

The Impact of Forest Bathing on Stress Reduction: A Randomized Control Trial

SWED-FOREST

Ethics & Trial registration: Ethical Committee in Sweden & <https://www.isrctn.com/>.

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WP3 GreenME

Scientific coordinator: Margarita Triguero-Mas, MPH PhD
Open University of Catalonia (UOC) – Health Sciences Department at
Rambla del Poblenou, 154-156
08018 Barcelona, Barcelona, Spain
E-mail: mtrigueroma@uoc.edu

WP3 Sweden

Principal investigator (PI): Anna María Pálsdótti (AMP), PhD, Associate Professor
Dept. of People and Society,
Swedish University of Agricultural Sciences (SLU), Alnarp, Sweden
E-Mail: anna.maria.palsdottir@slu.se

Vice investigator (VI): Marcus Hedblom, PhD, Professor
Dept. of SoL,
Swedish University of Agricultural Sciences (SLU), Ultuna, Sweden
E-Mail: marcus.hedblom@slu.se

Intervention: Petra Ellora Cau Wetterholm, MSc, Licensed Psychologist
CEO Scandinavian Nature and Forest Therapy Institute
Stockholm, Sweden
E-mail: contact@shinrin-yokusweden.se

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Rationale: Spending time in nature can reduce stress, improve mood, and enhance cognitive function (Yang et al, 2021; Yang et al, 2023; van Den Bosch & Bird, 2018; Triguero-Mas et al, 2017). Exposure to natural environments such as forests (as in forest bathing and therapy) can lead to decreased cortisol levels, lower blood pressure, and increased feelings of relaxation and happiness (Li, 2018; Triguero-Mas et al, 2017; Lai et al, 2018; Hartig et al, 2003). Nature-based therapies are also linked to increased social interactions (Natural England, 2016), which can lead to increased sense of belonging, decreased isolation and – consequently- potentially lower levels of experienced marginalization. Moreover, the increased skills development and confidence resulting from NBTs (Sempik & Bragg, 2016) may increase self-efficacy and resilience (White et al, 2023), even when faced with discrimination. While forest bathing show promise for improving mental health, evidence supporting their effectiveness is still limited. Many existing studies suffer from small sample sizes, lack of control groups, unclear intervention protocols, and reliance on short-term outcomes (Yang et al., 2023). Additionally, research often lacks consistency in measures and fails to explore differences across population subgroups or pathways through which NBTs impact mental health. Importantly, no study has directly assessed whether NBTs can reduce perceived discrimination, marginalization, or stigmatization—key factors that affect mental well-being. Therefore, research on this specific relationship is needed. Given the fact that NBTs can enhance the overall mental health (van den Bosch & Bird 2018), it is plausible that NBTs might also mitigate negative effects associated with perceived discrimination and/or stigmatization. With the growing interest in NBTs worldwide, there is a clear need for more robust research, particularly in health economics, to assess both the costs and health outcomes of these interventions (Busk et al., 2022). To date, no randomized controlled trials have combined cost-effectiveness with health outcomes for NBTs. (ibid). Given the resource constraints in public health, conducting such evaluations alongside clinical trials is crucial for informing policy decisions. This study aims to fill these gaps by evaluating the impact of NBTs on perceived stress and discrimination while also assessing their cost-effectiveness.

Overall study objectives: To evaluate the effectiveness of a guided forest bathing program in reducing perceived stress compared to usual care.

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Type of study:	<p>A prospective RCT, a two-armed intervention study.</p> <ul style="list-style-type: none">○ Arm 1: Intervention, forest bathing.○ Arm 2: Control (waitlist), treatment as usual (TAU). (After the study, the control group is invited to participate in six forest bathing session).
Primary outcomes:	<p>Forest bathing significantly reduces perceived stress compared to treatment as usual (TAU).</p>
Secondary outcomes:	<p>Improved quality of life (QoL) with forest bathing compared to treatment as usual (TAU).</p> <p>(QALYs) and healthcare/societal costs.</p> <p>Enhanced subjective well-being with forest bathing compared to TAU. Reduction in the effects of perceived stigmatization on mental health.</p> <p>Sustained improvements in mental health indicators (stress, QoL, and well-being) at 1 and 3 months post-intervention.</p> <p>The cost-effectiveness of the forest-bathing intervention.</p>
Type of intervention:	<p>Recovery-oriented intervention (a non-clinical intervention).</p>
Study population:	<p>Individuals experiencing significant stress in their daily life.</p>
Sample size:	<p>158 participants (79/group minimum (n=158), medium-large effect size d=45, power=80%, $\alpha=0.05$).</p>
Eligibility:	<p><i>Inclusion:</i></p> <p>Age 18–64 years.</p> <p>Stress interference in daily life being significant or very significant; ICD diagnoses: F43.8a (primary), F32.0, F32.1, F41.0 (secondary).</p> <p>Ability to understand the information for participation in the study and the forest bathing intervention, both by oral and written instructions.</p> <p>Signed Content, protocol compliance.</p> <p><i>Exclusion:</i></p> <p>Intellectual disability, phobias, dissociative behaviours (ICD-11 codes).</p> <p>Conditions preventing participation or intervention suitability.</p> <p>Participated in any kind of NBI in the last 12 months.</p>

