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A Pragmatic Controlled Trial of Forest Bathing Compared with Compassionate Mind Training in the UK: Impacts on Self-Reported Wellbeing and Heart Rate Variability

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Abstract: Forest Bathing, where individuals use mindfulness to engage with nature, has been reported to increase heart rate variability and benefit wellbeing. To date, most Forest Bathing studies have been conducted in Asia. Accordingly, this paper reports the first pragmatic controlled trial of Forest Bathing in the United Kingdom, comparing Forest Bathing with a control comprising an established wellbeing intervention also known to increase heart rate variability called Compassionate Mind Training. Sixty-one university staff and students (50 females, 11 males) were allocated to (i) Forest Bathing, (ii) Compassionate Mind Training or (iii) Forest Bathing combined with Compassionate Mind Training. Wellbeing and heart rate variability were measured at baseline, post-intervention and three-months follow-up. There were improvements in positive emotions, mood disturbance, rumination, nature connection and compassion and 57% of participants showed an increase in heart rate variability. There were no significant differences between conditions, showing that Forest Bathing had equivalence with an established wellbeing intervention. The findings will help healthcare providers and policy makers to understand the effects of Forest Bathing and implement it as a feasible social prescription to improve wellbeing. Future research needs to involve clinical populations and to assess the effects of Forest Bathing in a fully powered randomised controlled trial.

Keywords: Compassionate Mind Training; Forest Bathing; heart rate variability; nature connection; positive emotion; social prescribing

1. Introduction

The World Health Organization [1] states that green space is a “necessary component for delivering healthy, sustainable, liveable conditions” (p. 5). Indeed, a review of the literature indicates the diverse health benefits of accessing green spaces [2]. Access to nearby green spaces and interventions to increase engagement with the natural environment are one of the fastest growing ways of improving human health [3]. Though empirical evidence is still needed, so-called social prescriptions, as an alternative to more traditional treatments for poor mental and physical health, have recently gained increased attention [4,5]. Social prescribing came about to respond to health inequalities in deprived areas; nature-based social prescriptions in particular have shown promise in reducing health inequalities because of their low cost and wide accessibility [6,7]. However, for any health and wellbeing intervention to be implemented in national services such as the National Health Service

(NHS), empirical evidence is needed to assure healthcare providers and link-workers that interventions are effective.

Forest Bathing [8] (in its native Japanese *Shinrin-yoku*) is one such social prescription. Forest Bathing is broadly defined as walking in and viewing the forest while taking in the atmosphere through the senses [9]. In a review of Forest Bathing research, [10] found that Forest Bathing sessions sometimes encompassed wider activities such as deep breathing, meditation, yoga and bushcraft. Forest Bathing can be an unguided or guided walk; for the purpose of this study, Forest Bathing is defined as a guided walk using mindful awareness through the senses (sight, sound, touch, smell) to pay close attention to the forest. Forest Bathing potentially offers a low cost, sustainable and scalable solution to address poor health and wellbeing; however, research is needed to evidence its effectiveness in the UK.

Forestry England, a UK government agency responsible for managing and promoting forests in the UK, recently published their 'Forests for Wellbeing' document [11]. They outline the importance of forests as natural resources to support mental wellbeing and provide guidance on how to try Forest Bathing to aid relaxation. The research supporting the safety and effectiveness of Forest Bathing in Japan and Korea is extensive [9,12]. Forest Bathing has been shown to regulate blood pressure [13], the cardiovascular system [14], immune function [9], inflammatory markers e.g., cortisol [15] and relieve depression [16]. Typical outcome measures utilised in previous studies include questionnaires measuring positive and negative emotions (Profile of Mood States (POMS)), depression (BDI) and anxiety (STAI) and physiological measures including heart rate variability (HRV), blood pressure and inflammatory markers (e.g., cortisol) [14,17]. These intervention studies and meta-analyses [13,16,18,19] show statistically significant effects of Forest Bathing on both subjective (questionnaire) and objective (HRV) indices of health and wellbeing and support their continued use as an intervention. Forest Bathing has been implemented widely in Japan given the ease of access to forested environments (68.5% of forest cover) [20], conscientious governmental recommendations [17] and likely due to its cultural focus on valuing nature (e.g., Shintoism and Buddhism). Whilst Forest Bathing is an established part of Japan's public health service where it is offered to patients reporting stress or presenting with high blood pressure, it is relatively new to the UK and has yet to be assessed in terms of its effectiveness for a UK population who only have access to 13.1% of forest cover [20] and do not share a similar cultural history.

In this study, Forest Bathing is compared with an established emotion regulation intervention in the UK, Compassionate Mind Training (CMT) [21]. CMT provides a good comparison with Forest Bathing because both interventions are based on evolutionary models, target the stimulation of the parasympathetic nervous system and have been shown to increase parasympathetic activity as measured through HRV [16,19,22,23]. Compassion is commonly defined as a sensitivity to the distress of the self and others with a motivation to alleviate it [21]. CMT [21] is one of the most prominent psychological interventions in the UK for improving emotion regulation and wellbeing in the general public and a clinical version called Compassion Focused Therapy is used to treat patients with mental health difficulties in 25 countries. Its effectiveness in improving wellbeing is supported by many years of research evidence [24]. CMT targets long-term emotion regulation and is based on neuroscience; it aims to stimulate the neurophysiological systems (primarily the parasympathetic system) associated with feelings of safeness and soothing through practising compassionate imagery (i.e., imagining receiving compassion from oneself or another person). The capacity for compassion evolved alongside the mammalian attachment system and forms a fundamental part of supportive and caring relationships [21]. As such, CMT is based on an evolutionary perspective that focuses on the attachment and affiliative systems. Taking a function-analytical approach to emotion, CMT notes that all emotions have a function and usefulness. It thus de-stigmatizes 'negative' emotions by explaining their role in keeping us safe by detecting threat and preparing us for action. It comprises (i) psychoeducation about the nature of suffering in all species, the importance of supportive attachment relationships for survival, emotion regulation and wellbeing and how our

brains have adapted to deal with the demands of our environments and (ii) exercises such as generating and practising compassionate imagery and compassionate letter-writing.

