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Research Article

Green Social Prescribing: A Before and After Evaluation of a Novel Community-Based Intervention for Adults Experiencing Mental Health Problems

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There is a strong body of evidence that points to the mental health and well-being benefits of nature alongside a growing evidence based on the health and well-being benefits of green social prescribing. Central to the UK government's commitment to transform mental health services, seven successful 'test and learn' green social prescribing sites were identified across England, including the Humber and North Yorkshire green social prescribing programme. We used a cohort design to compare participants' mental health and well-being outcomes before and after exposure to nature-based interventions offered via a referral from social prescribing organisations linked to the green social prescribing initiative. Data were collected between February 2022 and March 2023 using before and after questionnaires to determine the impact of green social prescribing on mental health and well-being outcomes using ONS-4 and Hospital and Anxiety Depression scales. In total, two hundred and twenty-three participants from across Humber and North Yorkshire were included in the cohort evaluation. Survey data were analysed quantitatively using descriptive and multivariable analyses. After adjustments for deprivation and health status, larger benefits for improvements in well-being were found to be associated with nature-based activities with durations of nine to 12 weeks compared to those with durations of one to four weeks. Horticultural and care farming activities were also shown to be associated with some improvements in well-being over nature-based sports and exercise activities. We have undertaken the first longitudinal and quantitative evaluation of the NHS England green social prescribing "test and learn" programme across Humber and North Yorkshire. Our evaluation in Humber and North Yorkshire showed green social prescribing is beneficial for mental health and well-being among community-based adults, suggesting potential as a timely and relevant community-based intervention to address the demand for mental health care in an era of high unmet need.

1. Introduction

Social prescribing allows general practitioners (GPs), health and social care professionals and other trusted individuals in community settings to refer people to a variety of local, nonclinical services through a social prescribing link worker or 'connector' to support users' health and well-being while strengthening connections with the community [1]. Social prescribing link workers, who are typically nonclinical professionals based in primary care practices or community organisations, manage these referrals and assist individuals in accessing community-based resources through engaging in a 'What matters to you' conversation [2]. The social prescribing process generally involves an initial referral (e.g., from primary or secondary healthcare), intermediary support from the link worker or 'connector' and a social prescription (e.g., advice, programmes or activities), with impacts at individual (e.g., health and well-being), community (e.g., social connectedness) and systems level (e.g., health service usage) [3]. Social prescriptions encompass a broad range of services, including physical activity programmes, arts and cultural activities, nature-based activities, volunteering opportunities, advice (e.g., housing support, financial and legal services) and adult education and literacy programmes [4, 5].

Social prescribing is currently offered in over 20 countries worldwide and is continuing to expand globally [1]. Despite this growth, terminology and delivery models vary both across and within countries [6], and conceptual and operational definitions have only recently been established [1]. In the United Kingdom, health policy is devolved, resulting in different models of delivery across the four nations—England, Scotland, Wales and Northern Ireland. In England, social prescribing is guided by NHS England and is an integral part of the comprehensive model of personalised care that underpins whole population approaches to support people of all ages and their carers to manage their health, build community resilience and make informed decisions about their healthcare [7]. Priority cohorts for social prescribing in England include adults experiencing subthreshold and mild to moderate common mental health problems [8].

Social prescribing can offer significant value by adding to conventional models of health (which primarily focus on treating health conditions) through its emphasis on prevention, health promotion and addressing social determinants via collaborative partnerships between the health sector and the voluntary, community and social enterprise (VCSE) sector [6]. Lifestyle factors and chronic stress are influential risk factors in the development and exacerbation of various health conditions, such as anxiety, depression, coronary heart disease and other noncommunicable diseases [9–13]. This underscores the relevance for accessible and affordable interventions at individual and community levels to support the management of modifiable risk factors and other determinants of health [12, 14, 15]. Furthermore, having multiple physical health conditions is associated with increased hospitalisations and comorbid anxiety and depression [16]. This is of significance as a quarter of all adults in England currently live with two or more long-term conditions (LTCs) [17].

There is also growing demand for mental health services [18], and an increased focus on the importance of identifying alternative effective treatments [19]. During the COVID-19 pandemic, the prevalence of anxiety and depression increased [20], with 21% of adults in Great Britain experiencing depression (compared to 10% in March 2020) [21]. Rates of depression for adults in Great Britain remain elevated (16%) compared to prepandemic levels, where in the context of a cost-of-living crisis, 27% of adults in Great Britain who struggled to pay energy bills reported depressive symptoms [22]. In the United Kingdom, the demand for mental health support is exceeding supply, with forecasts indicating that over the next three to five years, at least 10 million people will require support for depression, anxiety or both [23].

Green social prescribing, as a variant of social prescribing, involves connecting people to nature-based interventions, which are activities, strategies or programmes designed to enhance health and well-being through engagement with nature [24]. Nature-based interventions aim to harness the direct and indirect mental health benefits associated with nature engagement, such as stress reduction [25, 26], reduced anxiety and depression [27, 28], increased positive affect [29, 30] and enhanced social capital [31, 32], while conferring environmental cobenefits, such as ecosystem restoration and biodiversity enhancement [33]. Nature-based interventions generally fall into two categories: 'green' activities, which involve engagement with nature in predominantly terrestrial environments to promote health and well-being (e.g., social and therapeutic horticulture, nature conservation activities and exercise-focused activities such as walking), and 'blue' activities, which involve engagement with aquatic environments (e.g., sports-related activities such as fishing and exercise-focused activities such as surfing) [15, 34].

Emerging evidence suggests that nature-based interventions can significantly enhance mental health. A review of 36 experimental and quasiexperimental studies indicated that interventions involving nature, particularly group green walks and gardening, are linked to improved well-being (in five studies) and reduced stress (in 18 studies) [35]. Similarly, nature-based interventions, such as gardening, green exercise and therapies utilising natural spaces for stress relief (e.g., forest bathing), were shown to effectively reduce depression and anxiety while improving emotional well-being [36]. Research also demonstrates the mental health benefits of blue interventions/prescriptions [34, 37]. These interventions may be particularly suited for populations less represented in social prescribing schemes, such as males and individuals with physical disabilities [38]. Moreover, tailoring nature-based interventions to specific populations has the potential to enhance impact, widen accessibility to social prescribing and reduce health inequalities [39, 40].

