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LESSONS FROM BEYOND THE LECTURE THEATRES: WHAT IS STILL UNKNOWN WHEN IT COMES TO NATURE-BASED INTERVENTIONS FOR UNIVERSITY STUDENTS' WELLBEING?

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Abstract: *This paper presents lessons learnt from research on integrating urban nature into university students' daily lives for wellbeing benefits. It examines the application of traditional and technological interventions as a way of increasing university students' engagement with urban nature to support their mental health. It focuses on two research questions: (1) How does a walking intervention and a mobile phone app intervention in urban nature compare - in terms of their effect on nature connection and wellbeing measures? (2) How should engagement with the natural environment be encouraged for university students' wellbeing? The use of two different styles of nature-based interventions demonstrated the implementation opportunities and challenges amongst the student population. Results analysed the extent of changes over time and differences within groups. This confirmed that the relationship between different aspects of an individual's relationship with nature is complex and dynamic. The experience of conducting this research highlighted the challenges to implementing novel technological interventions - including creating a nature-based intervention scheme at a university. The difference in outcome measures and unexpected direction of change for connection to nature suggests the need for a holistic approach to improve student wellbeing, including different ways to integrate nature into the university experience.*

Keywords: *urban nature, university students, interventions, mobile phone app, wellbeing.*

Introduction

There are numerous studies demonstrating the wellbeing benefits of engaging with nature ranging in example, from volunteering with animals through to planting a window box. Plants indoors and outdoors have been found to provide opportunities for mental health restoration and recovery. Whilst the causal mechanisms behind the mental health benefits associated with connecting with nature are not comprehensively understood (Mayer *et al.*, 2009), one mediator is the facilitation of mental restoration through creating opportunities for soft fascination such as watching the clouds (Kaplan and Kaplan, 1989). This is known as Attention Restoration Theory (ART) (Kaplan, 1995). Lower levels of stress and fatigue achieved through the application of ART to indoor spaces have shown wide reaching effects on health, work productivity and wellbeing (Kaplan, 1993). Other research has considered the theory that humans have an innate connection with nature, this is known as Biophilia (Wilson, 1984). Developments in this area includes research considering the role of life satisfaction (Howell, Passmore and Buro, 2013) and engagement with beauty (Lumber, Richardson and Sheffield, 2017) as mediators between connection with nature and wellbeing.

Significant to busy urban living, urban nature provides a space with softer biological time rather than demanding mechanical time of city life (Maller *et al.*, 2009). At present, in order to reduce physiological stress, it is recommended to regularly (three times a week) spend 20-30mins in the natural environment (Hunter, Gillespie and Chen, 2019). As health is greatly influenced by social and environmental determinants, aspects such as lifestyle, environment and community are now taken into greater consideration than ever before (Barton and Grant, 2006). Furthermore, the importance of nature has been highlighted during national Covid-19 lockdowns with people reporting a change in time spent outdoors, partially due to stay-at-home restrictions (Soga *et al.*, 2021). At an individual (rather than a population) level there are two prominent approaches to integrate nature into an individual's life for wellbeing: (1) through specially designed landscapes such as healing gardens; or (2) through behaviour change intervention (Milligan, Gatrell and Bingley, 2004; Richardson and Sheffield, 2017). Nature-based interventions facilitate experiences with nature and the associated benefits. Paradoxically, during the same time period as this paper's research into these benefits, the mental health of university students in the UK decreased.

University students' wellbeing

Mental health is a growing health burden around the world and in the UK there has been a particularly high rise amongst university students (Lau, Gou and Liu, 2014; Aronin and Smith, 2016). A university survey found that 37% of respondents reported their state of wellbeing had deteriorated since they started studying in higher education, with 64% reporting this was related to their studies and university lifestyle (Randstad, 2020). University students represent a unique subsection of the population as they undergo an intense period of transition in location, social and economic status, and context, moving from one stage in their life-course to the next (Ibrahim *et al.*, 2013). The Office for Students reported that students who suffer from mental health issues are more likely to drop out of university, underperform academically and are less likely to secure higher level employment (Office for Students, 2019).

Whilst the underlying factors contributing to the increase in mental health support at university requires further investigation, there is an immediate need to respond to the increased demand for support services. There are three main agreed points: (1) an increased awareness of mental health issues and therefore more people seeking support for their mental health issues, which may have previously been left undiagnosed; (2) increased financial pressures on UK students due to increased fees and concerns over the job market; and (3) an increased number of students from vulnerable backgrounds attending university (Usher and Curran, 2019). Whilst studies from both USA and UK universities present a mixed understanding of mental health issues, it is evident that mental health support for depression and anxiety is needed amongst the university student

population (Blanco *et al.*, 2008; Ibrahim and Fadzil, 2013). The introduction of a scheme to support better mental health at university, known as the University Mental Health Charter in the UK (https://www.studentminds.org.uk/charter.html), means that this aspect of the UK university sector will soon be under closer scrutiny, with an expected assessment and therefore possible comparison as part of the award (Hughes and Spanner, 2019). In agreement with other research and as part of the 'live' dimension of the Charter, university green spaces should be developed as a wellbeing resource for students and staff (Hipp *et al.*, 2016; Hughes and Spanner, 2019). Specifically for young adults, nature has been found to be beneficial as it provides a non-judgemental space (Birch, Rishbeth and Payne, 2020). Thus, this research explores if engagement with nature could improve mental health amongst UK university students.