Many of the examples concerning the nature of suffering and the challenges to survival in the psychoeducational element of CMT are based on examples from nature and other species. These examples provide a sense of common humanity; for example, that all species suffer and struggle for survival, get ill and eventually die. They also provide a sense of context to the problems that an individual is facing in that moment. For example, personal obstacles can become trivial and stressors seem either manageable or unimportant following the awe generated by viewing nature [25]. Given the species-wide examples used in CMT and given that both Forest Bathing and CMT both target and have been shown to stimulate parasympathetic activity, one could argue they are complementary approaches and a combination of Forest Bathing and CMT might offer greater wellbeing benefits. The benefits could be two-fold as CMT could also lend itself to cultivating compassion beyond other humans and oneself towards other species and the environment, thus impacting upon pro-environmental attitudes.

Until now, most Forest Bathing studies have been conducted in Asia. In their review of Forest Bathing, Hansen et al. [18] encourage research in Western cultures to assess the therapeutic effects of Forest Bathing. To our knowledge, this paper constitutes the UK's first pragmatic controlled trial of Forest Bathing. To enable comparison with previous data collected in Asia, this study will utilise two key outcome measures frequently used in Asian studies of Forest Bathing. These include an assessment of mood via the Profile of Mood States (POMS) questionnaire and HRV, which is an important physiological marker for overall health and is a validated measure of balance between the parasympathetic and sympathetic branches of the autonomic nervous system [26]. Whilst lower resting HRV has been associated with an increased risk of cardiovascular disease [26], previous Forest Bathing studies have consistently shown increases in resting HRV [14,19] indicative of increased parasympathetic activation and good physiological health. In traditional Forest Bathing studies, the control condition is often a walk in an urban setting, which has been shown to increase stress, making a comparison less meaningful [10]. The current study aimed to provide a more robust control comparison condition and therefore compared Forest Bathing with an established emotion regulation intervention, Compassionate Mind Training (CMT) [21], which is also known to increase HRV (namely parasympathetic activity) and low arousal relaxing positive emotions [22,23]. The study additionally included a further condition that combines Forest Bathing with CMT to assess whether a combination of these activities could have a greater impact on wellbeing, parasympathetic stimulation and compassion than Forest Bathing or CMT alone. Previous research into the benefits of natural settings and psychological interventions have tended to focus on unidimensional positive emotions whereas the current study includes a multidimensional measure of positive emotions that distinguishes between low (relaxing) and high (exciting) arousal positive emotions. The study offered 2 h of continuous measurement of HRV allowing the examination of which specific tasks (i.e., visual, auditory) have the greatest impact on HRV. The study also included a three-month follow-up, providing rare longitudinal data (the lack of follow-up in Forest Bathing studies has been noted as a limitation [16,18]).

2. Aims

The primary aim of the study was to assess whether Forest Bathing in a UK population would result in improvements in a range of self-reported and physiological outcome measures commonly used in Asian studies of Forest Bathing (i.e., Profile of Mood States (POMS) scale and HRV). A secondary aim was to see whether Forest Bathing would have equivalence with an established wellbeing intervention, CMT. A third aim was to assess the effectiveness of a combination of Forest Bathing and CMT and to assess whether this was superior to practising Forest Bathing or CMT alone. A fourth aim was to utilise the continuous measurement of HRV to see which aspects of Forest Bathing offered the greatest benefit to participants.

3. Materials and Methods

3.1. Design

The study followed a mixed-method 3×3 repeated measures experimental design including data collection at baseline, post-intervention and three-months follow-up. The sample was a convenience sample as participants were allocated in equal numbers to each condition based on their availability for the session dates. After providing consent, participants were informed of their appointment to engage with a session of either (i) Forest Bathing in semi-ancient woodland, (ii) CMT conducted indoors or (iii) CMT combined with Forest Bathing in semi-ancient woodland. All sessions lasted approximately two hours as the standard duration of Forest Bathing for the Forest Bathing Institute would normally be between two to three hours and in a review of previous literature the duration of Forest Bathing ranged from twelve minutes to three hours [16].

3.2. Conditions

3.2.1. Forest Bathing

Forest Bathing sessions were led by two qualified practitioners from The Forest Bathing Institute and involved guided discovery and mindful appreciation of woodland. The session comprised moving slowly in silence through woodland, stopping to observe using all of the senses and engaging in slow, relaxing breathing. Practitioners completed a risk assessment of the site and checked walking routes before testing. Guided exercises to aid engagement with the senses included (i) visual exercises, e.g., noticing colours and patterns (fractals), looking at the foreground and looking further into the distance; (ii) auditory exercises, e.g., cupping the ears forward and actively listening to nature; (iii) touch exercises, e.g., stroking tree bark and noticing changes in texture; (iv) smelling exercises, e.g., practising breathing before smelling leaf litter, mosses and lichens. Photographic examples of these exercises can be found in Figure 1. Participants engaged in seated self-guided mindfulness whilst leaning against a preferred tree along with a practitioner-guided mindfulness task whilst lying down under the tree canopy. Participants also engaged in three sharing circles throughout the session where they were invited to feed back on their experience. The intention of sharing circles is peer learning and benefiting from the experience of others. For example, one participant may notice a unique smell from a particular moss causing other participants to perhaps seek out and smell the same moss.



Figure 1. Cont.