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	MB23.0 - aggressive behaviour Suicidal risks, known drug or alcohol abuse, evaluated by referring MD.
Estimated study Period:	Recruitment: Spring 2025 (after approval of the ethical application) Last month of recruitment is at end of March 2026. Intervention: May or June 2025 (depending on ethical approval). The last intervention session will be at end of June 2026 Last follow-up: October/November 2026.

Figure 1: Flow chart Study overview – see appendix (bilaga) T3.2&T3.3_Flowchart_ForSweden

Recruitment:	Healthcare units in Stockholm.
Allocation:	Healthcare unit: Lägereld, Stockholm (SLU supervision).
Randomization:	Computer-generated allocation by software: Sealed Envelope (pseudorandom number generator).
Participant withdrawal:	Participants can withdraw from the study at any time without providing a reason. If a reason is given, it will be documented. Withdrawn participants will not be replaced.
Investigator's withdrawal:	The investigator has the right to withdraw the patient from the study in the event of Disease progression and/or Non-compliance.
Study design:	A prospective RCT incorporating both qualitative and quantitative methods as an add-on to TAU.
Data transfer & managements:	All study data will be securely stored in the project's cloud-based storage system (Microsoft Teams-UAB-GreenM under the lead Margarita Triguero-Mas). Databases templates in Qualtrics, are country specific data set, see above outcome measurements for Sweden. No data will be saved on local desktop computers or laptops on country level. The completion of the T3.3 dataset, it will be made available on the GreenME website upon request by contact with the lead M. Triguero-Mas. Two years after the conclusion of the GreenME project

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or after the primary publications are released, processed, anonymized, and aggregated data (along with corresponding metadata) will be deposited in a trusted repository, such as ddd.uab.cat, dmp.csuc.cat, or zenodo.org. The data will be shared in standard formats (.csv, .doc, .pdf, .jpg, .txt), and a Digital Object Identifier (DOI) will be assigned to the dataset.

Metadata will be created following the Dublin Core standard, including relevant keywords from an established thesaurus (e.g., MESH terms) to ensure discoverability.

The UAB ethics committee will review all data storage and access procedures before publication. Data will be retained and accessible for a minimum of five years following the completion of the study.

An external drive will be used to create a security copy of all the documents of the project each month. The external memory will be kept in a locked physical place at UAB, which location will only be known by a very small group of people (approximately 4 people including the 2 scientific coordinators of the project).

Outcome measurements and covariates are the same as WP3 General Protocol, with country application of choice of questionnaires at the four measurements occasions:

- 1) Baseline, before the start randomisation for the arm 1 (intervention) or arm 2 (control group);
- 2) FU1 =Measurements at the end of the intervention (both arms).
- 3) FU2=Measurements four weeks after intervention (both arms).
- 4) FU3=Measurements 12 weeks after intervention (both arms).

Overview Evaluation:

Stress: Perceived Stress Scale (10 items)
Quality of life: EuroQol 5 Dimensions 5 levels
Wellbeing: (ONS-4 or OECD-4
Anxiety: Generalized Anxiety Disorder-7 (GAD-7 items)
Sleep quality: PSQI (2 items)
Depression: PSQ (9 items)
Human-Nature connectedness (6 items)
Perceived benefits from nature (1 item)
Self-Perceived biodiversity (3 items)
Everyday Discrimination Scale (9 items).