Creating a connection with nature

There is a strong evidence base supporting positive health and social outcomes from nature-based interventions, sometimes known as green prescriptions (Bragg and Atkins, 2016; Burt and Preston, 2017). Evidence to support psychological benefits of engaging with nature includes reduced stress and anxiety, increased perceived wellbeing and improved concentration (Annerstedt and Wahrborg, 2011). Three main elements have been identified as the means by which green prescriptions improve mental health: directly, by restoration through nature; positive social contact; and facilitating meaningful activity (Bragg and Atkins, 2016). These interventions can also influence social behaviours. Whilst the average person will not visit the rainforest, their connection with nature within their usual environment may affect their behaviour, voting preference and desire to protect vulnerable ecosystems (Dunn *et al.*, 2006). The majority of the UK population live in cities, therefore the nature they are regularly exposed to and able to more deeply engage with will be urban. Referred to as the 'pigeon paradox', the survival of worldwide vulnerable flora and fauna relies on urban populations' connection with urban habitats and wildlife, such as pigeons (Dunn et al., 2006).

An individual's 'connection to nature' is subject to change in relation to their personal and social circumstances. Research has found that everyday nature experience will have an effect on an adult's connection to nature (not moderated by childhood experience) (Cleary *et al.*, 2018). The influence of life stage alongside current natural environment experience is an important consideration within research for understanding the design of intervention to encourage engagement with the natural environment. Cleary *et al.* (2018) encouraged the development of adult nature-based initiatives that are tailored to consider the age, ability, cultural and social context of the target population.

Interventions to connect with nature have varied in success and approach, from facilitated art and gardening clubs through to virtual reality apps. Those of relevance to this research are interventions which use walking and mobile phone apps. Previously mobile phone apps have been used to: create different ways of enjoying nature; provide publicly accessible environmental knowledge; and as a research tool for collecting detailed information on the experience a sample of the population have with the natural environment (Jepson and Ladle, 2015). Walks are common green prescribing interventions with evidence supporting a wide range of benefits, such as increased physical activity and positive mental health (Roe and Aspinall, 2011; Nisbet and Zelenski, 2013; Gladwell *et al.*, 2016; Kondo, Jacoby and South, 2018). Walking through an urban green space is found to be more beneficial to mental restoration and physical health than walking through a built-up area (Nisbet and Zelenski, 2011; Song *et al.*, 2015). Implemented by many different organisations in the UK, a group/shared walk intervention is an opportunity for social interaction in a natural environment which has been found to reduce isolation and improve mental health (Walking for Health, 2014; Lovell, Depledge and Maxwell, 2018; Active Fife, 2019).

Engaging with nature through a mobile phone app

The advancement and integration of technology into daily life has been held partly accountable for the increased nature deficit amongst young adults and children (Moss, 2012; Fletcher, 2017). Harnessing this technology may provide an opportunity to counter this deficit with those who are experienced in the use of smart phone apps (Buettel and Brook, 2016). Mobile phones offer an instant form of information sharing, with various approaches utilising the potential, from city parks texting office workers about interesting nearby green spaces to encourage visits, through to citizen science projects using apps to capture the relationship between city experience and wellbeing (Hitchings, 2013; Bakolis *et al.*, 2018). Advances in virtual technology could provide an opportunity for the user to: experience a historic landscape; or illustrate the potential of ecosystem restoration; or develop their knowledge of the ecosystem through identification of flora and fauna (Buettel and Brook, 2016). Previous mobile phone and nature connection research has challenged technology's role in neither enhancing nor hindering the participants' experience, suggesting there is further research required in this developing area (Barrable and Booth, 2020).

Knowledge gap addressed in this research

This paper draws on PhD research from 2018 which explored the opportunities to implement urban nature-based interventions amongst the university student population. At present this style of intervention is primarily offered to children, the acutely unwell and the elderly (Bragg and Leck, 2017). There is the prospect to respond to the increased university student mental health concerns through adapted preventative measures which harness the positive health effects of nature. The trial of two possible interventions for students allowed this research to document the opportunities and challenges in implementing nature engagement on university campuses. The pressures of university and need for time with nature has become more prominent due to Covid-19 and associated national lockdowns (Frampton and Smithies, 2021).

Research Questions:

(1) How does a walking intervention and a mobile phone app intervention in urban nature compare - in terms of their effect on nature connection and wellbeing measures?

(2) How should engagement with the natural environment be encouraged for university students' wellbeing?

Method

The overall aim of this intervention study was to increase the participant's connection to nature as a pathway to increase wellbeing. A behaviour change activity was designed via an app, with the aim to increase attention to nature within daily activities.