Green social prescribing may have greater relevance now than ever in supporting positive mental health and well-being outcomes. Recent World Health Organisation (WHO) guidelines recommend psychosocial interventions over antidepressants for adults, suggesting the use of antidepressants only when psychological interventions are unavailable [41]. The inclusion of nature-based interventions alongside conventional therapies has also been emphasised, where engaging with nature has been linked to improvements in affective states, cognitive function and overall mental health across diverse populations [42]. A recent review found that at least 10 minutes of nature exposure can provide short-term benefits for adults with mental illness, highlighting potential healthcare implications for prescribing nature-based interventions [43]. While there is emerging evidence that green social prescribing is associated with positive improvements in depression and anxiety, much of this evidence is at high risk of bias [27], underscoring the need for robust evaluations to establish the health benefits of green social prescribing.

Green social prescribing is a central component of the UK government's COVID-19 mental health recovery plan to support individuals living with mental illness [44]. In 2021, a cross-government investment of over £5.5 million was made to embed green social prescribing into communities whose mental health had been disproportionately impacted by COVID-19 [45]. This initiative was underpinned by the launch of a 'test and learn' programme with the aim of understanding how green social prescribing can enhance mental health outcomes, reduce health inequalities, alleviate pressure on the health and social care system, and establish best practices for making green social prescribing activities more resilient and accessible [45]. Seven 'test and learn' sites were funded across England, one of which was delivered by the Humber and North Yorkshire Health and Care Partnership [46, 47].

This paper reports the findings of a cohort evaluation of the Humber and North Yorkshire green social prescribing 'test and learn' programme and includes analyses and interpretations not discussed in previously published reports [46, 47]. Our primary objectives were to (1) measure the effect of exposure to nature-based interventions on self-reported mental health and well-being among adults referred by social prescribers to nature-based interventions including those funded via the Humber and North Yorkshire 'test and learn' project; (2) identify and quantify which types of nature-based prescriptions were most effective; and (3) identify and quantify the optimal length of delivery of nature-based interventions. In the discussion, we reflect on pragmatic challenges pertaining to the implementation of green social prescribing and explore how the functionality and sustainability of green social prescribing can be enhanced to more equitably and effectively connect people with nature-based interventions.

2. Methods

This study is reported in accordance with the guidelines for Strengthening the Reporting of Observational Studies in Epidemiology [48]. The Humber and North Yorkshire green social prescribing programme was led by HEY Smile Foundation (a local infrastructure charity that works across the VCSE and health sectors to forge a stronger and more resilient future for communities) on behalf of the Humber and North Yorkshire Health and Care Partnership, who were commissioned to deliver one of the seven green social prescribing 'test and learn' projects. Ethical approval was granted by the University of York, Environment and Geography Research Ethics Committee (DEGERC/Res/23112021/1).

We used a cohort design to compare participants' mental health and well-being outcomes before and after exposure to nature-based interventions that were offered via a referral from social prescribing organisations across East Yorkshire, Hull, North Yorkshire, Vale of York, North Lincolnshire and North East Lincolnshire. A wide range of social prescribing services participated in this study, including social prescribing services embedded within primary care in the NHS, secondary care mental health services, services delivered by the VCSE sector and those led by local authorities (Table S1: Description of participating social prescribing/referring services in the Humber and North Yorkshire Green Social Prescribing cohort evaluation). Nature-based intervention providers were identified by the green social prescribing 'test and learn' programme team and shared with the social prescribing services. In addition to existing nature-based interventions offered across Humber and North Yorkshire, the "test and learn" programme funded additional nature-based interventions to support the referral of participants to green social prescribing.

2.1. Participants. Eligible participants were adults $\geq$ 18 years experiencing mild to moderate mental health issues that included mild to moderate anxiety (generalised anxiety disorder, panic disorder, health anxiety and medically unexplained); mild to moderate depression and low mood (including postnatal depression, work-related stress, bereavement and sleep difficulties); social phobia/anxiety; specific phobias; single incident posttraumatic stress disorder; and obsessive–compulsive disorder. Participants needed to be at a low level of risk to themselves and others, motivated and interested in engaging in a green social prescribing activity and were able to take part in some physical activity independently without one-to-one support. Level of risk was assessed by the link worker (or equivalent job title) in the social prescribing and referral services who had access to participant records, and who were guided by existing service governance (e.g., clinical risk assessments) and liaised with clinical team members as part of the initial 'What Matters to You' conversation. Where it was possible and appropriate, green social prescribing activities were tailored to meet individual physical health needs. Participants were excluded if they were at an active risk of harm to self, exhibited current suicidal intent or had a recent suicide attempt or were still in crisis; were an active risk of harm to others or had a recent history of violence, drug and alcohol misuse as a primary problem or the level of misuse was likely to prevent engagement in regular access of green social prescribing; ongoing, active or relapsing symptoms of social emotional health needs, psychosis, manic or hypomanic episodes or a diagnosed personality disorder, or significant psychosocial or physical health factors that would prevent engagement in a green social prescribing activity or require input from a multidisciplinary team and where home visits were required.

2.2. Recruitment and Data Collection. Participants were recruited by the social prescribing and referral services between 01 February 2022 and 31 March 2023. Potential participants who met the inclusion criteria were identified by a social prescribing link worker (or equivalent job title) embedded within each service in each of the six places across Humber and North Yorkshire. Through a 'What Matters to You' conversation, participants were offered a nature-based activity from a menu of vetted providers currently running activities in their area. As part of this conversation, the link worker invited eligible participants to take part in this study and took informed consent.

A bespoke 'before' and 'after' survey was developed and hosted on a cloud-based survey platform (Qualtrics, Provo, UT) [49]. Data were collected at two points: at baseline before the participant engaged with the 'green' or 'blue' activity, and at follow-up, after the participant had completed the nature-based activity, or at 3 months, whichever was sooner. 'Before' and 'after' surveys were completed in-person directly using a link to the online survey; a minority of surveys were completed as hard copies and inputted online by the link worker. To support participant recruitment, a plain English Information Sheet, a script for link workers (both codesigned with social prescribing teams), and a study webpage were developed by the research team.