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	Experiences of stigmatization: Self-esteem and Stigma Questionnaire Medication Exposure to different levels of NBIs
Qualitative data: group will be	Semi structure interviews with clients on their experience of the forest bathing interventions. In addition, the control invited for semi-structured intervention to understand their lived experience during the time as control/waitlist. Forest bathing Guides will also be interviewed on the practical aspects of running the forest bathing intervention.
Covariates:	Age; Gender; Education; Perceived income; Medication; Experience of marginalization; Experience of stigmatization. Ethnicity.
User Satisfaction:	Adapted version of the Client Service Receipt Inventory (CSRI)
Statistical methods: originally patients from a dropouts will increase the risk participants who do not adhere more than just their focus of our study, it dilutes the effect as heterogeneous with noncompliance, participants (however, it increases	We will analyse our data as intention-to-treat (i.e. analysis the participants according to the groups to which they were assigned during randomization, because excluding randomized trial due to noncompliance or of bias in a study as research shows that to the intervention assigned differ in ways adherence. Although it is not the main intention-to-treat minimizes type I error as the “exposed” group is highly dropouts and compliant generalizability). After this, we will also perform a sensitivity analysis, including only information from participants who adhered to the as those who attended >75% of the NBT sessions). This is of what “per protocol” analyses would be. Nature-health analyses will include descriptive analyses of the exposure (natural space characteristics), outcome (different indicators of mental health) and covariate data (e.g. gender, age). We will also perform basic statistical analyses on the associations between exposure to nature and some of the main mental health outcomes per each intervention for D3.5. Last, meta-analyses will be performed for the scientific outputs. We will use meta-analyses instead of cluster analyses outcomes will have been measured in a
intervention (defined an estimation because: (i) our	

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standardized way across overall effect size and effect (i.e. our main objective is not better investigated through account for and model random-effect model). That is, with all data and then conduct gender (if data allows, also ethnicity/race or by a composite score

interventions, (ii) we aim to estimate an sizes by specific subgroups, such as gender to explore data grouping, which would be cluster analysis), (iii) meta-analysis can intervention heterogeneity (e.g. using a we will undertake a general meta-analysis a subgroup analysis separately (at least) by by education, perceived income, of marginalization).

medication

Moreover, cost-effective analyses from a societal perspective will include direct costs (e.g. visits to the doctor and consumption) and indirect costs (e.g. work sick leave) .

Intervention Programme:	Forest bathing program as an example of NBI
Location:	Urban and peri-urban forested areas, Stockholm
Methodology:	Nature Based Stress Therapy (NBST)
Intervention model:	A closed Group based intervention.
Group size:	8-12 participants, one guide and one assistant
Duration of programme:	12 consecutive weeks/one session each week for 120 minutes at time.
Frequency sessions:	1 session/week
Duration of each session:	120 minutes/session
NBST- programme:	The NBST is a manualised and guided programme. It is firmly grounded in the <i>Eco Forest Therapy</i> methodology but with methodological and skills additions, targeting support and adjustments for stress-related disorders. The 12 programme sessions are divided into two parts and 4 phases, each committed to supporting stress reduction, recovery, nature connectedness, and nature-based self-care.
The two parts of NBST:	The programme offers a gradual process; from stress reduction and recovery to the maintenance of a nature-based self-care. All sessions follow the same Eco Forest Therapy-structure, but with additions tailored to support stress related ill health.

1. 6 weeks targeting mainly stress reduction, rest and recovery
2. 6 weeks adding nature activities and social sharing

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The 4 phases of NBST: The four phases of NBST are the intended treatment progression of the programme. For each phase, particular focuses or themes are introduced, as guidelines for the choice, pacing and energy level of activities. These are seamlessly integrated into the (Eco Forest Therapy) methodological structure, invisible for the participant, but a key function for the guide.

- Session 1-3: Stress reduction and rest
- Session 4-6: Recovery, connectedness and attachment
- Session 7-9: Nature -activities, -relation and -coherence
- Session 10-12: Integration, nature based social sharing and the maintenance of nature-based self-care

EFT Methodology: Petra Ellora Cau Wetterholm developed the Eco Forest Therapy methodology as part of Shinrin-Yoku Sweden and its operational platform, the Scandinavian Nature and Forest Therapy Institute.