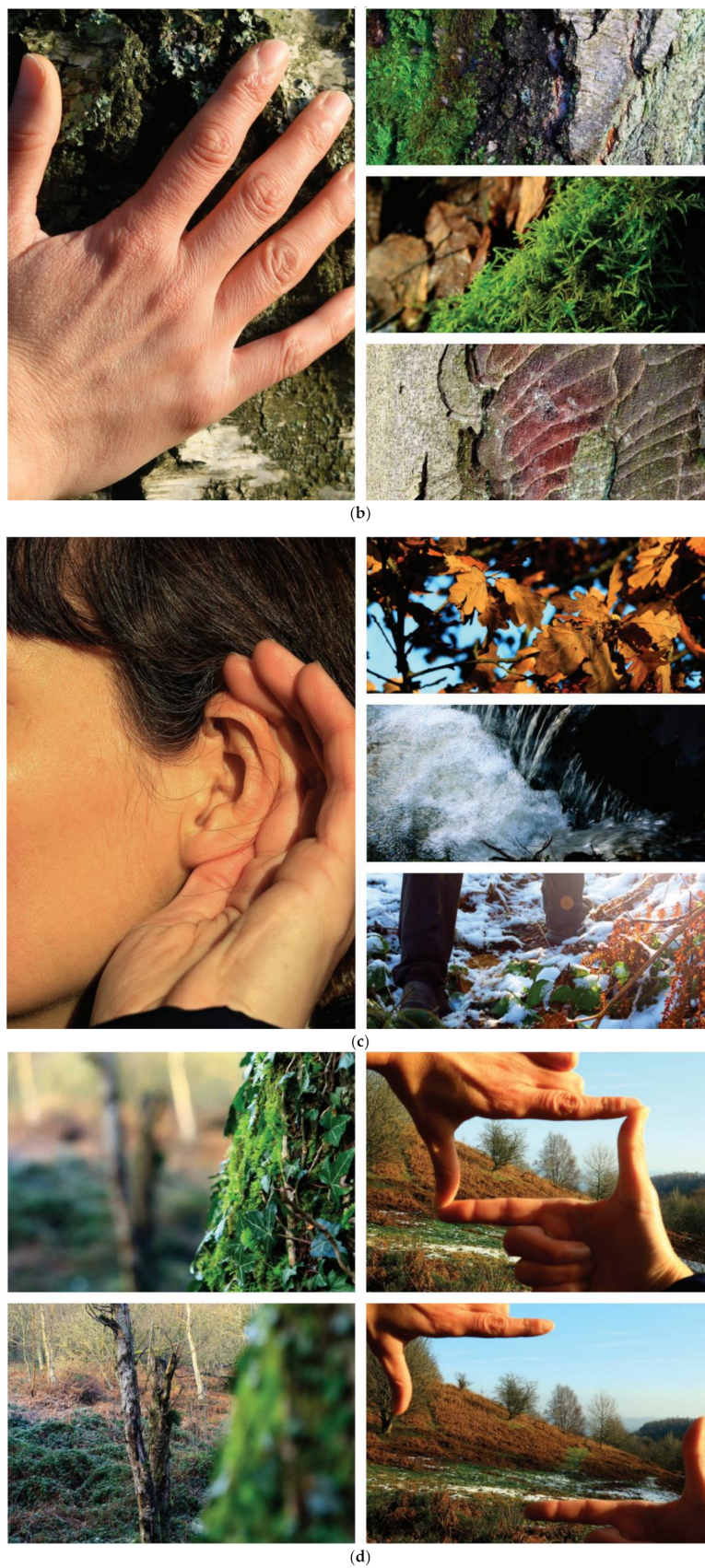


Figure 1. Cont.



(e)

Figure 1. Photographic examples of Forest Bathing exercises: (a) smelling exercises, (b) touch exercises, (c) auditory exercises, (d) visual exercises, (e) seated self-guided mindfulness.

3.2.2. Compassionate Mind Training (CMT)

The standardised CMT condition sessions were led by a researcher with expertise in CMT and a qualified Clinical Psychologist. The session entailed standard practices used in CMT: (i) a brief introduction to CMT including a definition of compassion and discussion of how people may respond to CMT to normalise responses, (ii) psychoeducation and (iii) compassionate imagery practices involving imagining having compassion for others, receiving compassion from others and giving compassion to oneself. For example, psychoeducation explains that we share motivations common with most mammals such as avoiding harm, seeking resources and allies and caring for kin. More recently in our evolutionary history we have evolved complex reasoning capacities, creative thinking, a capacity for anticipating the future and reflecting upon the past. This particular biological make-up can lead to distress in the form of rumination and worry about the past and the future. Furthermore, psychoeducation clarifies how complex our emotions are and that they can be difficult to regulate and maps our emotions onto three systems: (i) the threat system, which is about protection and safety and the main emotions attached to it are anger, anxiety and sadness; (ii) the drive system, which is incentive and resource-focused and (iii) the soothing system, which is about settling, non-wanting and safeness. Mental distress can arise from the misbalance of those systems; for instance, from an overactive threat system. In an attempt to stimulate the soothing system, clients are encouraged to practise compassionate mental imagery (i.e., the act of giving compassion to oneself or receiving compassion from an idealised compassionate other who has the qualities of non-judgement, kindness, empathy, wisdom etc.). To be consistent with the Forest Bathing condition, participants engaged in sharing circles throughout the session.

3.2.3. Forest Bathing and CMT Combined

In the Forest Bathing combined with CMT condition, sessions proceeded as a Forest Bathing session but combined the following elements of CMT: (i) a psychoeducation element of CMT that drew on more explicit examples from nature and other species; (ii) the inclusion of guided soothing rhythm breathing, compassion for others, for the self and for strangers imagery tasks and (iii) an additional imagery task was used that involved imagining compassion for other species and the environment.

3.3. Participants

Participants ($n = 61$, 50 females, 11 males) were staff and students recruited from the University of Derby who were naïve to Forest Bathing and CMT. All participants were over 18 years old; 9.8% were aged 18–30, 16.4% were aged 30–39, 31.1% were aged 40–49, 26.2% were aged 50–59 and 16.4% were over 60 years old. In the Forest Bathing condition participants comprised 16 females and 3 males aged under 30 (5.3%), 30–39 (5.3%), 40–49 (52.6%), 50–59 (31.6%) and over 60 (5.3%). In the Forest Bathing combined with CMT condition participants comprised 17 females and 4 males aged under 30 (4.8%), 30–39 (14.3%), 40–49 (19%), 50–59 (28.6%) and over 60 (33.3%). In the CMT condition participants comprised 17 females and 4 males aged under 30 (19%), 30–39 (28.6%), 40–49 (23.8%), 50–59 (19%) and over 60 (9.5%). Hansen et al. [18] noted in their review that previous study samples have tended to be homogeneous and biased towards males of University age. This study therefore offers a more heterogeneous sample. Usually for risk assessment purposes and quality of the experience, the maximum group size in Forest Bathing and CMT is ten participants. Two sessions per condition were therefore needed to reach the total recruitment target per condition (i.e., $n = 20$).

For the controlled collection of heart rate variability (HRV) data, participants were asked to refrain from eating, drinking tea or coffee and strenuous exercise two hours preceding the scheduled appointment. They were asked to follow a normal sleep routine the day before and record sleep and wake times, avoid intense physical training the day before and avoid alcohol for 24 h [26]. In the Forest Bathing sessions, the actual time spent walking was limited to 18–20 min in line with previous Forest Bathing research to reduce the effects of physical activity on HRV [18].