It was important to use a mixed method approach that captured the entire experience; both through the outcome measures and from the participants' perspective (Peat *et al.*, 2001). As influenced by environmental psychology, the intervention study is a small-scale study with repeated quantitative wellbeing measurements (Lumber, Richardson and Sheffield, 2017). The choice of these outcome measurements allowed for the study outcomes to be compared with other research in this field (Bragg and Leck, 2017; Pritchard *et al.*, 2019). The research used self-reported scales to measure the participants' connection to nature and wellbeing. All statistical analyses were conducted using SPSS version 25. Post-intervention participants were invited to take part in focus groups (or open text survey for those unable to attend). The focus groups were conducted two weeks after the intervention at the university. Due to participants' (sometimes unpredictable) timetable, attendance greatly varied. The groups were divided by intervention condition (app only, walk only, or both). These findings are written up elsewhere (Boyd, 2022). Taking a mixed method approach allowed for the strengths and weaknesses of both intervention approaches to be

reviewed by the participants. This provides a vital opportunity to learn how interventions such as these could be applied to the university student population.

Mobile Phone App

Smartphone apps are a widely available and constantly advancing technology that offers an innovative way to interface with real world spaces. There is an opportunity to design and implement mobile phone apps to support the general public's engagement with nature. Ninety-five percent of 16-24 year-olds own or have access to a smartphone (O'Dea, 2019).

Shmapped was a specially designed app created for an associated research project targeted at the general population of Sheffield (see appendix for further information on IWUN). The intervention approach is based on the effects of gratitude and noticing nature as previously trialed in campaigns such as 30 days wild (Richardson and McEwan, 2018). The app development included a user group test phase and a redevelopment based on feedback after its initial launch. It collected data on users' wellbeing, relationship with nature and additional information such as their location and context (see reference McEwan *et al.*, 2019 for further details on the development). Specifically, the app also functioned as an intervention to improve connection with nature and thereby improve wellbeing. Participants received notifications either when in a green space or at random during the day (McEwan *et al.*, 2019).

Walking

The walk was designed to emulate a common 'health walk' style of green prescriptions. Previous research found that walks in rural and urban settings were beneficial for those who experience mental health difficulties (Roe and Aspinall, 2011). Additionally, walking in a group can be an integral part of therapeutic landscape experiences (Doughty, 2013). Walking as a research opportunity is discussed by Pink *et al.*, (2010), who state that walking should be recognised as something more than movement between one place to another, but it is itself a form of engagement with our perception of the environment. In acknowledgment of this opportunity, the researcher maintained a walk research journal.

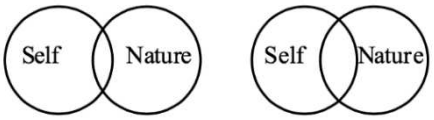
The walk aimed to encourage participants to take a break from their work on campus to visit an easily accessible local park with the opportunity to chat as we walked if they wished. It took place in two local public parks. Weston Park is five hectares with the boundaries defined on three sides by roads. A municipal park opened to the public in 1875, it retains much of its original planting scheme. Crookes Valley Park was created around the existing reservoir in the early 20th century. It is just under five hectares and contains an area of naturalistic woodland with occasional rose flowerbeds. The walk took about 20 minutes depending on the groups' walking and talking speed. Later in the week participants were emailed to prompt them to walk in nature again that weekend. This aimed to create more moments in nature and reach the beneficial levels of nature engagement per week.

Self-reported measures

To assess change in how the participants related to nature and their overall wellbeing, the study used the following measures (Table 1): Inclusion of Nature in Self (INS); Nature Relatedness (NR-6); and Recovering Quality of Life (ReQoL) (Nisbet and Zelenski 2013; Martin and Czellar, 2016; Keetharuth *et al.*, 2018). The two measures of *connection to nature* (INS and NR-6) allow for different aspects of an individual's connections to be measured. ReQoL is specifically focused on the mental aspects of *quality of life*. An improvement in ReQoL of at least five points is considered either within the clinical range if the ReQoL score is 24 or lower, or non-clinical if the score is 25 and over. NR-6 is trait based and focused on the 'self' and 'experience' based dimensions. INS is a concise single

item scale, designed to measure the extent that an individual includes nature as part of their identity.

Table 1 Overview of measures used in app and questionnaire

Name	Measure	Scale	Extract
Inclusion of Nature in Self (INS)	The extent that an individual includes nature as part of their identity	Single score	
Nature Relatedness (NR-6)	Trait based and focused in relation to nature, aspects of 'self' and 'experiential'	6-item scale	I feel very connected to all living things and the earth.
Recovering Quality of Life (ReQoL)	Mental health aspects of quality of life	10-item scale	Over the last week: I found it difficult to get started with everyday tasks

All of the quantitative data collected within this research is self-reported. Self-reported measures can be influenced by a number of factors including societal pressures and the participants' desire to respond to the researcher. In research which investigates wellbeing outcomes, self-reported data is the most common technique. Evidence has shown that individuals are accurate in knowing their own health and the changes within this (Krueger and Schkade, 2008). Self-reported measures can be less robust for interpersonal comparisons and individual factors such as economic status may have an influence (Krueger and Schkade, 2008). Hence, this analysis is primarily focused on comparison across time points on the same individual or means between groups. The groups were formed to be reflective of the student population and as balanced as possible to reduce the influence of individual factors (age, ethnicity and gender). Taking multiple measurements across time points increased the reliability of the findings.