2.3. Variables and Outcomes. Data were collected on location and name of social prescribing service; full postcode; gender (i.e., male; female; nonbinary/third gender; prefer not to say); age (i.e., 18 years to 85+ years; prefer not to say); ethnicity (i.e., Office for National Statistics [ONS]; census; prefer not to say); single-item question for activities of daily living (ADLs); physical and mental health impairments; employment status; highest educational qualification; reason for green social prescribing referral; referral source (e.g., primary care); type of green social prescribing activity; duration of green social prescribing activity (i.e., one to four; five to eight; nine to 12-weeks); and frequency of green social prescribing activity (i.e., more than once a week; weekly; every fortnight; every month) (Figure S1: The Humber and North Yorkshire Health and Care Partnership Green Social Prescribing Cohort Evaluation 'before' and 'after' Survey).

Primary outcomes were well-being measured using the ONS-4 and symptoms of anxiety and depression were measured using the Hospital Anxiety and Depression Scale (HADS). The ONS-4 is a validated 4-item measure of well-being used as part of the wider Measuring National Well-Being Programme at the ONS [50]. The ONS-4 measures three types of well-being: evaluative, eudaemonic and affective experience. It consists of 4 single-item questions measuring satisfaction with life, meaning and purpose in life and levels of happiness and anxiety using an 11-point Likert scale. Thresholds range from low to very high for life satisfaction, sense of feeling worthwhile and happiness with higher scores indicating greater levels on each of the three subscales. Thresholds for the anxiety subscale range from very low to high with higher scores indicating greater levels of anxiety (Table 1).

The HADS is a 14-item validated measure of anxiety and depression symptoms consisting of two 7-item subscales for anxiety and depression [51]. The HADS was originally developed for use in clinical settings; however, it is now widely used in nonclinical populations [52]. Thresholds for HADS range from subthreshold and in the normal range (< 8), mild anxiety and depression (8–10), moderate anxiety and depression (11–15), to severe anxiety and depression (16–21). Permission was received from the publisher to use the HADS for the purpose of data collection in the cohort evaluation.

2.4. Analysis. Summary statistics were calculated for demographic variables and outcome variables. For the primary analysis, pre–post differences in the outcomes (ONS-4 and HADS) were tested using the Wilcoxon two-sample paired signed rank test, and Cohen's D was calculated to estimate the standardised mean difference for each outcome. For interpretation, we draw on established cutoffs used in behavioural science for effect sizes whereby standardised mean differences of 0.56–1.2 are categorised as large, effect sizes of 0.33–0.55 as medium and effect sizes ≤ 0.32 as small [53].

As a secondary, exploratory analysis, we used multivariable linear regression models to estimate the relationship between the subscales of each of outcome variables and the type and duration of green social prescribing at 3-month follow-up (or intervention end, whichever was sooner). To reduce the risk of overfitting, following discussions with the Humber and North Yorkshire green social prescribing programme steering group, we adjusted only for baseline deprivation and health status in these multivariable models.

For the purposes of regression analyses, type of green social prescribing activity was trichotomised into *horticulture and care farming*, *sports, exercise and outdoors* and *creative and alternative*, using the Nature on Prescription Handbook [54]. Participants who engaged with more than one type of green social prescribing activity from which a 'main' green social prescribing activity type could not be determined were excluded from analyses ($n = 4$). We adapted an approach to categorise Index of Multiple Deprivation (IMD) which was categorised as heavily deprived (deciles 1–4), moderately deprived–affluent (deciles 5–7) and highly affluent (deciles 8–10) [55] (Table S2: IMD categories for regression model). Health status was based on self-reported ADLs (limited significantly; limited, but not significantly; not limited) (Table S3: ADL categories for regression model). Missing data in demographic variables were imputed using multiple imputation by chained equations (MICE), with 30 imputations. IMD category was imputed from those demographic variables which were complete: age category, gender, ethnicity (dichotomised for this purpose as white vs nonwhite) and ADL. We present the results using imputed data in this text. As a form of sensitivity analysis, we repeated the multivariable analyses using the nonimputed data (Table S5: Results from multivariable analyses on nonimputed data).

Descriptive statistics were performed in IBM SPSS Statistics software (Version 28; IBM Corp 2021) [56], with imputation and regression analyses performed using Stata (Version 18; StataCorp, 2021) [57].

3. Results

3.1. Descriptive Statistics. Among those who were eligible for social prescribing across the study region, two hundred and thirty-two participants were recruited and completed

Table 1: Personal well-being thresholds for ONS-4.

Life satisfaction, sense of feeling worthwhile and happiness		Anxiety	
Response on an 11-point scale	Label	Response on an 11-point scale	Label
0–4	Low	0–1	Very low
5–6	Medium	2–3	Low
7–8	High	4–5	Medium
9–10	Very high	6–10	High