3.4. Procedure

3.4.1. Self-Report Questionnaires

At baseline, participants provided demographic information to control for the effects of extraneous variables on HRV (i.e., age, gender, smoking status, habitual alcohol consumption, weight, height, sleeping and waking hours and use of medication [26]). At baseline, post-intervention and three-months follow-up, participants completed the following self-report measures: (i) the 18-item Types of Positive Emotion Scale (TPAS), scored 0–4, assessing safe, relaxed and activated positive emotions [27] thus providing a test of both a low arousal (relaxation) and high arousal (excitement) positive emotion with the hypothesis that low arousal soothing positive emotions (relaxed and safe subscales) would increase across conditions; (ii) the 38-item fears of compassion scale, scored 0–4 [28], which is hypothesised to improve with CMT; (iii) the single item Inclusion of Nature with Self scale (INS), scored 1–7, providing a measure of nature connection [29], which is hypothesised to increase in the Forest Bathing conditions; (iv) the 15-item New Ecological Paradigm scale measuring pro-environmental attitudes, scored 0–4 [30], which is hypothesised to increase across conditions because an aim of the Forest Bathing Institute is to use Forest Bathing to increase concerns about protecting the environment and also compassion can elicit judgements and actions across different moral domains that should extend beyond humans and include other species and the environment [31]; (v) a 2-item measure of state rumination, scored 1–7 [32], included because the Forest Bathing Institute has received qualitative feedback that Forest Bathing reduces negative rumination; (vi) the 37-item short form of the Profile of Mood States (POMS), scored 1–5 [33], which has been used extensively in Forest Bathing research so provides a useful UK comparison. Few studies distinguish between the different senses used and those that have the greatest influence on wellbeing [18]; hence, participants in the Forest Bathing condition rated on a scale of 0–10 how much they used each of their senses during the session (i.e., smell, touch, sound, sight and taste). At three-month follow-up, participants were sent an email invite to complete the measures again electronically and were asked if they had continued to practise any of the exercises used in the sessions.

3.4.2. Heart Rate Variability (HRV)

Heart rate variability (HRV) was recorded in all female participants as gender differences occur in HRV and our sample comprised mostly female participants. HRV was recorded using seven ambulatory devices (Bodyguard, Firstbeat Finland). Participants were asked to sit for three minutes without moving or talking whilst their HRV was measured at baseline and post-intervention. Participants continued to wear the HRV device during the intervention to collect HRV data across all aspects of the intervention and assess the tasks responsible for changes to HRV and to be less invasive due to only fitting the HRV device once. HRV data were cleaned and analysed in Kubios Premium (version 3.3.1) with the artefact correction threshold set 'very low' at 5%. Data collected whilst walking were not used; rather data that related to specific tasks (e.g., baseline, post-intervention, listening tasks, smelling tasks, compassionate imagery) were extracted and entered into SPSS (version 26). Root Mean Square of the Successive Differences (RMSSD) was selected as a reliable primary outcome measure as it is thought to primarily reflect parasympathetic activity [26].

4. Results

4.1. Statistical Analysis

All data were subjected to tests of significant difference in questionnaire scores and HRV within data collection points (baseline and post-intervention) and between conditions (Forest Bathing, Forest Bathing combined with CMT and CMT) using a Multiple Analysis of Variance (MANOVA). Significance was set at α 0.05 and partial eta squared was calculated as the effect size parameter using Cohen's guidelines (0.2 = small, 0.5 = medium, 0.8 = large) in their interpretation. Questionnaire and HRV data were assessed for outliers using z-scores and normality was tested by examining skewness and kurtosis and the Shapiro–Wilk test. Log transformation was conducted on data that were shown to be not normally distributed (POMS and HRV data).

The influence of extraneous variables on HRV (e.g., waking/sleeping times, medication, caffeine) was tested using independent *t*-tests. The only extraneous variable to show any significant effects was medication. Participants taking medication were more likely to show a decrease in RMSSD post-intervention ($M = -12.64$, $SD = 31.97$) than those not on medication ($M = 14.26$, $SD = 20.62$) ($t = 2.52$, $df = 25$, $p = 0.018$).

To assess whether samples in each condition were comparable, independent *t*-tests were used to assess any differences in questionnaire scores and HRV between conditions at baseline. The CMT condition showed significantly higher baseline scores ($t = -2.19$, $df = 37$, $p = 0.035$) in compassion for the self ($M = 20.62$, $SD = 15.57$) compared with the Forest Bathing condition ($M = 11.22$, $SD = 10.13$) and compared with the Forest Bathing combined with CMT condition ($M = 10.53$, $SD = 8.60$). The CMT condition also showed higher baseline scores ($t = -2.71$, $df = 39$, $p = 0.010$) in compassion from others ($M = 20.19$, $SD = 9.91$) compared with the Forest Bathing combined with CMT condition ($M = 12.55$, $SD = 8.00$). There was a significant difference ($t = -2.78$, $df = 29$, $p = 0.009$) between HRV baseline measurements between the CMT condition ($M = 36.40$, $SD = 20.48$) and the Forest Bathing condition ($M = 60.71$, $SD = 28.19$) and between CMT and the Forest Bathing combined with CMT condition ($M = 52.75$, $SD = 22.81$) ($t = -2.10$, $df = 29$, $p = 0.044$). The CMT condition participants showed a lower mean baseline HRV. This might be due to the contrast between taking measurements indoors (CMT) vs. outdoors (Forest Bathing conditions). HRV is generally shown to be lower indoors in urban settings compared with outdoor natural settings [14].

4.2. Questionnaire Data

A repeated measures MANOVA was used to assess any within-subject differences in participants' scores between baseline and post-intervention and to assess any between-subject differences between conditions. Descriptive statistics across all conditions are shown in Table 1.

Table 1. Means (and standard deviations) for all study variables per condition at baseline and post-intervention.