Intervention study

The interventions both occurred over the same 7-day period with a pre, post and follow up questionnaire. The follow up measure occurred on day 30. This was to allow for potential behaviour change to occur. This study contained two interventions: a mobile phone app 'Shmapped' and a walk intervention which involved one group walk and one individual walk. These were divided into three conditions: (1) App group, (2) AppWalk group and (3) Walk group. A second wave of recruitment and intervention for the walk condition was needed to mitigate for the high dropout rate which occurred in the initial wave of research, potentially due to poor weather. To reduce change in environmental conditions and not clash with the Easter holidays, the second wave occurred the following week. To monitor for bias created by the involvement of a facilitator to the app users, an additional group was created from the larger Shmapped study (McEwan *et al.*, 2020). This group was extracted from the Shmapped dataset based on their age and gender (occupation was not collected by Shmapped). These participants had undertaken their app use at a similar time of year.

The intervention was run in two waves in Spring 2018. It should be noted that during this time there was a strike by university staff, which stopped teaching on campus, and unprecedented heavy snow. Both are likely to have affected the study, but also reflect the varying nature of university life for students.

Participant Recruitment

Recruitment aimed to be representative of the student population and avoid the common issues within this area of research, where those who are already engaged with nature are interested in participating – thus perpetuating the knowledge gap regarding those with limited nature connection.

Nearly 250 expressions of interest forms were completed by students. Accounting for eligibility and duplication, the study included 240 potential participants. Using stratified sampling on year of study, gender, age and ethnicity (to replicate the university's current undergraduate population), 50 participants per group were contacted, resulting in 25 participants per group willing to take part. A second wave of recruitment was run to bring this to 30 per group, (total of 90 contacted). On the day of the group walk a further 20% dropped out. This resulted in a third wave of recruitment. Sixty-nine participants completed the baseline-questions and 52 completed all three time point measurements. The addition of 60 Shmapped users were added to the dataset, these users did not require recruitment and would support the robustness in the tests conducted.

The project was ethically reviewed by the Department of Landscape Architecture in accordance with procedure laid down by the University of Sheffield's Research Ethics Committee.

Results

Initially the data was tested for normality, this allowed the researcher to identify which statistical tests can then be applied to check for relationships between the data. Whilst the data shows changes across time, the statistical tests identify changes that are statistically significant, ensuring that finding have enough data to be confident in the output.

Descriptive Statistics

Non-parametric tests were used due to the modest sample sizes and Shapiro-Wilk test of normality demonstrating data were not normally distributed.

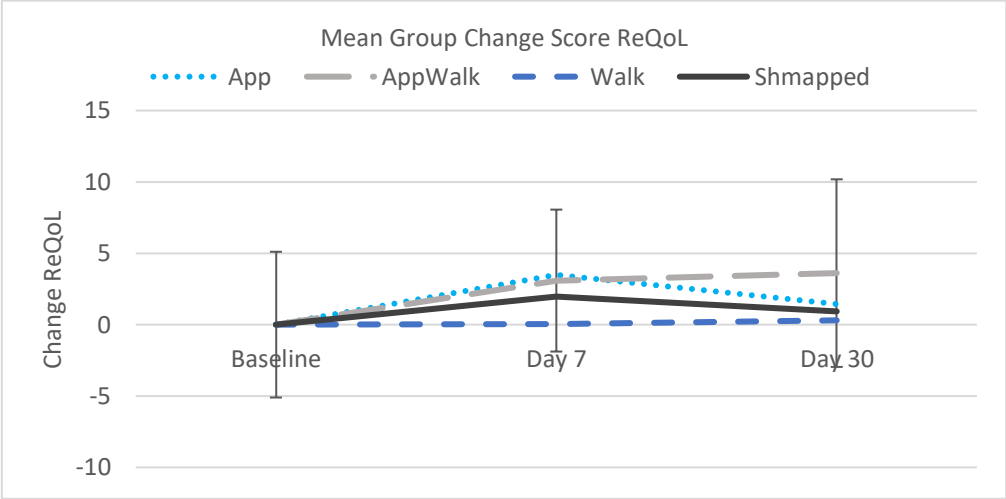
Table 2 below shows descriptive statistics for the measures and demonstrates the large variability within the data. The change across time is shown graphically in Figure 1.

