

# Enhancing health and wellbeing through green infrastructure design and construction: Impacts of the Fit For the Future project on NHS healthcare staff, patients and community members

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## Abstract

Spending work or leisure time in nature-based settings has positive impacts on health and wellbeing especially for those experiencing stress or those with poorer physical health, mental health or wellbeing. This research examined the impact of participation in a sustainable green infrastructure and landscape management project delivered through Down to Earth at a National Health Service (NHS) hospital site. The three participant groups comprising healthcare staff ( $n=27$ ), NHS patients ( $n=37$ ) and community participants ( $n=22$ ) experienced changes in one or more self-reported measures over time. Patient and community participants showed reductions in self-reported anxiety, boredom and sense of failure. Healthcare staff showed increased resilience, wellbeing, community connection, and connection to nature alongside a reduction in common mental health symptoms. These findings reveal positive impacts of “working in/with nature” on wellbeing and mental health, and provide novel evidence of their potential for improving the health/wellbeing of healthcare workers within their workplace.

## Keywords

green care, sustainable construction, mental health, wellbeing, burnout

## Introduction

The health and wellbeing benefits of “being in” and “interacting with” a natural environment (nature exposure) are increasingly being recognized and quantified (Haubenhofner et al., 2010; Twohig-Bennett and Jones, 2018). Research has shown the potentially positive effects of

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nature exposure on the mental health of those with physical health problems (Trøstrup et al., 2019), and on mental health (e.g. depression and anxiety) and wellbeing (including stress) more widely (e.g. Coventry et al., 2021; Jimenez et al., 2021). At the most general level, simply living in and having access to the natural environment can have health impacts. At a population level, living in a neighborhood with greater levels of vegetation cover and more birds has been linked to a lower prevalence of depression, anxiety, and stress (Cox et al., 2017). Additionally, the quality, quantity and availability of green spaces in urban settings (Callaghan et al., 2021) and engaging in nature-based recreation (i.e. leisure activity that relies on the natural environment; Lackey et al., 2021) have both been positively associated with improved mental health. Such positive impacts of experiencing nature appear to be especially evident for those living in or moving to more socioeconomically deprived areas (Belcher et al., 2024; Thompson et al., 2021).

Alongside the general mental health and wellbeing benefits of nature exposure (Geary et al., 2023), the positive effects of nature-based settings and schemes on clinical groups with existing mental health problems have also been examined. For example, woodland management activities have been reported to have positive health, wellbeing and social connectedness outcomes for those with depression (Townsend, 2006), whilst accessing garden spaces may reduce agitation amongst those with dementia in a care home setting (Whear et al., 2014). A recent systematic review and meta-analysis revealed that nature-based interventions improved depressive mood and increased positive affect and reduced anxiety and negative affect amongst adults including those with pre-existing mental health problems (Coventry et al., 2021). Gardening, green exercise and nature-based therapy, offered for 20–90 minutes over an 8 to 12 week period were found to be particularly effective. Alongside this, research has also shown the positive impacts of nature-based interventions on those living within a range of institutional settings such as hospitals

and psychiatric settings, nursing or retirement homes and in prisons (Moeller et al., 2018). Researchers have also examined more intensive programs comprising day long sessions taking place over a 6–12 week period. In a study using an innovative “sustainable construction” approach, participants who were considered vulnerable or hard to reach were actively involved in building useable structures (e.g. meeting and office spaces) using traditional sustainable materials (e.g. cob). Those with pre-existing poor mental health and social connection showed statistically and clinically significant improvements in depression, anxiety, resilience, and social connection over the course of their engagement (Davies et al., 2020). Thus, active participation with and within nature may lead to mental health benefits in addition to those associated with simple exposure to blue (water bodies such as rivers and lakes and beaches; White et al., 2021) and green spaces (places containing vegetation e.g. parks, woodlands, gardens and countryside; see Taylor and Hochuli, 2017 for a detailed discussion).

The COVID-19 pandemic placed a specific focus on access to and engagement with outdoor spaces. Whilst wide-ranging impacts of lockdowns introduced as part of the global response to the COVID-19 pandemic have begun to be articulated (Onyeaka et al., 2021), green space access appeared to play an important role in individual’s welfare during this time (Day, 2020). For those providing hospital-based care, a range of negative mental health impacts were reported during the pandemic (Dragiotti et al., 2022). To reduce stress and aid coping with the challenges presented, arguments were made for staff to have access to outside and garden space within their workplace and during work-time (Iqbal and Abubakar, 2022). Advocating for the importance of access to work-based green/outdoor spaces for care staff have continued since the pandemic, with a small but growing evidence base developing to support this (Sachs, 2023). Evidence from the workplace more widely shows a range of nature exposure approaches being taken, typically

occurring within an employee's lunch break (Gritzka et al., 2020). However, study quality and risk of bias ratings show significant limitations within this evidence base.