	Forest Bathing		Forest Bathing and CMT		CMT	
	Baseline	Post	Baseline	Post	Baseline	Post
Safe positive emotion	9.68 (1.73)	9.98 (2.32)	10.14 (3.55)	11.75 (3.01)	10.24 (2.81)	11.19 (3.27)
Relaxed positive emotion	12.37 (3.68)	14.22 (5.47)	12.10 (4.25)	15.95 (5.58)	12.71 (4.34)	14.95 (5.27)
Active positive emotion	20.11 (4.81)	20.28 (4.85)	19.86 (5.94)	20.10 (6.04)	19.71 (4.70)	19.52 (4.99)
Compassion for others	11.05 (7.37)	9.06 (6.90)	12.43 (5.88)	8.90 (6.90)	14.90 (8.26)	11.57 (9.15)
Compassion from others	13.61 (11.22)	13.06 (12.01)	12.55 (8.00)	11.50 (9.54)	20.19 (9.91)	16.62 (10.03)
Compassion for self	11.22 (10.13)	10.72 (11.88)	10.53 (8.60)	10.75 (10.20)	20.62 (15.57)	15.52 (11.28)
Pro-environmental attitudes	44.32 (7.79)	46.17 (8.29)	45.20 (8.22)	47.21 (9.55)	44.57 (7.12)	46.86 (8.90)
Inclusion of self in nature	4.63 (1.38)	5.22 (1.52)	4.70 (1.59)	5.53 (1.17)	4.00 (1.52)	4.25 (1.62)
Tension	10.83 (4.53)	7.72 (3.03)	10.86 (3.85)	7.89 (2.88)	12.33 (4.63)	7.24 (1.87)
Depression	9.17 (3.07)	7.78 (2.10)	10.10 (4.90)	8.26 (2.45)	11.14 (6.95)	8.67 (2.67)
Anger	8.56 (3.29)	7.50 (1.04)	8.86 (4.19)	7.84 (3.02)	9.10 (4.50)	7.76 (1.48)
Fatigue	7.72 (2.54)	6.72 (2.52)	9.52 (5.03)	8.79 (4.16)	10.43 (5.93)	8.48 (4.30)
Confusion	9.00 (3.85)	6.61 (2.57)	8.71 (3.29)	6.47 (2.09)	9.24 (3.49)	7.29 (2.47)
Vigour	14.44 (5.26)	15.56 (5.85)	15.19 (5.36)	16.37 (6.57)	12.10 (5.49)	12.52 (6.58)
Mood disturbance	45.28 (13.39)	36.33 (10.35)	48.05 (17.76)	39.26 (12.30)	52.24 (21.98)	39.43 (11.02)
Rumination on feelings	5.11 (1.45)	4.11 (2.19)	4.95 (1.47)	4.85 (1.69)	4.57 (1.60)	5.05 (1.56)
Rumination on problems	4.79 (1.69)	3.11 (1.84)	4.24 (1.41)	2.80 (1.82)	5.19 (1.29)	3.57 (1.75)
HRV (RMSSD)	60.71 (28.19)	53.94 (20.99)	52.75 (22.81)	59.10 (31.11)	36.40 (20.48)	39.28 (28.61)

There was a statistically significant within-subject difference in participant scores between baseline and post-intervention ($F(19,25) = 12.02$, $p = 0.000$, $\eta_p^2 = 0.901$). Univariate tests revealed significant improvements in the scores for the measures of safe and relaxed positive emotions, compassion for self, for others and from others, rumination on problems, nature connection, pro-environmental attitudes and mood disturbance (including depression, anger, tension, confusion and fatigue). There were no significant main effects for activated positive emotions, vigour or rumination on feelings. The strongest effect sizes were for rumination on problems, tension and confusion (all $\eta_p^2 > 0.5$).

There was no between-subject effect of condition ($F(38,52) = 1.52$, $p = 0.080$, $\eta_p^2 = 0.526$). However, there was a significant interaction effect between scores at baseline and post-intervention and conditions ($F(38,52) = 1.09$, $p = 0.047$, $\eta_p^2 = 0.546$). Univariate tests

revealed that this effect was due to a greater improvement in nature connection scores (Inclusion of Nature in Self (INS)) in the Forest Bathing (change score = 0.72) and the Forest Bathing combined with CMT (change score = 0.84) conditions compared with the CMT condition (change score = 0.25).

In the Forest Bathing and the Forest Bathing combined with CMT conditions, participants were asked to rate on a scale of 0–10 how much they used each of their five senses. Descriptive statistics indicated that participants preferentially used their senses in the following order: visual ($M = 9.06$, $SD = 0.97$), auditory ($M = 8.29$, $SD = 1.21$), feeling ($M = 6.82$, $SD = 2.40$), smelling ($M = 5.59$, $SD = 2.48$) and tasting ($M = 1.18$, $SD = 1.55$).

4.3. Follow-Up Questionnaire Data

Participants were emailed and asked to complete questionnaires online at three-month follow-up; 44.26% ($n = 27$) of participants completed the follow-up assessment. When asked whether they had continued to practise exercises from the sessions, 26.3% of participants had practised Forest Bathing; 33.3% of participants had practised Forest Bathing combined with CMT and 38.1% of participants had practised CMT.

A series of ANOVAs were used to compare the follow-up data with the post-intervention data. These revealed a significant main effect of all three types of positive emotions that increased (especially activated positive emotions) ($F(3,20) = 12.46$, $p = 0.000$, $\eta_p^2 = 0.651$). There was a main effect of all three types of fears of compassion that increased ($F(3,21) = 24.93$, $p = 0.000$, $\eta_p^2 = 0.781$). There was a main effect for both types of rumination that increased ($F(2,22) = 10.71$, $p = 0.001$, $\eta_p^2 = 0.493$). Finally, there was a main effect for nature connection (INS) that reduced ($F(1,20) = 13.62$, $p = 0.001$, $\eta_p^2 = 0.405$).

4.4. HRV Data

A repeated measures ANOVA revealed no significant effects for HRV (RMSSD). When change scores in RMSSD were examined across conditions it was apparent that 57% of the sample showed an increase in RMSSD whilst 43% showed a decrease. Reductions in RMSSD in 34% of Forest Bathing [14] and 50% of CMT participants [23] have been noted previously and attributed to biophobia or self-criticism, respectively. Correlations were conducted between the change in RMSSD and baseline data across conditions. A significant correlation emerged between the change in RMSSD and anger and the change in RMSSD and RMSSD at baseline. A reduction in HRV was associated with higher anger ($r = -31$, $p = 0.037$) and higher HRV at baseline ($r = -40$, $p = 0.007$). Previous studies have shown that higher anger and higher resting HRV were associated with less engagement and fewer therapeutic gains [34]. Previous Forest Bathing studies were analysed using paired t -tests. Paired t -tests for the separate conditions showed no significant differences between HRV at baseline and post-intervention.

The continuous measurement of HRV across the two-hour sessions can be seen in Figure 2. For the Forest Bathing and Forest Bathing combined with CMT sessions, RMSSD increased during lying down, compassionate imagery, listening to water, smell, sharing circles and spending time with a tree. For the CMT condition RMSSD increased during compassion from others and soothing rhythm breathing. For each condition, paired t -tests comparing the mean RMSSD over the entire session with specific activities (e.g., listening tasks, smell tasks, compassionate imagery) were conducted. In the Forest Bathing condition, there was a significant increase in RMSSD above the session mean during the spending time with a tree task. In the Forest Bathing combined with CMT condition, RMSSD reduced below the session mean during the psychoeducation element, looking at water and the first sharing circle and increased above the session mean during the compassion imagery task and spending time with a tree task. In the CMT condition, RMSSD did not significantly increase above the session mean for any of the specific tasks.