Table 2 Variables' Means and Deviation

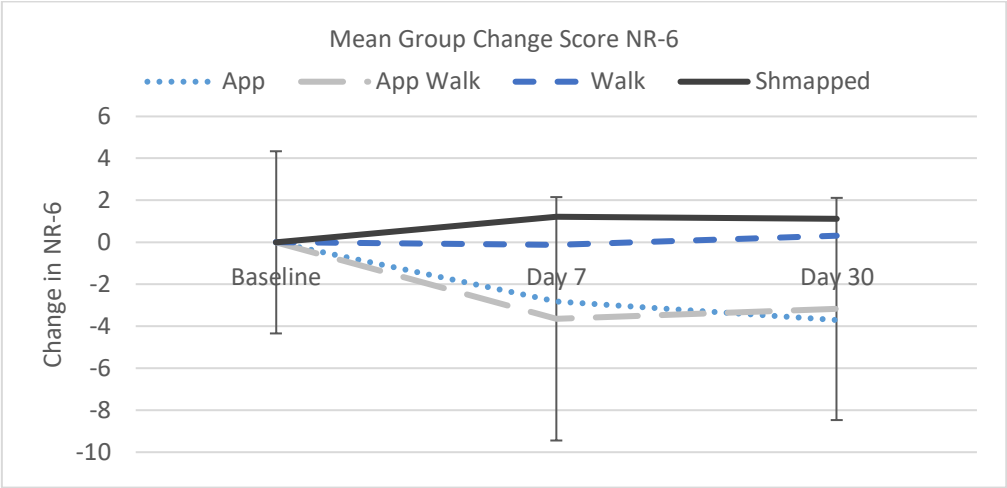
Measure	Condition	Baseline (Day 0)	Day 7	Day 30
Mean (SD)				
ReQoL *Change of 5 signifies clinical improvement*	*Group 1: App*	28.96 (5.73)	32.45 (3.88)	30.41 (4.70)
	Group 2: AppWalk	29.00 (5.10)	32.09 (4.97)	32.61 (6.57)
	Group 3: Walk	31.11 (3.90)	31.16 (4.94)	31.41 (5.32)
	Group 4: Shmapped	28.07 (6.83)	30.04 (5.98)	28.98 (6.43)

Measure	Condition	Baseline (Day 0)	Day 7	Day 30
Nature Relatedness (NR-6) *Average college student score is 3.28*	*Group 1: App*	4.15 (1.03)	3.68 (1.05)	3.53 (1.16)
	Group 2: AppWalk	4.29 (0.72)	3.68 (0.97)	3.76 (0.88)
	Group 3: Walk	4.05 (0.87)	4.03 (0.88)	4.11 (0.85)
	Group 4: Shmapped	3.39 (0.94)	3.6 (0.94)	3.58 (0.93)
Inclusion of Nature in Self (INS)	*Group 1: App*	43.35 (21.96)	48.30 (21.17)	50.36 (22.67)
	Group 2: AppWalk	49.62 (20.74)	54.17 (24.81)	55.44 (24.10)
	Group 3: Walk	40.39 (17.50)	50.24 (20.84)	46.14 (20.06)
	Group 4: Shmapped	42.55 (22.94)	46.38 (22.30)	51.16 (22.04)

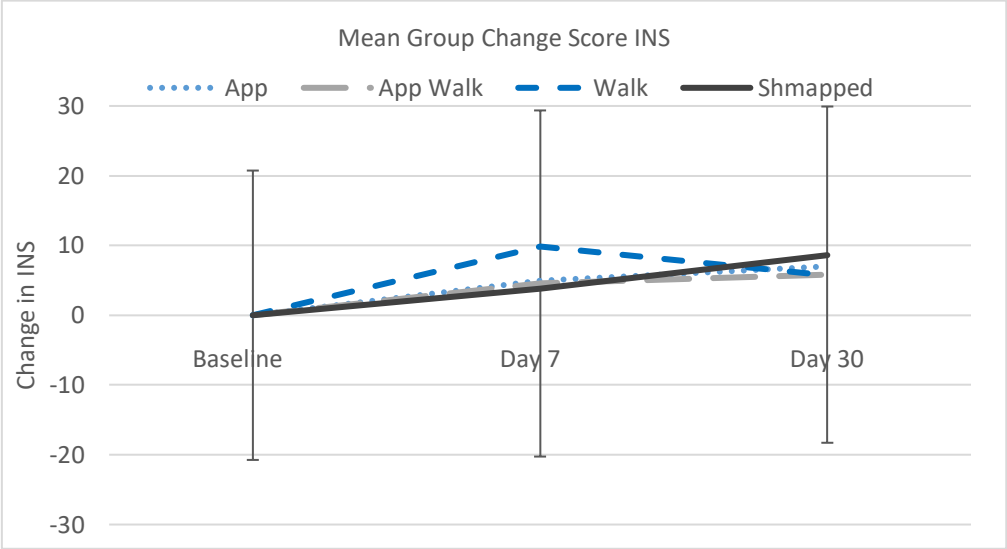
Figure 1. Graphs showing mean change between groups and outcome measures



a) Group mean change score by group for ReQoL



b) Group mean change score by group for NR-6



c) Group mean change score by group for INS

Research Question:
(1) How does a walking intervention and a mobile phone app intervention in urban nature compare, in terms of their effect on nature connection and wellbeing measures?

This research question is divided into the following hypothesis:

1. **Hypothesis One: The participants will experience a positive change across the intervention in connection to nature and quality of life scores.** Connection to nature is explored as NR-6 and INS. Quality of life is measured as ReQol.
2. **Hypothesis Two: The app and walk intervention will experience a positive change between baseline (day 0) to day 7 and baseline to day 30 in both connection to nature and therefore quality of life.** It is expected that group 2 (AppWalk) will demonstrate the highest increase over the intervention compared to the other groups.