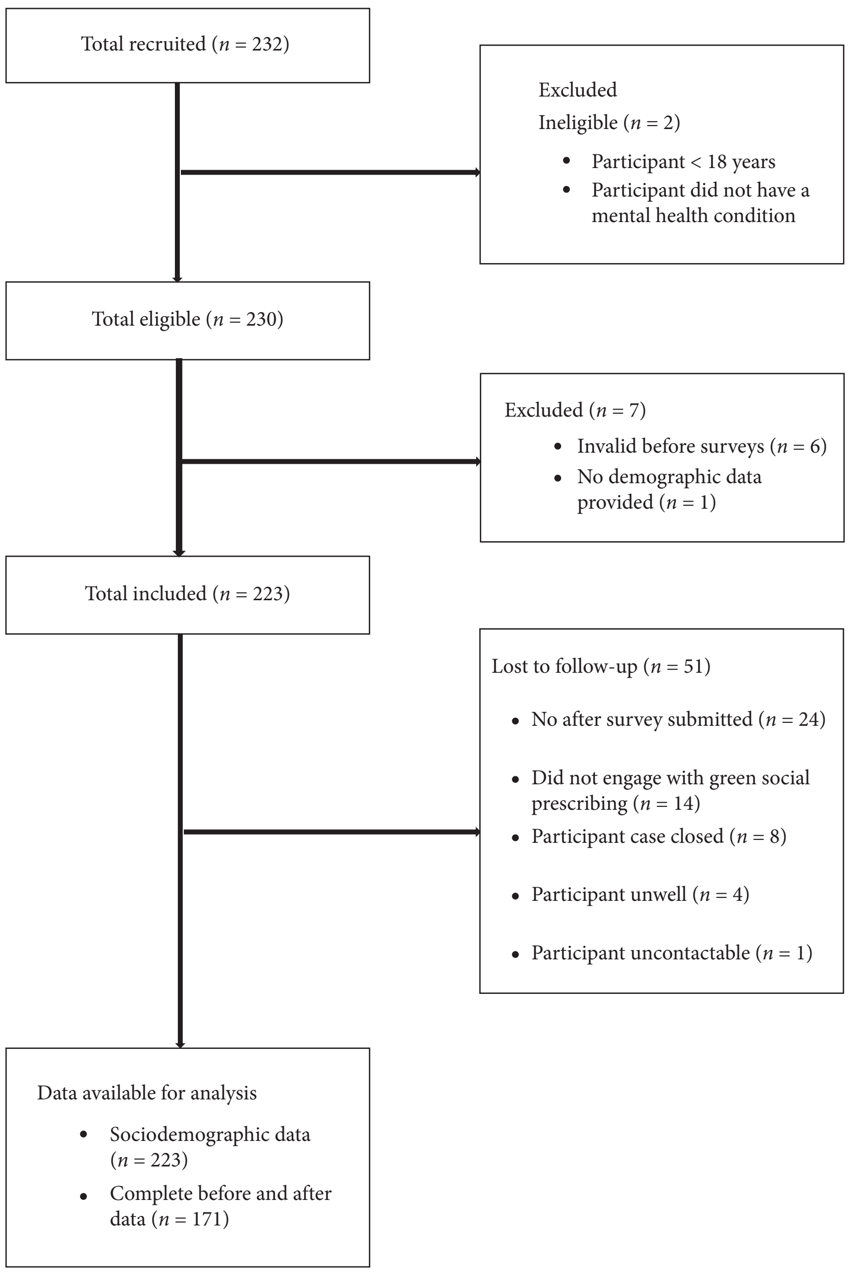

Figure 1: Cohort evaluation flowchart.

a baseline 'before' survey (Figure 1). Two participants were excluded because they did not meet eligibility criteria, and six (2.5%) baseline surveys were invalid. One participant provided no data on demographics (i.e., preferred not to say). Therefore, 223 participants were included in the cohort study. Fifty-one (22%) participants were lost to follow-up, and 171 (76%) 'before' and 'after' surveys were included in the analyses.

Table 2 describes participant characteristics. Among the 223 included participants, 195 (87%) were aged 18–64 years and 59% identified as female. The majority of participants were British (92%). A substantial proportion of participants (44%) were either unemployed or not able to work due to ill health or disability, and nearly two-thirds (65%) reported living in the most deprived geographical areas (i.e., IMD Deciles 1–4). The majority of participants (74%) self-reported at least one mental health condition, while just over one-fifth (21%) reported any other long-term illness or health condition, and just under one-fifth (17%) self-reported as having dyslexia or an autistic spectrum disorder. Participants also reported a high level of disability. Eighty percent reported that either a mental health or physical health problem limited ADLs; a fifth of these were limited significantly.

The majority of participants were referred to green social prescribing for mental health reasons (74%), while 15% of participants were referred for both mental and physical health reasons. Self-referral was the most common pathway to green social prescribing; only 10% ($n = 23$) of participants were referred via primary care (Table S4: Referral pathways for green social prescribing).

Green social prescribing activity type was available for $n = 200$ participants (Table 3). Of these, $n = 102$ (51%) took part in horticultural and care farming activities. Sixty-four participants (32%) took part in sports, exercise and outdoor activities, and $n = 35$ (17.5%) participated in creative and alternative activities. Over a third (37%) of green social prescribing activities had a duration of between five and eight weeks, while the remainder were evenly split, lasting either one to four weeks (32%) or nine to 12 or more weeks (31%). The majority (80%) of green social prescribing activities were attended on a weekly basis.

3.2. Primary Analyses: Change in Mental Health Symptoms. Among the 171 participants included in the analyses, the median follow-up for data collection between presurvey and postsurvey was 60 days (IQR 35–97). Table 4 displays before, after, change and standardised mean differences for each of our outcome variables.

At the follow-up, participants reported significant improvements in all well-being domains measured by the ONS-4, as well as significant reductions in anxiety on this scale (Table 4). When converted to standardised mean differences, a large effect size was observed for life satisfaction (SMD = 0.65; 95% CI 0.49–0.82) and sense of feeling worthwhile (SMD = 0.61; 95% CI 0.45–0.77), and a medium effect size was observed for happiness (SMD = 0.50; 95% CI 0.34–0.66) and anxiety (SMD = −0.39; 95% CI −0.54 to −0.23).

When analysing changes in HADS scale scores, we observed a statistically significant reduction in anxiety and depression symptoms at follow-up. When converted to standardised mean differences, a medium effect size was observed for anxiety (SMD = −0.55; 95% CI −0.71 to −0.38) and for depression (SMD = −0.51; 95% CI −0.67 to −0.35). The size of the effect for depression exceeds minimally reported differences.

3.3. Secondary Analysis: The Relationship Between Activity Duration and Change in Outcomes. Table 5 displays the results from the univariable and multivariable linear regression models modelling the relationship between change in each of the outcome variables and activity duration. We observed several statistically significant results for the beneficial impact of longer green social prescribing duration on the outcomes measured, adjusting for IMD and ADL. Undertaking green social prescribing activities for nine to 12 weeks compared with one to four weeks was associated with statistically significant improvements in life satisfaction ($\beta = 1.27$, 0.38 to 2.16, $p = 0.01$), sense of feeling worthwhile ($\beta = 1.46$, 0.56 to 2.35, $p = 0.002$) and happiness ($\beta = 1.35$, 0.18 to 2.53, $p = 0.03$) on the ONS-4. We also observed a significant effect for five to eight weeks of green social prescribing activity compared with one to four weeks on the happiness subscale of the ONS-4 ($\beta = 1.71$, 0.55 to 2.87, $p = 0.004$).

Similarly, on the HADS subscales, a duration of five to eight weeks (compared to one to four weeks) was associated with improvements in symptoms of anxiety ($\beta = -1.83$, −3.63 to −0.03, $p = 0.05$) and depression ($\beta = -2.00$, −3.86 to −0.14, $p = 0.04$). In contrast, nine to12 weeks (compared to five to eight weeks) was associated with worse scores on the HADS anxiety subscale ($\beta = 1.84$, 0.04 to 3.65, $p = 0.05$). On sensitivity analysis, when we analysed the nonimputed data, no changes in inferences were observed (Table S5: Results from multivariable analyses on nonimputed data). Similarly, adjusting for IMD and ADL made no substantial differences in the results.