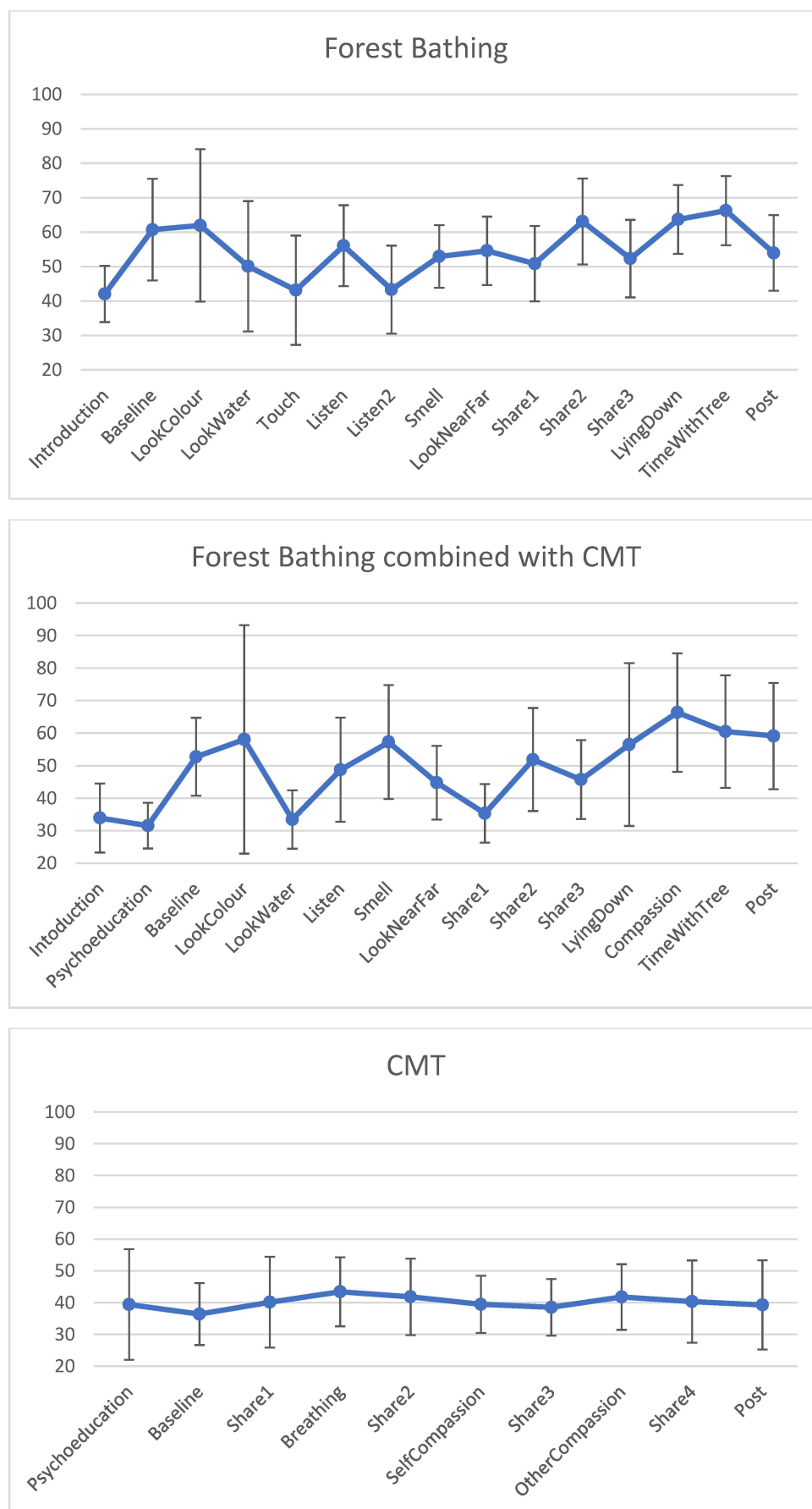


Figure 2. Root Mean Square of the Successive Differences (RMSSD) during all study conditions.

4.5. Forest Bathing and CMT as a Social Prescription

To consider the next steps in recommending Forest Bathing as a social prescription, it is necessary to consider its acceptability. Previous studies have failed to report drop-out rates [16] or adverse events [19] and the effect these may have on an individual's likelihood of engaging with the session and/or future sessions. Of those who consented, 83% attended their session. Reasons cited for non-attendance were: (i) forgetting their appointment; (ii) feeling unwell or having an unwell child; (iii) having too much work; (iv) following a postcode instead of the map and written directions provided and therefore being unable to find the woodland. In terms of adverse events, in the Forest Bathing condition, one participant had suffered a back injury the day before and found sitting or lying down painful. They were also irritated by insects crawling on them and biting them. In the Forest Bathing and CMT condition, one participant had autism and found being in a group and the unpredictable movements of others unpleasant; they also struggled to imagine receiving compassion from another person. At baseline, seven participants scored above 4 on the single item of anxiety within the tension subscale of the POMS (scored 1–5). This anxiety score might be associated with biophobia; however, no specific biophobia data were collected so this cannot be concluded. At post-intervention, no participants scored above 4 on anxiety, indicating that anxiety was alleviated post-intervention. In terms of suitability for a UK population, in comparison with POMS effect sizes from six Asian studies that reported enough statistical information from which to calculate effect sizes [35–39], the large effect size for tension was similar whilst remaining mood disturbance subscales showed smaller effect sizes than previous studies. With regards to HRV, a meaningful comparison with previous literature cannot be made as the majority of papers only assessed between-subject effects. Only two papers assessed within-subject effects and found non-significant [39] or significant results [40] in terms of an increase in HRV with Forest Bathing. Previous research indicates that those with a greater clinical need benefit more from Forest Bathing [17,40]. To assess this, a *t*-test was conducted comparing participants who scored lower or higher than the median tension score (11 on the POMS tension subscale) at baseline. This revealed that the higher the tension score at baseline, the greater the improvements seen in tension ($t = 5.37$, $df = 55$, $p = 0.000$), anger ($t = 2.85$, $df = 55$, $p = 0.006$), confusion ($t = 2.26$, $df = 55$, $p = 0.028$) and nature connection ($t = 3.27$, $df = 54$, $p = 0.002$).