Hypothesis One:

This hypothesis tested if the intervention had an effect on the participants' wellbeing or connection to nature and was run on related samples (Table 3). The null hypothesis is that the distribution between the three time points are the same. This test was run on ReQoL, INS and NR-6 for the four groups. The Friedman's non-parametric ANOVA allowed for the same population to be tested across time points. **The null hypothesis states that the distribution across the time point 0, 7 days and 30 days are the same.**

Table 3 Hypothesis One b: Friedman's ANOVA

Condition	NR-6 (n, d.f, p**)	ReQoL (n, d.f, p**)	INS (n, d.f, p**)
Group 1 App	Difference *(17, 2, 0.000)* Δ	No diff. (17, 2, 0.000)	Difference (17, 2, 0.032) Δ
Group 2 AppWalk	Difference *(16, 2, 0.000)* Δ	Difference *(16, 2, 0.000)* Δ	No diff. (16,2, 0.773)
Group 3 Walk*	No diff. (6, 2, 0.827)	No diff. (6, 2, 0.827)	No diff. (6, 2, 0.834)
Group 4 Shmapped	No diff. (56, 2, 0.497)	Difference. *(56, 2, 0.497)*	Difference (55, 2, 0.007) Δ

Δ represents a significant change; *due to an error in data collection n=6; ***Significance threshold* = *p 0.05*

Connection to nature (NR-6 and INS): Table 3 shows a significant change in the NR-6 scores within the App and AppWalk condition. The result for NR-6, however, showed negative change – which was contra to expectation. Significant positive increases were found for INS for both the App and Shmapped groups.

Quality of life (ReQol): For ReQoL score, a positive change occurred across the time points within the Shmapped dataset and the AppWalk group.

The participants did not all experience a significant increase across all groups for the connection to nature and quality of life. Therefore, the hypothesis that all participants will experience an increase in both scores over the three time points of the intervention is rejected.

Hypothesis two:

A Mann-Whitney was conducted to test the difference between the groups (Table 4). The independent variable was the change in scores (either ReQoL, NR-6 or INS) between the two times periods (baseline today 7; and day 7 to day 30). The null hypothesis is that the two sample sets of data have been taken from a common population so any apparent difference between them is due to chance. To reject the null hypothesis would be to state that the difference between the sample sets of data is due to an intervention (*i.e.* not chance and a significant difference between the groups exists).

Table 4 Mann-Whitney of Variables of Interest against Groups

Condition	ReQoL		NR-6		INS	
U (p*)	Baseline - Day 7	Day 7 - 30	Baseline - Day 7	Day 7 - 30	Baseline - Day 7	Day 7 - 30
App v AppWalk	No diff.	Sig. diff.	No diff.	No diff.	No diff.	No diff.
	218 (0.769)	80 (0.045)	195 (0.391)	111 (0.353)	217 (0.742)	113 (0.406)
App v Walk	Sig. diff.	No diff.	Sig. diff.	No diff.	No diff.	No diff.
	148 (0.020)	36 (0.319)	150 (0.021)	40 (0.414)	232 (0.681)	33 (0.206)
App v Shmapped	No diff.	No diff.	Sig. diff.	No diff.	No diff.	No diff.
	416 (0.088)	399 (0.358)	250 (0.000)	378 (0.196)	565 (0.697)	446 (0.775)
AppWalk v Walk	Sig. diff.	No diff.	Sig. diff.	No diff.	No diff.	No diff.
	170 (0.015)	39 (0.541)	142 (0.002)	48 (0.971)	238 (0.302)	41 (0.605)
AppWalk v Shmapped	No diff.	No diff.	Sig. diff.	No diff.	No diff.	No diff.
	481 (0.077)	308 (0.068)	198 (0.000)	438 (0.891)	679 (0.907)	345 (0.188)
Walk v Shmapped	No diff.	No diff.	No diff.	No diff.	No diff.	No diff.
	150 (0.734)	150 (0.735)	644 (0.415)	158 (0.810)	623 (0.219)	99 (0.107)

**Significance threshold = p 0.05*

Connection to nature (NR-6 and INS): The Mann-Whitney found no differences in INS responses between the groups either for baseline to day 7 or between day 7 and 30. Similarly, there were no differences for NR-6 between day 7 and 30. There were significant differences in NR-6 for baseline to day 7 between the: App and walk; App and Shmapped; AppWalk and walk; and Appwalk and Shmapped. Recourse to Table 1 and Figure 1 suggests that differences result from the negative change in NR-6 for the App and Appwalk, whereas in contrast the walk intervention remained unchanged (baseline to 7 days) and there were some positive increases within the Shmapped group.

Quality of life (ReQol): The only significant differences at baseline to day 7 were between: App and Walk and AppWalk and Walk. This appears to be driven from no change occurring for the Walk but increases in ReQol being found for both the App and AppWalk interventions. As shown in Table 3, there is a difference between the App and AppWalk for ReQoL between day 7 and 30, where the AppWalk remains relatively constant, but App scores experience negative change (Table 1 and Figure 1).