3.4. Secondary Analysis: Green Social Prescribing Type. Table 6 displays the results from the univariable and multivariable linear regression models modelling the relationship between change in each of the outcome variables and activity type. Only two relationships were statistically significant at the $p = 0.05$ level. Adjusting for IMD and ADL, those who participated in activities classified as 'sports, exercise and outdoors' had statistically worse outcomes in relation to changes in sense of feeling worthwhile than those who participated in horticulture and care farming activities ($\beta = -0.95$, −1.76 to −0.14, $p = 0.02$). That is, we observed a statistically significant improvement in a sense of feeling worthwhile in those who participated in horticulture and care farming activities. Similarly, those who participated in creative and alternative activities, in comparison to horticulture and care farming activities had worse outcomes in changes in happiness ($\beta = -1.70$, −3.16 to −0.24, $p = 0.02$). Again, adjusting for IMD and ADL had little effect on the results. Similarly, on sensitivity analysis with the nonimputed data, no changes in results were observed (Table S5: Results from multivariable analyses on nonimputed data).

Table 2: Demographics of cohort participants.

Demographics	N (%)*
Gender	
Male	86/223 (39%)
Female	131/223 (59%)
Nonbinary	4/223 (2%)
Prefer not to say	2/223 (1%)
Age group	
18–24 years	24/223 (11%)
25–34 years	36/223 (16%)
35–44 years	39/223 (18%)
45–54 years	52/223 (23%)
55–64 years	43/223 (19%)
65–74 years	21/223 (9%)
75–84 years	3/223 (1%)
85 years +	3/223 (1%)
Prefer not to say	2/223 (1%)
Ethnic group	
British	206/223 (92%)
Irish	2/223 (1%)
Other White	5/223 (2%)
White and Black Caribbean	1/223 (1%)
White and Black African	1/223 (1%)
White and Asian	1/223 (1%)
Any other mixed background	2/223 (1%)
Pakistani	1/223 (1%)
Other	1/223 (1%)
Prefer not to say	3/223 (1%)
Employment status	
Employed full-time (30 h or more each week)	32/222 (14%)
Employed part-time (under 30 h each week)	31/222 (14%)
Unemployed	36/222 (16%)
Unable to work due to ill health or disability	63/222 (28%)
Retired	33/222 (15%)
Voluntary worker	13/222 (6%)
Looking after family home	7/222 (3%)
In education/training	2/222 (1%)
Other	5/222 (2%)
Education status	
None	25/222 (11%)
GCSE/O-level or equivalent	62/222 (28%)
A/AS level or equivalent	27/222 (12%)
Diploma/foundation level degree or other Level 5 qualification	50/222 (23%)
Undergraduate degree with honours (for example BA Hons, BSc)	24/222 (11%)
A higher degree (for example, PhD or Masters)	8/222 (4%)
Other	9/222 (4%)
Prefer not to say	17/222 (8%)
IMD decile	
Heavily deprived (IMD Deciles 1–4)	132/201 (66%)
Moderately deprived–affluent (IMD Deciles 5–7)	38/201 (19%)
Highly affluent (IMD Deciles 8–10)	31/201 (15%)
Health conditions (one or more)	
Physical health condition	21/224 (9%)
Sensory impairment	8/224 (4%)
Mental health condition	165/224 (74%)
Learning difficulty or disability	17/224 (8%)
Dyslexia or an autistic spectrum disorder	38/224 (17%)
Long-term conditions such as HIV, cancer, heart/respiratory condition	19/224 (9%)
Any other long-term health condition	46/224 (21%)
Health status	
Limited significantly	47/223 (21%)

Table 2: Continued.

Demographics	N (%)*
Limited, but not significantly	132/223 (59%)
Not limited	44/223 (20%)

*Note percentages may not sum to 100% due to rounding.

Table 3: Green social prescribing categories and subcategories based on Nature on Prescription Handbook.

Green social prescribing category	N (%)*
Horticulture and care farming	**102/200 (51%)**
Gardening	69/200 (35%)
Food growing	13/200 (7%)
Animal care	19/200 (10%)
Sport, exercise and outdoors	**64/200 (32%)**
Green exercise	40/200 (20%)
Bush craft	17/200 (9%)
Conservation	5/200 (3%)
Model boat and fishing	1/200 (1%)
Sport aligned	1/200 (1%)
Creative and alternative	**35/200 (18%)**
Photography	7/200 (4%)
Crafting	13/200 (7%)
Woodwork	1/200 (1%)
Creative writing	1/200 (1%)
Site specific drama	1/200 (1%)
Setting up Santa in park	1/200 (1%)
Bike repair	1/200 (1%)
Yoga or other mind body activity	5/200 (3%)
Confidence building	2/200 (1%)
Menopause support	2/200 (1%)
Community café	1/200 (1%)

Note: Categories and values in bold pertain to the three main categories of green social prescribing with subcategories and values for each main category.

*Note percentages may not sum to subtotal percentage due to rounding.

4. Discussion

We evaluated whether the Humber and North Yorkshire green social prescribing programme was associated with mental health benefits for adults. We have shown that connecting people with common mental health problems to nature-based activities via social prescribing is associated with short-term improvements in mental health outcomes and hedonic (i.e., happiness) and eudaemonic (i.e. life satisfaction) well-being. After adjustments for deprivation and health status, we observed generally larger benefits for improvements in well-being were associated with nature-based activities that had longer duration. These findings were most pronounced when comparing durations of nine to 12 weeks to those with durations of one to four weeks. We also observed some limited evidence that horticultural activities and care farming may have some benefit over sports and exercise or creative activities.