5. Discussion

The primary aim of the study was to assess whether Forest Bathing in a UK population would result in improvements in the outcome measures commonly used in Asian Forest Bathing studies (i.e., Profile of Mood States scale (POMS) and HRV). Significant improvements were found in questionnaire scores for mood disturbance (POMS-tension, depression, anger, fatigue, confusion), low arousal relaxed and safe positive emotions, rumination on problems, nature connection, pro-environmental attitudes and compassion for the self, others and from others. There were no significant changes in activated positive emotions, vigour or rumination on feelings. The results for HRV were mixed with 57% of participants showing an increase in HRV. Reductions in HRV in a percentage of participants have been found before in Forest Bathing [14,41] and CMT [23] studies and have been attributed to biophobia or self-criticism. There was some indication that 43% of participants might have shown a reduction in HRV due to higher baseline scores in anger and HRV, both of which have been found to be associated with less engagement and fewer therapeutic gains [34]. Overall, there were no significant differences between conditions or between baseline and post-intervention in HRV.

A secondary aim was to utilise a more robust control condition compared with previous Forest Bathing studies where the control condition was often a walk in an urban setting, which has been shown to increase stress, making a comparison with Forest Bathing less meaningful [10]. The current study compared Forest Bathing with an established UK intervention called Compassionate Mind Training (CMT). Unlike urban walking control conditions that are expected (and indeed found) to perform worse than Forest Bathing in terms of wellbeing outcomes [41], we hypothesised that the control condition of CMT,

which has been shown to be effective in improving a range of wellbeing measures and HRV [22–24], would perform similarly to Forest Bathing. Indeed, no significant differences in the questionnaire scores or HRV were found between Forest Bathing and its control condition of CMT, indicating an equivalence across interventions. In other words, Forest Bathing produced benefits similar in magnitude to an effective and established UK wellbeing intervention (CMT).

A third aim was to assess an additional condition comprising a combination of Forest Bathing and CMT and to assess whether this was superior to practising Forest Bathing or CMT alone. Both interventions target and have been shown to increase parasympathetic activity as reflected by increased HRV [16,19,22,23] and both are based on evolutionary theories. Hence it was felt that the approaches were complementary and might produce greater wellbeing benefits if combined. It is also not uncommon for previous studies of Forest Bathing to combine viewing the forest with other interventions such as meditation or yoga activities [10]. As an equivalence was found across interventions, there was no evidence that Forest Bathing combined with CMT was superior to Forest Bathing or CMT alone. The only partial evidence for the superiority of the combined condition came from the finding that Forest Bathing combined with CMT revealed greater improvements in nature connection scores compared with Forest Bathing or CMT alone.

A fourth aim was to utilise the continuous measurement of HRV to provide a novel examination of the mechanisms of effectiveness within the interventions (i.e., to see which aspects offered the most benefit to participants). In previous Forest Bathing studies continuous HRV measurement was frequently used; however, it was typically reported in five-minute time segments and was not explicitly related to the specific activities within Forest Bathing such as visual, listening and touching tasks. This study therefore provides the first assessment of which specific activities produced the greatest changes in HRV. The following tasks produced the greatest increases in RMSSD: lying down, compassionate imagery, listening to water, smell, sharing and spending time with a tree; hence, these tasks should be considered important elements of these interventions. To sum up, this study provides early support for the feasibility and effectiveness of Forest Bathing in the UK. This study is novel in that it has responded to a need for rigorous scientific testing to inform the effectiveness of a UK Forest Bathing intervention and potentially increase buy-in among key authorities.

This study offered a rare follow-up assessment at three months. At follow-up fears of compassion and rumination had increased and nature connection had decreased. This indicated that the continued practise of Forest Bathing and CMT were required to maintain the beneficial effects. It has been recommended that Forest Bathing is practised two to three hours every two weeks [9] whilst CMT would usually be practised over > 12 practitioner-guided sessions and independent daily practice is encouraged [21].

The findings of this study have implications for policy regarding areas of woodland. The UK government has committed to improving the collaborative relationship between Local Nature Partnerships and Health and Wellbeing Boards [42], indicating an intent to embed access to the natural environment within mental health support services. The WHO [1] supported Forest Bathing as a healthy intervention and outlined a need for high-quality and well-maintained woodland to allow people to engage with green space in a safe and healthy environment. Paying attention to the quality of forested environments can buffer against any negative effects of being fearful of poorly maintained and potentially dangerous woodland where crime rates may be high [1]. Department for Environmental Food & Rural Affairs (DEFRA) [43] released a Government Forestry Policy Statement outlining the need to “grow a new appreciation of woods and forests” (p. 2), showing a commitment to improving public access to forested areas especially for those near to urbanised areas to maximise the number of people who can benefit from visiting them. The statement further outlined the intention to encourage local authorities to make use of opportunities for engaging with forests and improving access to these, stating the need to “work to improve and restore our native and ancient woodlands” (p. 4). The results of this

study help to inform public awareness of the need to engage in more pro-environmental attitudes, which can be increased through engaging with the natural environment [1]. Biodiversity 2020 is a national strategy outlined by the UK government aiming to slow down the rate of biodiversity loss in England [44]. With evidence that biodiversity is associated with greater wellbeing [45] and with only 13% of the UK being forested [20] and only 2.4% of this being ancient woodland [46], it is crucial to implement interventions that encourage the appreciation and protection of forests as a health and wellbeing resource.

6. Limitations and Future Directions

Pragmatic constraints of the study (the Forest Bathing practitioners were in Derbyshire for three days only) meant that participants were assigned to conditions based on the dates that they were available to attend sessions. In a review, [19] noted that only one study reduced the risk of bias in sampling by using computer-generated random codes. A future study would use computer-generated randomisation delivering a full randomised controlled trial (RCT) design. In addition, due to these time constraints it was only possible to run Forest Bathing sessions for 20 individuals per day (10 per session); hence, the sample size was limited by this constraint and in future studies should be based on a sample size calculation.

