	N	Condition: Green/Built	Mean age (SD)	Gender: Female/Male/Other gender	BAME	Platform: Android/ ios
Baseline	435	285/150	36.82(13.33)	244/135/3	36	174/207
Post	50	28/22	39.34(13.99)	38/15/0	4	25/28
Follow-up	10	7/3	45.30(15.42)	5/5/0	0	7/3

Table 4. Baseline and post-intervention means and standard deviations for the outcome measures

Measure	Condition	Baseline Mean (*SD*)	Post Mean*(SD)*
ReQoL	Green	30.12 (7.90)	31.50 (8.16)
	Built	29.06 (8.11)	30.88 (5.77)
Safe	Green	11.12 (3.53)	11.62 (3.37)
	Built	8.59 (3.22)	10.06 (3.07)
Relaxed	Green	13.54 (4.58)	14.73 (4.37)
	Built	11.76 (3.75)	12.73 (3.50)
Activated	Green	19.12 (6.32)	20.62 (5.45)
	Built	17.29 (5.51)	18.59 (4.56)
Nature Relatedness (NR6)	Green	24.77 (4.25)	25.81 (3.05)
	Built	23.29 (5.08)	23.76 (4.67)
Nature Connection (INS)	Green	34.65 (23.06)	43.31 (25.64)
	Built	41.47 (25.76)	48.94 (25.12)
Natures Beauty	Green	20.85 (3.98)	21.31 (3.56)
	Built	20.47 (4.89)	21.71 (5.24)