4.1. Interpretation and External Validity. The finding that the greatest mental health and well-being gains were observed among those who took part in green social prescribing activities for between five and 12 weeks is consistent with previous research about the importance of brief contact with nature. Therapeutic offers of 20 min but no more than 80–90 min in nature gardens have been shown to improve mood in people with dementia in nursing homes [58]. At a general population level, people who have contact with nature for 120 min a week are more likely to report good health or high well-being, regardless of how that contact is achieved [59]. This is significant given that people have a tendency to underestimate the extent to which even brief contact with nature can result in positive impacts [60]. Prescribing short nature-based activities might therefore be of special value to people with mental health problems faced with long waiting times for mental health services. In the context of primary care mental health services people with mild to moderate depression or anxiety might be offered psychological talking therapies such as individual or group-based behavioural activation or cognitive behavioural therapy (CBT) over the course of eight sessions [61]. The effect sizes observed for green social prescribing activities compare favourably with those observed for behavioural activation [62] and CBT [63] and point to the potential to mainstream nature-based activities as alternative therapeutic offers for people with preexisting mental health problems. This is especially relevant for those living in the most deprived regions who are less likely to experience improvement or recovery after talking therapies [64]. Two-thirds of participants in this study lived in the most deprived regions and had lower levels of well-being than population averages, suggesting our findings have real-world value and applicability.

Our findings indicate that participation in green social prescribing activities was associated with significant improvements in anxiety and depression symptoms at five to eight weeks compared with one to four weeks, followed by a subsequent decline. This pattern aligns with the concept of a dose-response effect observed in psychological medicine, where most improvement occurs in the early phases of treatment [65]. Similarly, with nature-based interventions, mental health and well-being benefits tend to peak and then plateau or decrease over time as individuals become accustomed to the intervention or as novelty effects wane [59, 66].

The differential patterns between ONS-4 well-being scores and HADS symptoms of anxiety and depression may reflect the distinct nature of these constructs. While subjective well-being encompasses broader evaluative and eudaemonic dimensions, HADS specifically captures clinical symptoms of mental distress, which may be influenced by short-term factors like habituation or contextual stressors [67]. This could explain why HADS scores showed transient improvements at five to eight weeks, whereas ONS-4 scores demonstrated sustained benefits for longer periods.

Table 4: Before, after and differences for each of the outcomes in this study.

ONS-4 subscale	Mean (SD)		Difference (95% CI) (before–after)	*p* value
	Before	After		
Overall, how satisfied are you with your life nowadays?	5.10 (2.33)	6.67 (1.90)	1.57 (1.21–1.94)	< 0.001
Overall, to what extent do you feel that the things you do in your life are worthwhile?	5.36 (2.43)	6.84 (1.99)	1.48 (1.11–1.85)	< 0.001
Overall, how happy did you feel yesterday?	5.15 (2.60)	6.71 (2.29)	1.56 (1.08–2.03)	< 0.001
Overall, how anxious did you feel yesterday?	5.35 (2.75)	4.06 (2.58)	−1.28 (−1.78–−0.78)	< 0.001
HADS subscale				
Anxiety	11.12 (4.69)	8.50 (4.40)	−2.63 (−3.35–−1.90)	< 0.001
Depression	8.11 (4.48)	5.57 (4.43)	−2.54 (−3.29–−1.79)	< 0.001

Note: Increases in scores on the first three ONS-4 subscales represent an improvement in symptoms. Decreases in scores on the anxiety subscale of the ONS-4, as well as both subscales of the HADS represent an improvement in symptoms.

Table 5: Results from univariable and multivariable models modelling the relationship between activity duration and changes in mental health outcomes (multiply imputed data, $n = 171$).

	Unadjusted β (95% CI)	p value	Adjusted β (95% CI)	p value
ONS-4: life satisfaction				
5–8 weeks (v 1–4 weeks)	0.94 (0.07–1.80)	0.03	0.78 (−0.10–1.66)	0.08
9–12 weeks (v 1–4 weeks)	1.43 (0.53–2.32)	0.002	1.27 (0.38–2.16)	0.01
9–12 weeks (v 5–8 weeks)	0.49 (−0.37–1.35)	0.26	0.49 (−0.40–1.37)	0.28
ONS-4: worthwhile				
5–8 weeks (v 1–4 weeks)	0.79 (−0.07–1.65)	0.07	0.76 (−0.13–1.64)	0.09
9–12 weeks (v 1–4 weeks)	1.59 (0.70–2.49)	0.001	1.46 (0.56–2.35)	0.002
9–12 weeks (v 5–8 weeks)	0.80 (−0.06–1.66)	0.07	0.70 (−0.19–1.59)	0.12
ONS-4: happiness				
5–8 weeks (v 1–4 weeks)	1.67 (0.56–2.79)	0.003	1.71 (0.55–2.87)	0.004
9–12 weeks (v 1–4 weeks)	1.44 (−0.29–2.60)	0.02	1.35 (0.18–2.53)	0.03
9–12 weeks (v 5–8 weeks)	−0.23 (−1.34–0.88)	0.68	−0.36 (−1.52–0.81)	0.55
ONS-4: anxiety				
5–8 weeks (v 1–4 weeks)	−0.49 (−1.70–0.71)	0.42	−0.13 (−1.36–1.10)	0.84
9–12 weeks (v 1–4 weeks)	−1.07 (−2.32–0.17)	0.09	−0.92 (−2.17–0.32)	0.14
9–12 weeks (v 5–8 weeks)	−0.58 (−1.78–0.62)	0.34	−0.80 (−2.03–0.44)	0.20
HADS: anxiety				
5–8 weeks (v 1–4 weeks)	−1.93 (−3.67–−0.18)	0.03	−1.83 (−3.63–−0.03)	0.05
9–12 weeks (v 1–4 weeks)	−0.20 (−2.01–1.60)	0.82	0.01 (−1.81–1.83)	0.99
9–12 weeks (v 5–8 weeks)	1.72 (−0.02–3.46)	0.05	1.84 (0.04–3.65)	0.05
HADS: depression				
5–8 weeks (v 1–4 weeks)	−2.14 (−3.94–−0.34)	0.02	−2.00 (−3.86–−0.14)	0.04
9–12 weeks (v 1–4 weeks)	−1.67 (−3.53–0.20)	0.08	−1.46 (−3.34–0.43)	0.13
9–12 weeks (v 5–8 weeks)	0.48 (−1.32–2.28)	0.60	0.54 (−1.33–2.41)	0.57

Note: Higher scores on the first three ONS-4 subscales represent an improvement in symptoms. Lower scores on the anxiety subscale of the ONS-4, as well as both subscales of the HADS represent an improvement in symptoms.