This hypothesis is accepted. Between baseline and day 7 there is a significant difference in NR-6 and ReQoL scores for the App versus Walk interventions. In relation of NR-6 score there is significant difference between most of the groups between baseline and day 7 (App v Walk; App v Shmapped; AppWalk v Walk; and AppWalk v Shmapped). However, the hypothesis is rejected if considered in relation to the INS only as there was no significant difference between the groups in relation to the nature connection when measured as INS. The difference in nature connection

outcome could be partial explained by the difference in measurement; NR-6 measures trait-based aspects considering elements of 'self' and 'experience', whereas INS is a single measure for the extent to which an individual includes nature as part of their identity.

It was expected that there would be a consistent difference between the Walk and App condition. However, the variety of similarities and differences between groups displayed in this data suggests the need for further research and that the difference in the type of nature connection and quality of life is a more complicated mechanism than previously explored.

Discussion

Limitations and Opportunities

There may be additional variables affecting participants that have not been accounted for within the study. Statistically significant differences between groups may not have been identified within this study due to the relatively small participant numbers. Additional research would be required to test this further. Whilst the size of this study limits the generalisation of the findings and application to the wider population, it does maintain a manageable participant size for recruitment and intervention implementation. It also reflects the challenges of creating a nature-based intervention scheme at university. With changing timetables and prioritises, the high level of initial interest did not convert into a high level of intervention adherence. This research examined both (1) the outcome, and (2) the experience of the intervention.

Outcome: the role of the intervention for connection to nature and quality of life

The sample size and variation in the data effected the significance of the findings. Whilst trends were visible within the descriptive data, the robustness required for statistical significance in the further analysis was often not met. However, there was a difference between the interventions as displayed through hypothesis one and two. When compared to each other the intervention displayed differences in quality of life and connection to nature (NR-6), but no difference between groups in relation to connection to nature when measured as INS (Table 5).

Table 5 Overview of result change

Baseline to post intervention (day 7)	NR-6	INS	ReQoL
Group 1: App	↓Decrease	Same	Increase ↑
Group 2: AppWalk	↓Decrease	Same	Increase ↑
Group 3: Walk	Same *Slight negative*	Increase ↑	Same *Slight negative*
Shmapped	Same *Slight positive*	Same *Slight positive*	Increase ↑

The participants who used the app experienced a negative change in their connection to nature (when measured as NR-6) over the 7-day intervention. The participants in the walk intervention experienced no change in their wellbeing score. In relation to connection to nature, the walk only group displayed no change in their NR-6 score but had a positive increase in INS score that suggests an increase in how they embed nature within their own identity post intervention. After 30 days, all participants using the app experienced a negative change to their connection to nature score (NR-6). For wellbeing, the App group (group 1) experienced no change over the 30 days; over the same time period, the AppWalk group (group 2) experienced a negative change (both statistically significant). The Walk group (group 3) experienced no change in wellbeing score or connection to nature score after 30 days (not statistically significant). The participants drawn from

the Shmapped dataset experienced no change in nature connection across the 30 days. The wellbeing score for the Shmapped participants increased at day 7 (post intervention) and then decreased at the follow up on day 30.

The trend overall for all participants was an increase in wellbeing after 7 days, decreasing at day 30. For connection to nature this was a negative score at day 7 and day 30. When connection to nature is measured through INS there is a positive change in the overall data set with small effect. This suggests further research is required to identify the nuanced differences which have occurred for the participants. It would appear that for some participants their trait-based relationship with nature has decreased, but the inclusion of nature within their identity has increase over the intervention.

To summarise in terms of statistical outcomes, using the app had a positive effect on the participant's quality of life, however it had a negative or no effect on their connection to nature. Taking part in a walk only intervention had a positive or limited effect on the participant's connection to nature but no effect on their quality of life. The limited statistical power behind these numbers minimises the opportunity for generalisation of the results. The IWUN project conducted the app intervention across a larger population and geography, with recruitment from across the city of Sheffield. The findings from this research presented a positive outcome in recovering quality of life and connection to nature (McEwan *et al.*, 2019). In contrast to the Shmapped research from IWUN (McEwan *et al.*, 2019) and the evaluation of 30 Days Wild (Richardson *et al.*, 2016), this research did not find a significant positive association between increased nature connection and wellbeing. This could be due to the number and type of participants involved (difference in sample size and focused on a student population aged 18-24 years old). This outcome highlights the complexity of nature-based interventions.

Experience: the lessons learnt and participants' experiential differences

The implementation of any new method using novel technology is likely to face challenges. Whilst the app was reported by participants in the focus groups as easy to use, it did present several issues brought to our attention through: personal use of the app, emails from the IWUN study participants and emergence over time. These included notification glitches, software update issues and GPS inaccuracies. One of the design challenges with all app development is different platform software, compliance requirements and updates. This would be a challenge for any population level intervention on a smartphone.