Together, the available body of research reveals positive impacts of being in and engaging with nature on the general population and for those with mental health difficulties, with an emerging evidence for the impacts of nature exposure within the workplace. However, many of the nature exposure approaches, especially those for healthcare staff within work, are short and utilize rest or break periods. Consequently, the current study sought to investigate the impact of engaging in a unique nature exposure intervention – a sustainable construction/sustainable land management project – on three participant groups: healthcare staff, patients, and community members. For all groups this involved attending day long sessions over a 6–8 week period, and for healthcare staff this replaced their usual job role for the day. It was hypothesized that structured engagement would

- i. improve participant self-reported current mood and experience
- ii. increase participant self-reported social connection and connection to nature
- iii. increase healthcare staff participants' self-reported workplace wellbeing (reduce burnout), general wellbeing, resilience and mental health

## Method

### Design

A quantitative within-subjects (repeated measures) design was utilized in which participants completed a set of self-report psychometric measures at the start of the program (time 1) and again in the penultimate session (time 2).

### Intervention

Participants engaged in a brief (1 day per week, 6–8 week duration) group-based land management and sustainable construction program. The Fit For the Future – Our Health Meadow

project (<https://downtoearthproject.org.uk/fit-for-the-future/>) was a green infrastructure partnership project between Down to Earth, Cardiff & Vale Health Charity and Cardiff & Vale University Health Board delivered at the University Hospital Llandough site. The scheme was designed to transform a neglected piece of land owned by and adjacent to a busy district general hospital site from an overgrown woodland and semi-natural grassland to a grass meadow and outdoor healthcare and rehabilitation facility. The project ran from 2021 to 2023; however, participants typically joined for a single 6–8 week program during this period. Where participants engaged in successive groups, study data was collected during their first group engagement only. Program sessions were attended by National Health Service (NHS) healthcare staff, NHS patients, and non-NHS community participants, during which participants actively engaged in and contributed to the work being undertaken on site at that time. This included land and woodland management activities, planting, craft-based activity, and creating temporary and permanent structures with sustainable materials. Each 6–8 week program undertook specific aspects of this work under the direction and guidance of a small team of skilled workers.

### Participants

All those attending program sessions outlined in the intervention above were invited to take part in the research. NHS healthcare staff and NHS patients and were drawn from a number of services located on the main hospital site (e.g. mental health, neurorehabilitation, heart disease) whilst community participants took part through their involvement with other organizations (e.g. The Prince's Trust, the Welsh Refugee Council) or education (e.g. college). Staff came from nursing and occupational, physical and psychological therapies backgrounds. All participants were required to have capacity to, and to provide informed consent. In total, 86 people completed both time points of the study (NHS healthcare staff,  $n=27$ ; NHS patients  $n=37$ ; non-NHS community  $n=22$ ).

NHS healthcare staff participated in the project either as part of their role in supporting a patient(s) to access the program ( $n=14$ ) or through attending a funded and accredited Wellbeing in Nature Practitioner Training course ( $n=13$ ). This course provided healthcare staff with the skills and experience required to deliver rehabilitation and recovery in the outdoors. The overall sample contained 26 men, 59 women and one person who identified as non-binary; the average age was 37.4 years (NHS healthcare staff: three male, 24 female, average age 38.4 years; NHS patients: 17 male, 19 female, one identified as non-binary, average age 40.8 years; Community participants: six male, 16 female, average age 28.5 years).

### *Ethical approvals*

Ethical approval for the community participants was received from Swansea University (Ref: 2021-5253-4378) and for NHS patients and NHS healthcare staff via the Integrated Research Application System (Project ID: 302027).

### *Materials*

*Self-report measures: All participants.* All participants completed a standardized set of self-report measures. Measures were selected based on their psychometric properties, and their availability, brevity, and ease of use.