There was some indication from the first sharing circle where participants said what had attracted them to the session that many participants had an interest in mindfulness, meditation or compassion. In addition, most of the sample comprised women. The Forest Bathing Institute (TFBI) report that it is mainly women who are attracted to Forest Bathing sessions, perhaps due to its association with mindfulness and self-care. Ideally, future studies will recruit more heterogeneous participants via signposting from health professionals and will target participants struggling with issues such as anxiety, depression, stress, high blood pressure or social isolation. Previous reviews have noted the need for more studies with clinical samples to establish evidence of the therapeutic value of Forest Bathing [16]. Research indicates that the positive impact of Forest Bathing is relative to the severity of participants' stress levels, i.e., the more stressed, the better the rewards [17]. Support for this was found in the current study which found that higher scores in tension at baseline were associated with a greater improvement in wellbeing scores. This indicated that high stress populations may be worthy targets for intervention.

At baseline, seven participants scored above 4 on the single item of anxiety within the tension subscale of the POMS. While this score reduced post-intervention, future studies should include a measure of biophobia. Biophobia is largely ignored in nature-based studies [47] despite its relevance to informing the suitability of nature-based interventions. For example, two studies [14,41] noted that 20% [41] or 34% [14] of their participants showed an adverse HRV response to Forest Bathing and suggested that this could be due to biophobia. This study measured nature connection, which increased after Forest Bathing, but did not specifically measure biophilia or biophobia so whilst there was some evidence, it would be difficult to draw firm conclusions. Future research should assess whether any adverse effects are experienced during Forest Bathing and whether these are linked to biophobia.

The emphasis of Forest Bathing delivered by the Forest Bathing Institute is on ancient or semi-ancient woodland because this offers greater biodiversity (which in turn is associated with greater wellbeing [41]) and greater sensory richness, thus offering more opportunities for mindfulness exercises based on the senses. However, some of the most socioeconomically deprived individuals with the greatest need for interventions such as Forest Bathing may not have access to such high-quality greenspace. Hence, this study highlights the need for more high-quality urban greenery, making the best of what is available locally. In other words, an urban version of Forest Bathing might bring the intervention closer to the populations who have the greatest need. Research has shown the general benefits to wellbeing of noticing the green spaces in urban environments [48]. More specifically, there is evidence that quick, less in-depth experiences in wooded en-

vironments produce self-reported relaxing effects [35] and activate the parasympathetic nervous system [14]. Such findings could be used to inform city planning. For example, that there are mental health benefits to accessing forested areas near a city centre [35] is evidence that could be used to increase not only the quantity of green space in and around urban areas but crucially also the quality of this green space. Typically, there is a lack of quality green space in densely urban areas [49], which can limit the likelihood of those living in these areas connecting with nature. By introducing more appealing and diverse types of green space, the barriers to engagement with the natural environment among those living in inner-city areas with greater socioeconomic deprivation could be addressed.

The mixed results for HRV could partly be an effect of how HRV was measured in our study. In previous studies baseline HRV was frequently taken inside a windowless room and post-intervention HRV was taken in the forest. It is likely therefore that HRV would be lower at baseline than at post-intervention due to previous findings that built and urban environments are associated with lower resting HRV than natural environments [50]. This also renders the Forest vs. Urban comparison in previous studies less helpful in determining the effectiveness of Forest Bathing than comparisons with other therapies [10]. In future studies, to produce more comparable HRV data with previous studies, two baselines will be taken in indoor conditions and on entering the forest. In addition, given the active nature of the sessions completing 2 h of light exercise, in future studies, measures could be taken in daily life and compared with data during sessions.

It is generally recommended that Forest Bathing is practised two to three hours every two weeks [9] whilst CMT would usually be practised over > 12 practitioner-guided sessions [21]. Future studies should therefore look at the cumulative effects of Forest Bathing over the course of a longitudinal study.

Finally, previous research has largely focused on unguided Forest Bathing with the few examples of guided Forest Bathing featuring a range of activities [10]. Future studies would benefit from directly comparing unguided with guided Forest Bathing. To date only one study has examined this and found no differences [51]. However, detailed written guidance and maps were still provided in the unmanaged group, making it a less robust control compared with, for example, a completely unguided walk in a woodland. There was some evidence from our follow-up that participants struggled to practise without a guide. At the time of writing, the Covid-19 pandemic was significantly affecting health and wellbeing with a second mental wellbeing pandemic predicted [52]. Forest Bathing is an outdoor small group activity that has the potential to benefit health and wellbeing even during times of restricted movement and social contact.

7. Conclusions

This study offers the first UK pilot of Forest Bathing, demonstrates improvements across a range of wellbeing measures and shows equivalence of Forest Bathing with an established wellbeing intervention (CMT). The study also offers a rare follow-up assessment that demonstrated the need for continued practise of Forest Bathing and CMT. It is important to remember that the interventions assessed in the study were one-off 2 h sessions; hence, the improvements in wellbeing were all the more impressive. Usually, Forest Bathing should be practised every two weeks and CMT is delivered over > 12 sessions and ongoing independent practice is encouraged. In the future, it is hoped that the findings of this paper will encourage healthcare providers, policy makers and organisations to implement Forest Bathing as a feasible social prescription intervention to improve public and patient health and wellbeing. Indeed, we are pleased to say that following presentations about Forest Bathing and this study to Guildford Council (Surrey, UK), Forest Bathing is now socially prescribed by Guildford Council via Voluntary Action Surrey and is now being piloted amongst 200 NHS patients as part of the UK government's green social prescribing programme [53] to aid the development of a Surrey-wide scheme. The next steps for this research are a fully powered RCT and the involvement of participants with a clinical need to truly assess the therapeutic value of Forest Bathing. There are additional

implications for nature conservation and the wellbeing of the natural environment. By promoting Forest Bathing, it is hoped that compassion for nature and valuing biodiverse natural environments such as forests can be increased, making it more likely that such areas will be protected and producing a symbiotic relationship where humans and nature work together for their mutual wellbeing.

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Institutional Review Board Statement: The study was conducted according to the guidelines of the Declaration of Helsinki, and approved by the Ethics Committee of the College of Health, Psychology and Social Care Research, University of Derby (21/06/19).

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: Data available on request due to ethical restrictions. The data presented in this study are available on request from the corresponding author. The data are not publicly available due to not having participants consent to share their anonymized data with a third party.

Conflicts of Interest: Two of the authors are Forest Bathing practitioners who run a Forest Bathing organisation and have an interest in evidencing Forest Bathing to facilitate it becoming a social prescription. These two authors were only involved in delivering the intervention and were not involved in the design, analysis or write-up of the study. Hence, any conflict of interest on their part is mitigated.

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