It became apparent during the focus groups that participants did not use all of the app's features resulting in incorrect placement of location and lack of uploaded user generated photos. A more extensive user test phase may have identified these issues earlier. Participants also expressed a lack of interest in the app beyond the study. The balance between research tool, behavioural change intervention and enthusing the public is a challenge for all research-based nature apps (Jepson and Ladle, 2015). As discussed in other literature, mobile phone apps within this category are generally either gamified (incorporating game-based activity to encourage participation) or knowledge-based (Buettel and Brook, 2016). As the Shmapped app is a dual data collection tool and wellbeing intervention, it was not a knowledge based or gamified nature-based app and this is where participants felt it lacked long-term potential from a user perspective.

Maintaining app adherence was an issue in this research and was also a challenge in the Shmapped study within the overarching IWUN research project. Within the IWUN project research, of the 582 participants who were eligible to participate and completed the baseline questionnaire, only 27.5% went on to complete the final follow-up measures (McEwan *et al.*, 2019). Both this research and the IWUN study included incentives and targeted recruitment to mitigate the uptake and

adherence issue. This aspect of apps for research can be overlooked, future app-based research should plan for similar challenges.

There is the potential for an adverse effect caused by the distraction of a mobile phone app, thus actually preventing users from noticing nature whilst in nature. Specifically, the notification to notice something could be distracting from engaging with the environment and for participants they reported being out cycling or driving past a green space when the prompt/alert occurred. This was not only a challenge with geofencing areas accurately but also the user's response to being interrupted. Richardson, Hussain and Griffiths' (2018) work identified the need for more research into the influence of individual traits in effective behavioural use of mobile phones and the effect on connection to nature. Generally, focus group participants were unlikely to recommend the app to a friend, but discussed the opportunity of an app which encouraged positive wellbeing based in local nature recommendation. This would be an interesting area to explore further.

A strength of this research is that it allowed for comparison between the outcome measures and the participant's experience of the intervention. It is this comparison that revealed some of the more interesting dimensions, such as personal connection to an area or social pressures to not visit a green space during the day (Boyd, 2022). An opportunity to further explore this research development would be provided by a closer examination of an individual's accumulated data across the study from understanding the pathway the participants took from signing up (leaflet, society approach or email advert), through to their change over the course of the intervention and finally their reflection on the experience. It would be beneficial to understand the baseline profile of the participants in more detail, including their lifestyle practices, environmental behaviours and use of other nature-based apps. This was not a consideration during the research design and therefore the process of maintaining anonymity of the participants (limited personal details collected at expression of interest, registers of walk and focus groups were destroyed after use) made this unachievable.

To further test the effect of nature-based interventions on individuals with a low nature connection it would be beneficial to repeat the study with additional participants (to increase robustness of the analysis outputs) and to collect nature connection scores at the point of sign-up. This would allow the researcher to predispose the composition of the study group more reliably towards those who are less likely to participate in this research area, which is important as this represents a current knowledge gap within the literature. There is a known influence of gender in the effect of nature connecting in the workplace and if more data had been available, it would have been desirable to run analysis that controlled for the influence of gender on the data (Lottrup, Grahn and Stigsdotter, 2013). The exploratory analysis of gender offered some insight to the influence this factor may have. This would be a suitable opportunity for future research.

This research was the first of its kind to test the implementation of a green prescription for UK university students. The challenges of unpredictable weather, university timetables and other more pressing priorities (as shown in the recruitment numbers and dropout rate) made it difficult to maintain participant numbers. Similarly, uptake and adherence has been reported as a challenge for implementing this style of intervention in New Zealand (Hamlin *et al.*, 2016). Therefore, for nature-based or green prescription interventions to be successful in the university population there is a need for further research, including learning from other social prescribing failures and successes.

Conclusion

Novel Nature-based Intervention for University Students

The challenges experienced in creating an intervention which suits the target audience (in this case university students) allows others to learn and examine the unique differences. Challenges included the effect of time prioritisation and immediate urban nature infrastructure on the effectiveness of nature-based interventions for university students. The role of an intervention was of equal importance to the surrounding infrastructure. This research demonstrated the lessons learnt from a novel nature-based intervention for university students. The experience of this research also highlights challenges to implementing novel technological interventions. The success and challenges of novel technological intervention should be discussed more openly to support future alternative developments. The difference in outcome measures and direction of change emphasises the requirement for a holistic approach to improve student wellbeing, including different ways to integrate nature into the university experience. The time and events which have occurred between the PhD research (conducted in 2018) and this article's publication have further highlighted the demand for better support for university student mental health. As highlighted in the complex results from this research, support should be designed with consideration to the target population and their multifaceted social and environmental determinants of health.

Health, Wellbeing and Nature

This research has demonstrated that the relationship between different aspects of an individual's relationship with nature (as accounted for with the two different measures of nature connection) is complex and dynamic. The influence that 'connection to nature' has on quality of life is also not necessarily a direct mechanism (Markevych *et al.*, 2017). The difference in outcome measures and direction of change suggests there may be additional variables affecting participants that have not been accounted for within the study. Further research into university students' relationship with the natural environment should consider the additional lifestyle and work-related influences.

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