*The Emoji Current Mood and Experience Scale – Abbreviated.* The abbreviated Emoji Current Mood and Experience Scale (Davies et al., 2024; hereafter the Emoji Scale) is a 5-item scale measuring mental health and wellbeing. Items contain Emojis and a single descriptor that reflect different facets of mental health and wellbeing. Participants are required to rate each Emoji on a 5-point scale (from “very little” (0) to “very much” (4)) based on how they feel in general (collected before starting activity) and right now (collected at the end of the day). This tool was developed to provide a quick measure with minimal literacy requirements for the measurement of a range of psycho-social and

wellbeing domains. It has demonstrated good concurrent validity, sensitivity to change, and stability over time.

*The Social Connection Scale.* Social connection was assessed using an adaptation of the Inclusion of Community in the Self Scale (based on Mashek et al., 2007). Participants are presented with pictures showing six pairs of circles at varying stages of overlap (from 1=completely separate to 6=almost completely overlapping). Using the circle pairs, participants were asked to indicate how connected they felt a) to their community at large and b) within Down To Earth, as used in previous research (Davies et al., 2020). The original authors report good test-retest reliability and validity (convergent and discriminant) for the scale.

*The Nature Connectivity Index – Images.* The Nature Connectivity Index – Images (NCI-I; Barry et al., 2023) is an adapted version of the Nature Connectivity Index (NCI-I; Richardson et al., 2019), which measures participants’ connectedness to nature. The six items are rated on a 7-point scale (from strongly disagree to strongly agree), with each item having picture prompts and the scale being supplemented by visual representations for each point of the scale. Research on the original scale showed a single factor with high internal consistency and good concurrent validity. Psychometric examination of the NCI-I suggests equivalence to the original NCI format (Barry et al., 2023).

*Self-report measures: Healthcare staff only.* In addition to the measures above, healthcare staff were also asked to complete four additional measures.

*The short work-related version of the Burnout Assessment Tool (BAT12).* The BAT12 (Hadžibajramović et al., 2022) is freely available tool measures facets associated with burnout in relation to the workplace. A total of 12 items are scored on a 5-point scale; for the current study, the overall level of burnout was calculated (sum score of all items/number

of items). The scale authors have subjected the shortened scale to psychometric analysis including Rasch modeling and have shown the scale to possess good reliability and validity.

*The Brief Resilience Scale (BRS; Smith et al., 2008).* The 6 items of the BRS (Smith et al., 2008), rated on a 5-point scale, indexes a person's ability to bounce back or recover from stress. Levels of resilience were calculated and these were categorized into three groups: Low resilience (1.00–2.99), Normal resilience (3.00–4.30) and High resilience (4.31–5.00) using the cut-offs outlined by Smith et al. (2008). Examination of the scale by Smith et al. (2008) showed a single factor scale with good reliability and validity (convergent and discriminant predictive).

*The Short Warwick-Edinburgh Mental Well-being Scale (SWEMWBS; Stewart-Brown et al., 2009).* The SWEMWBS (Stewart-Brown et al., 2009) is a 7-item 5-point scale measuring subjective well-being. Ratings reflect how often the item content is experienced (from “none of the time” to “all of the time”). Total scores were calculated and then transformed using a method supplied by the scale authors. The scale has been subject to detailed psychometric analysis and a score at or around 23 is typical for the general population (Ng Fat et al., 2017).

*Patient Health Questionnaire – 4 (PHQ-4).* The PHQ-4 (Kroenke et al., 2009) is a widely used, ultra-brief, 4 item scale measuring subjective levels of common symptoms associated with anxiety and depression. Participants rate each item according to how much they have been bothered by the problem described in the last 2 weeks (from “not at all” to “nearly every day”). Total scores based on responses to all 4 items were calculated (sum of items) and were categorized into four groups: None (0–2), Mild (3–5), Moderate (6–8) and Severe (9–12) using cut-offs as indicated by the authors. Scale scores were also produced by combining the two anxiety related items and the two depression related items.

## Procedure

Participants were provided with a Participant Information Sheet by the team at Down To Earth either before starting or on their first day of attendance on the program. All participants were given at least 48 hours to consider the participant information prior to being invited to complete a consent form if they wished to participate. All participants with a signed and fully complete consent form were asked to complete the self-report measures appropriate to their participant group in a quiet space on the Our Health Meadow site. All self-report data were collected during the second (time 1) and penultimate (time 2) sessions the participant was scheduled to attend.

## Approach to analysis

Differences between groups and within groups over time will be assessed using one-tailed (directional) analyses between groups or within-samples / paired ANOVA, *T*-Test or their non-parametric equivalent as appropriate. For the single item measures (i.e. Emoji's and Social Connection), a conservative approach of using non-parametric Wilcoxon tests will be used.