Table 6: Results from univariable and multivariable models modelling the relationship between activity type and changes in mental health outcomes ($n = 168$).

	Unadjusted β (95% CI)	p value	Adjusted β (95% CI)	p value
ONS-4: Life satisfaction				
Sport, exercise and outdoors (v Hort and care farming)	−0.63 (−1.42–0.17)	0.12	−0.56 (−1.37–0.26)	0.18
Creative and alternative (v Hort and care farming)	−0.45 (−1.62–0.71)	0.44	−0.44 (−1.60–0.71)	0.45
Creative and alternative (v sport, exercise and outdoors)	0.17 (−1.03–1.38)	0.78	0.11 (−1.08–1.31)	0.85
ONS-4: worthwhile				
Sport, exercise and outdoors (v Hort and care farming)	−1.10 (−1.88–−0.31)	0.01	−0.95 (−1.76–−0.14)	0.02
Creative and alternative (v Hort and care farming)	−0.58 (−1.73–0.56)	0.32	−0.55 (−1.70–0.60)	0.35
Creative and alternative (v sport, exercise and outdoors)	0.51 (−0.68–1.70)	0.40	0.40 (−0.80–1.59)	0.51
ONS-4: happiness				
Sport, exercise and outdoors (v Hort and care farming)	−0.93 (−1.91–0.06)	0.07	−0.87 (−1.89–0.16)	0.10
Creative and alternative (v Hort and care farming)	−1.72 (−3.17–−0.28)	0.02	−1.70 (−3.16–−0.24)	0.02
Creative and alternative (v sport, exercise and outdoors)	−0.80 (−2.29–0.70)	0.29	−0.83 (−2.34–0.67)	0.28
ONS-4: anxiety				
Sport, exercise and outdoors (v Hort and care farming)	0.07 (−1.03–1.17)	0.90	0.04 (−1.08–1.16)	0.95
Creative and alternative (v Hort and care farming)	−0.28 (−1.88–1.33)	0.73	−0.30 (−1.89–1.30)	0.72
Creative and alternative (v sport, exercise and outdoors)	−0.35 (−2.01–1.31)	0.68	−0.33 (−1.98–1.32)	0.69
HADS: anxiety				
Sport, exercise and outdoors (v Hort and care farming)	−0.13 (−1.72–1.47)	0.88	−0.16 (−1.80–1.49)	0.85
Creative and alternative (v Hort and care farming)	0.08 (−2.25–2.40)	0.95	0.01 (−2.33–2.35)	1.00
Creative and alternative (v sport, exercise and outdoors)	0.20 (−2.21–2.61)	0.87	0.16 (−2.26–2.58)	0.89
HADS: depression				
Sport, exercise and outdoors (v Hort and care farming)	0.85 (−0.80–2.49)	0.31	0.78 (−0.91–2.48)	0.36
Creative and alternative (v Hort and care farming)	−0.57 (−2.97–1.84)	0.64	−0.51 (−2.93–1.90)	0.68
Creative and alternative (v sport, exercise and outdoors)	−1.41 (−3.90–1.08)	0.26	−1.30 (−3.80–1.20)	0.31

Additionally, the decline in HADS scores after the initial improvement may be due to the complex interplay between psychological and situational factors, such as individual resilience, the severity of mental health conditions or the natural variation in symptom trajectories over time. These findings underscore the need for further research to disentangle the mechanisms underpinning the optimal dose of nature-based interventions for mental health improvement and suggest that offering more tailored interventions might enhance outcomes.

Our findings also provide some support for horticultural and care farming activities being associated with the most benefits. This is consistent with existing evidence suggesting that gardening and horticultural-based interventions positively affect psychosocial well-being [68]. These activities are shown to improve overall well-being, quality of life and health status in both general and vulnerable populations, including older adults and individuals with dementia [69]. Additionally, there is broad support for group-based gardening interventions as effective in enhancing well-being and reducing symptoms of depression [70]. Although the mechanisms by which gardening and horticultural activities enhance mental health are not fully understood, small-scale green interventions, such as urban allotments, offer opportunities for stress reduction, social and nature connection and enable self-development [71]. Participants in this study who engaged in a variety of horticultural activities—ranging from structured programmes at commercial garden centres to food growing and gardening on allotments—likely experienced benefits from these diverse social and ecological interactions. Similarly, emerging evidence suggests that care farming can reduce anxiety and depression in the short term. These benefits are linked to social connections, personal growth through acquiring new skills and caring for nonhuman entities and the restorative effects of nature [72]. Such mechanisms align with the idea that nature-based activities, which also provide environmental cobenefits, are perceived as purposeful and meaningful and offer substantial mental health benefits [73].

4.2. Challenges to Implementation. However, there are limits to the extent to which green social prescribing can function as an effective and sustainable system to enable people to equitably access nature-based interventions. Green social prescribing relies on a mix of health and short-term responsive funding and requires ongoing investment in human and social capital, making it unlikely to be a sustainable option in all settings [74, 75]. Additionally, a mutually beneficial ethos inclusive of support and training for VCSE organisations involved in green social prescribing schemes is essential for consolidating sustainability [75]. Implementation models also vary (i.e., from signposting to the provision of wrap-around care), and without a comprehensive understanding of the social prescribing pathway, it can be challenging to determine which referral pathways are effective and for whom [76]. As evidenced in the present evaluation, green social prescribing is a multimodal and heterogeneous process comprising diverse referral pathways and variations in models across services, and this further adds to the complexity for replications [74, 77] and evaluations [78, 79] of green social prescribing programmes.

From a pragmatic perspective, social prescribing potentially risks widening health inequalities where people with disabilities, ethnic minority groups and younger people are declining or not participating in social prescribing schemes [40]. This necessitates consideration of equity at all levels of implementation, ensuring the specific needs of individuals and population groups are addressed [80]. Adopting a more personalised model of implementation could potentially ensure that the needs, capacities, values and levels of nature connectedness of participants are considered when exploring the suitability of nature prescriptions [37, 76, 81]. This approach could be achieved by offering participants a diverse range of choices, with both design and delivery of nature prescriptions informed by participant's needs, environment and personal circumstances [82, 83]. This may also have implications for optimal 'dosage' (i.e., duration and frequency), whereby applying a multidimensional perspective can allow for tailoring of interventions according to an individual's needs, context and history [84].