The Eco Forest Therapy methodology offers two levels of expertise: forest bathing and forest therapy. The forest bathing methodology acknowledges the Japanese style of Forest Bathing (Shinrin-Yoku) as well as the American ways of Forest Therapy, developed by ANFT in the USA. It is further shaped by science, psychology, ecopsychology, ecology and not the least, the Scandinavian land, nature, language and culture. The Forest Therapy methodology is an add-on module for skills training and development to meet the adjustments necessary to guide individuals and groups with specific needs.

The definition and operationalisation of Eco Forest Therapy methodology are thoroughly expressed in the two extensive manuals written for the certified forest therapy guide training: "The Art of Forest Bathing Guiding " and "The Art of Forest Therapy Guiding" by Cau-Wetterholm, available for guides in training.

The methodology, overview, process, training and scientific underpinnings are compiled as the "SHIFT MAP", in three visual models:

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1. *The Forest Therapy process*: a chart showcasing four, experiential phases occurring during a guided Eco Forest Therapy walk,
2. *The Nature Compass*; a collection of scientific studies in support of nature connectedness and wellbeing,
3. *The Guide Compass*: four fields of expertise held by an SNFTI-certified forest bathing guide are personal nature connectedness and embodiment, guiding skills and experience, theoretical and scientific cultivation, and natural knowledge.

The session:

An Eco Forest Therapy session typically starts with a gathering of the group and a first connection; to each other and to nature. This is followed by a series of guided invitations with key features such as walking slowly and standing, leaning, sitting or lying down with an emphasis on sensory ways to notice, connect and relate to nature. Significant aspects of the guided interventions in the first half of a session are, guided meditations on the five senses in relation to nature, slowing down, various nature experiences and explorations and occasional sharing of experiences. The second half of the session emphasizes a gradual immersion of sensory experiences and relational qualities in support of mind-body rest and recovery. The forest bathing session typically ends with a formal tea ceremony. The guide prepares tea with edible forest herbs and serves the participants. This allows for an integration of experiences and benefits social connection and sharing. During the session, verbal silence is for the most part encouraged, except during gathering for brief sharing. "



Figure 3: Overview of the estimated timeline for the 120 min session including four main sequences 1) Therapeutic alliance (0-15 min); 2) Guided session with a focus on sensory-oriented nature connected in slow pace 15-60 min); 3) Guided sensory oriented nature connection, complementation and own time (60-100 min) and 4) Get together, reflections and light refreshments and tea (100-120 min). [in Swedish but translated in Figure text]

Certified FT guide:

A Certified Forest Therapy Guide by SNFTI has undergone two trainings: the four-month Forest Bathing Guide training and the two-

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month Forest Therapy Guide training, a continuous professional development programme.

The Certified Forest Bathing Guide is primarily trained as a guide with expertise in nature connectedness guiding. There is no requirement to hold a licence as a health professional. The training offers expertise in four domains: personal nature connectedness, skills/experiential guide training, naturalistic knowledge and academic studies with theory and science. The Forest Therapy Guide training offers an additional level of expertise. The methodology is firmly based on Eco Forest Therapy, with an additional program for skills development to meet the adjustments necessary to guide individuals and groups with specific needs.

Intervention executive plan: Certified Forest Therapy Guides – who is participating

Locations: Where are the interventions taking place?

Written manual for the NBST.

Checklist: nature trail assessment: ensuring conditions are the same for all groups.

Online meetings for the guides to ensure all is running fine in the intervention: information and supervision before the next, Q&A

Prior to intervention:

Each guide participating in the intervention study signed up voluntarily. They gather online with programme author and supervisor Petra Ellora Cau Wetterholm for an initial meeting to receive information and the possibility to ask questions. Thereafter they meet for a 3-day workshop and receive the NBST-manual and the forested area where the programme will take place.

Each guide assesses the forest trail in collaboration with the supervisor and plans the sessions according to the NBST manual.

Note: Guides are required to have an updated First Aid/HLR training (updated every 2 years).

During the intervention:

Each week, the guides and supervisor meet online for a mandatory, 1.5-hour follow-up report, in-depth review, information, and Q&A of the coming session.

Insurance:

SLU will ensure the intervention, guides as well as participants according to the Kamarkolliget and SLU agreement.

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Environment: GreenME WP4 Audit tool to evaluate the space across different dimensions. NEST tool (to evaluate access, recreational facilities, amenities, aesthetics, incivilities, significant natural features, usability) biodiversity, environmental justice aspects, and restorative landscape by Contemplative Landscape Model. This is a part of WP4 of GreenME.

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