## Results

### Self-reported mood and experience (Emoji scale)

For the sample as a whole, ratings made at time 1 showed that scores for “how I feel now” were significantly more positive than “how I feel on the average day” across all 5 of the Emoji domains (*connected*:  $z=-6.33$ ,  $p<0.001$ ; *failure*:  $z=3.44$ ,  $p<0.001$ ; *anxious*:  $z=4.62$ ,  $p<0.001$ ; *good about self*:  $z=-6.12$ ,  $p<0.001$ ; *bored*:  $z=5.59$ ,  $p<0.001$ ). In addition, the ratings across the whole group for how I feel on the average day significantly improved between time 1 and time 2 in relation to experiencing *failure* ( $z=2.293$ ,  $p<0.05$ ,  $r=0.4$ ); *feeling good about ones-self* ( $z=-2.971$ ,  $p<0.001$ ,  $r=-0.54$ ) and *feeling bored* ( $z=3.315$ ,  $p<0.001$ ,  $r=0.52$ ); subsequent analysis of the

three subgroups revealed these changes were accounted for by significant changes in the ratings given by the NHS patient sub-group.

### *Social connection*

Social connection was assessed both in relation to “my community” and the “community within the project group.” For the sample as a whole, there was a significant increase in general social connection between the start and end of the program ( $z=-2.3, p<0.05, r=-0.35$ ) and in social connection within the project group ( $z=-5.54, p<0.001, r=-0.8$ ). General social connection was rated as significantly lower than the social connection experienced within the project group at both these time points (T1:  $z=3.27, p<0.001, r=0.5$ ; T2:  $z=6.25, p<0.001, r=0.9$ ). Analysis of the subgroups revealed that all three groups showed significant change in relation to social connection experienced within the project group whilst only the healthcare staff group showed change in relation to general social connection.

### *Connection to nature*

In the sample as a whole, participant scores on the NCI-I showed an increase over time indicating that participants felt more connected to nature after participating in the program ( $t(84)=-2.57, p<0.05, d=-0.28$ ). Examination of the subgroups revealed that this change appeared to be accounted for by the significant change seen only in the healthcare staff group ( $t(27)=-3.3, p<0.01, d=0.62$ ).

### *Resilience, wellbeing, mental health, and burnout (Healthcare staff only)*

For the healthcare staff group, mean scores for resilience and wellbeing at time 1 were in line with published norms. Despite this, both showed statistically significant increases over time (BRS:  $t(26)=-2.07, p<0.05, d=-0.4$ ; SWEWBS:  $t(25)=-2.55, p<0.05, d=-0.5$ ). Similarly, the majority of healthcare staff reported no or very low levels of distress on the

PHQ-4 measure at time 1, with a limited number showing mild or moderate levels of distress. Again, statistical analysis showed an overall reduction in staff levels of combined anxiety and depression (PHQ4 total) after participating in the program ( $t(27)=3.78, p=0.001, d=0.73$ ). To examine the clinical significance of the changes in levels of distress being reported, individual scores at time 1 and time 2 were inspected. This revealed 11 individuals with no change in their score over time, two who experienced a one-point increase and 14 people who reported a decrease in distress of between one and six points. These changes corresponded to one person increasing in the categorical description of their distress over time (moving from “none/little” – score 2, to mild – score 3); seven of the nine staff reporting “mild” psychological distress at the start moving to the “none/little” category by the end (six of whom changed by 2 points or more); one person moving from the “moderate” to “none/little” category (score change of 6 points) and another from “severe” to “moderate” (score change of 3 points).

In contrast, no statistically significant change was observed for the overall BAT score; however, when compared to the available norms within the BAT manual (Flemish and Dutch workers; Schaufeli et al., 2019), the average total score at time 1 was already in the “green” range corresponding to “little to no risk of burnout.” Inspection of individual responses showed only five people scoring in the orange “at risk of burnout” category and two people scoring in the red “at high risk of burnout” category when compared against the Flemish sample. Examination of this very small sub-sample “at (high) risk of burnout” ( $n=7$ ) revealed a significant reduction in burnout corresponding to large effect size ( $z=-1.94, p<0.05, r=0.82$ ).