In this evaluation, self-referral was the main point of entry to green social prescribing among over half of participants suggesting that referral and uptake mechanisms need strengthening to avoid reinforcing existing health inequalities. Nature prescriptions can be tailored to overcome key challenges related to age, mobility and health status, which may prevent uptake or engagement with green social prescribing. Personalised prescriptions, as part of a service offer, which are inclusive of diverse user groups and adapted to their needs, could facilitate this [80], for example, facilitating passive or quasipassive nature engagement (e.g., bird watching or mindful photography), minimising physical activity, or making it optional [85] and adapting programmes or activities (e.g., shorter time and duration) to support referral, engagement and adherence for vulnerable groups [37]. Individual nature-based activities as part of a wider programme of delivery could be further tailored through identifying active, passive and quasipassive components personalised to an individual's preferences and needs. For example, horticultural projects could be adapted so that they integrate active (e.g., physical activity), passive and quasipassive (e.g., selecting plants and creating the design) and social (e.g., coordinating tea breaks and social activities) components. In this way, nature prescriptions could maximise their impact as an inclusive, accessible and equitable health intervention.

4.3. Limitations. There are a number of important limitations to our evaluation. First, because recruitment was outsourced to social prescribing services, the research team was not able to identify the total number of eligible participants across the region. As such, the participants included in this evaluation represent a self-selected proportion of the total eligible pool, and the findings are potentially at risk of selection bias. Additionally, we did not use a randomised or controlled design and are therefore unable to draw definitive conclusions about the causal relationship between green social prescribing and mental health outcomes. Our findings might also be prone to residual confounding owing to unmeasured variables (e.g., receipt of mental health care or treatment) or imprecise measurement of confounders. We measured deprivation using area level indices that do not take into account individual variation. While we did collect data on employment status, we did not include these data in multivariable analyses where additional detail on job type and/or salaries would enable a more individualised assessment of affluence. Many employed individuals may hold low-wage, precarious jobs that provide limited income and benefits, leaving them in a state of economic vulnerability, and as such, using data on employment status alone is not always an accurate marker of affluence. Future research should adopt a multidimensional approach to assessing deprivation, including capturing data on employment quality [86]. Likewise, we measured health status with a single-item question about ADLs rather than use a validated scale capable of offering a more granular approach to differentiating levels of impairment.

This evaluation focused on the mental health and well-being outcomes associated with nature-based interventions at the end point of the green social prescribing pathway. However, research suggests a more nuanced relationship between nature engagement and positive mental health. Individual factors such as demographic and cultural variables, health status and place attachment can have significant roles in influencing positive outcomes [87–90]. Additionally, the ecological quality of green spaces has been identified as contributing to well-being [91]. Although we assessed the impact of different nature-based activities, we did not systematically evaluate how the quantity or quality of green or natural spaces affected mental health outcomes. While this evaluation highlights the benefits of nature-based interventions at the end point of the green social prescribing pathway for improving mental health, the specific drivers behind these benefits remain unclear.

4.4. Future Research. To enhance the functioning and sustainability of green social prescribing, there is a need to better understand the complex process of prescribing in addition to a focus on how people experience and engage with nature-based activities. A research roadmap for improving social prescribing has previously been outlined, suggesting that it is critical to track and monitor how people are referred and move between healthcare settings to community-based assets, along with mapping where services and assets are located and how they are accessed [92]. This is relevant for green social prescribing too. Within the context of green social prescribing, mixed methods evaluations are likely to be best placed to unpick the complex interplay between natural, human and social components of green social prescribing and the benefits arising from these interactions [93].

Furthermore, green social prescribing may have relevance for groups typically underrepresented in such schemes, such as children and young people and individuals with serious mental illness, such as psychosis. Emerging evidence points to the protective factor of nature connectedness in managing ecoanxiety in children and young people [94, 95] and highlights the potential role of nature-based interventions in supporting children's and young people's mental health [96, 97]. However, from a practice perspective, this may also necessitate differentiated models of delivery and investment, where no distinction is currently made between social prescribing models for children and adults in England [98]. For adults living with serious mental illness, previous research also demonstrates nature-based interventions can have therapeutic value through improving biopsychosocial well-being, increasing connection to nature and promoting engagement with nature [76, 99]. Nonetheless, challenges and barriers pertaining to access and engagement for people with serious mental illness persist [100] and may warrant further exploration as part of a green social prescribing pathway.

5. Conclusion

We have undertaken the first longitudinal and quantitative evaluation of the NHS England Green Social Prescribing Test and Learn programme across Humber and North Yorkshire. Green social prescribing is beneficial for mental health and well-being among community-based adults, suggesting it could be an asset to address the demand for mental health care in an era of high unmet need. Horticultural and care farming activities were associated with the greatest gains in mental health and well-being, and these activities have the potential to confer health and environmental cobenefits. People who undertook green social prescribing activities for five to 12 weeks experienced more improvement in mental health and well-being, with implications for how comparable services might be commissioned to facilitate efficient and effective access to nature-based activities. Further work is needed to better understand how to improve access to and engagement with green social prescribing among excluded and underserved groups.

Data Availability Statement

The data that support the findings of this study belong to HEY Smile. The data will be deposited in the Research Data York repository (https://www.york.ac.uk/library/research-creativity/rdm/research-data-york/) and are open to third-party access on request to the corresponding author, subject to appropriate research governance permissions and a signed data sharing agreement being in place.

Disclosure

The views expressed in this publication are those of the authors and not necessarily those of the National Institute for Health and Care Research, the Department of Health and Social Care, Humber and North Yorkshire Health and Care Partnership or the Humber and North Yorkshire Green Social Prescribing funders.

Conflicts of Interest

The authors declare no conflicts of interest.

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Supporting Information

Additional supporting information can be found online in the Supporting Information section. *(Supporting Information)*

Table S1: Description of participating social prescribing/referring services in the Humber and North Yorkshire Green Social Prescribing cohort evaluation.

Table S2: IMD categories for regression model.

Table S3: ADL categories for regression model.

Table S4: Referral pathways for green social prescribing.

Table S5: Results from multivariable analyses on nonimputed data.

Figure S1: Humber and North Yorkshire Health and Care Partnership Green Social Prescribing Cohort Evaluation 'Before' and 'After' Survey.

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