## **Discussion**

This study provides evidence that green infrastructure design and construction within a healthcare setting can impact positively on the staff, patients and community participants who engage in such schemes. The findings of this

study add to the nascent evidence base of the impact and efficacy of the brief group-based land management and sustainable construction program which underpinned the Our Health Meadow scheme (Davies et al., 2020). Engagement in the Our Health Meadow project led to positive changes overall, which were in line with the study hypotheses, that is, improvements in self-reported (i) current mood and experience; (ii) social connection and connection to nature over time and (iii) increases in healthcare staff participant's self-reported workplace wellbeing (reduced burnout), general wellbeing, resilience and mental health, at least in those showing possible issues in these areas at time 1.

Analysis of the data by sub-group indicated that the nature and extent of change varied across the groups. For NHS patients, changes were found in general emotions and experience (sense of failure, good about self and boredom), and in a sense of connection to others within the project. Meanwhile, for those in the community groups, social connection to others within the project increased over time. The mean scores for those in the community group showed no increase in connection to nature or wider social connection over time – starting and remaining in the average range for both. This is in line with previous research (Davies et al., 2020), where change in wider social connection was only found when the analysis was restricted to those showing deficits in this area.

A novel focus for this study was the NHS healthcare staff subgroup. Over half of the healthcare staff who engaged with this research did so whilst supporting NHS patient participants from the clinical areas in which they worked (who were also accessing the scheme). The NHS healthcare staff participants showed positive change across various dimensions examined, namely increases in social connection within the project, and more generally increases in their sense of connection to nature, and increases in their sense of resilience, wellbeing and general mental health. Within the wider NHS context, efforts are being made to promote resilience, health and wellbeing

amongst healthcare staff (e.g. <https://www.workingwellglos.nhs.uk/wp-content/uploads/2019/01/Building-your-own-Personal-Resilience.pdf>, accessed 8/1/25). However, evidence suggests that barriers such as staffing shortages and help-seeking stigma may deter staff from accessing formal workplace health and wellbeing support services (Clarkson et al., 2023). Therefore, providing opportunities for staff to attend green healthcare schemes through supporting patients to engage may provide one way to overcome such barriers and promote staff access.

The most recent NHS Staff survey for Wales found that 41% of respondents “often” or “always” found their work emotionally exhausting, whilst 36% “often” or “always” felt burnt out because of work (NHS Wales, 2024). Although there are no UK healthcare staff norms for the burnout measure used in this study, using the thresholds in the user manual (Schaufeli et al., 2019) the staff sample appear to have had a slightly lower rate of risk of burnout (26%) at time 1 than found using the burnout item reported in the 2023 NHS Wales staff study (36%). Whilst the overall burnout scores for the healthcare staff participants started and remained in the low risk of burnout category, the small number of staff who reported experiencing burnout at the start of the study showed a significant reduction in their self-reported burnout experience by time 2. Whilst possible alternative explanations for this change were not recorded as part of data collection (e.g. changes to working practice or staffing levels within the respondent's workplace), this finding suggests that Our Health Meadow may have reduced workplace burnout for those at greatest risk of this. Further research is warranted to examine this potential effect further.

## Conclusion


This study provides evidence that engaging in sustainable construction and land management approaches on a hospital site as characterized by the Our Health Meadow project impacts positively on factors such as social connection and

wellbeing. It also provides the first evidence for the positive impact of participating in the sustainable design and construction and land management practice delivered by Down to Earth on healthcare staff across various domains including resilience, social connection, connection to nature, wellbeing, and mental health. It may also provide benefits for healthcare staff at risk of workplace burnout. Further access to and research into the impact on healthcare workers of involvement in green infrastructure design and construction on hospital premises is needed. This is especially important given the potential role such schemes could play in both improving the wellbeing of individuals alongside addressing wider climate objectives as set out in government policy (e.g. Well-being of Future Generations (Wales) Act 2015).

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### Ethical considerations

Ethical approval for the community participants was received from Swansea University (Ref: 2021-5253-4378) on 12 October 21 and for NHS patients and NHS healthcare staff via the Integrated Research Application System (Project ID: 302027) on 08 February 22

### Consent to participate

All participants gave written informed consent prior to engaging in the study.

### Consent for publication

All participants gave written informed consent to data being used for publication.

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### Declaration of conflicting interests

The authors declared the following potential conflicts of interest with respect to the research, authorship, and/or publication of this article: Mark McKenna is the co-founder and CEO of Down to Earth and Kate Denner and Chris Dow are employed by Down to Earth.

### Data availability statement

The data are not publicly available.

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