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Developing a new tool to capture the nature dose to reduce loneliness and improve quality of life

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## Developing a new tool to capture the nature dose to reduce loneliness and improve quality of life



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### ABSTRACT

Recognition of the health benefits of nature contact has increased. Simultaneously, growing numbers of people worldwide experience loneliness. There is a movement towards prescribing nature-based activities to improve/promote social connections, health, and quality of life. Yet, what constitutes a therapeutic nature dose is not well understood, due in part, to the lack of instruments that capture the characteristics of nature-based activities and measure 'nature dose.' We created a nature dose measurement tool to fill this gap by capturing various aspects of contact with nature and perceptions regarding park access, quality, naturalness, psychological distance to nature, and biodiversity. This tool will facilitate greater understanding of how natural areas, nature-based activities, and nature exposure reduce loneliness and promote health-related quality of life. Measuring nature dose with standardized tools and documenting benefits will generate

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the evidence base needed to design, implement and evaluate nature-based social interventions for improving health and quality of life.

- This tool captures the nature dose to reduce loneliness and promote quality of life.
- Constructs range from park quality and access, to mood, to biodiversity perceptions.
- The standardized nature dose tool will help design nature-based social interventions.

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## Specifications table

Subject area:	Psychology
More specific subject area:	<i>Environmental health, Environmental psychology</i>
Name of your method:	Nature dose tool to reduce loneliness and improve quality of life
Name and reference of original method:	This is a novel tool that we have developed as a research consortium
Resource availability:	Our nature dose tool is included (Supplement A). All open research data will be deposited in a certified repository (e.g., ZENODO) and open access will be established to identify users for access and use of this data. Other resources and tools developed in the project will be made available via the project website ( <a href="http://www.recetasproject.eu">www.recetasproject.eu</a> ) or upon request. Data sharing is not applicable to this article as no datasets have been generated thus far.

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## Background

Recognition of the physical and mental health benefits of nature contact has increased [1]. Simultaneously, increasing numbers of people worldwide experience loneliness [2]. The health and wellbeing benefits of green and blue space was reinforced during the COVID-19 pandemic with many people around the world experiencing loneliness and social isolation in response to public health measures [2]. Many relied on time outdoors in natural areas to cope [3].

The benefits of nature contact have been shown to be wide-ranging, including reduction in cardiovascular disease, depression, obesity, and mortality [1,4]. Greater attention to everyday nature may increase one's overall sense of connectedness to others [5]. Furthermore, urban greenspace may also enhance perceptions of trust in neighbors, thus reduces the risk of loneliness [6].

Loneliness is understood as the gap between an individual's preferred and actual social relationships [7]. Research shows that one third of people in industrialized countries experience loneliness [4]. It is increasingly recognized as a public health issue, with mounting evidence highlighting physical and psychological health implications [8,9]. Lonely people are more likely to report higher rates of depression, anxiety, dementia, obesity, and sleep disorders [10].

The natural environment is a potential remedy to the growing loneliness problem [11]. Still, our understanding of what constitutes a therapeutic dose of nature is limited. We do not fully understand the impact of the effects of different types of activity or the effects of variation in characteristics of the natural environment. For example, exposure and dose can vary. Those exposed to the same concentration of air pollution may experience a different biological effect [12]. Similarly, nature dose may depend on different levels of attention, preference, and personal connection to nature. The impacts of a nature experience may depend on one's age, gender, mood, and personal traits and characteristics [12,13].

Much research on nature dose has focused on the *time* (duration or frequency) spent in nature as the key to receiving health benefits [14]. Researchers have suggested that as little as 10 min periodically [15] up to 120 min total per week are sufficient for receiving health and wellbeing benefits from nature exposure [16]. However an emerging area of research suggests that time spent in nature is a necessary therapeutic component, but it does not account for individual factors such as the way an individual engages with nature [17]. Other mechanisms may have a greater influence on improved mental health, such as the level of nature connectedness, perceptions of biodiversity, or the type of interaction with flora or fauna. Feeling connected to nature, and engaging in nature-based activities may be more predictive of mental wellbeing than time spent in nature [17]. These aspects of nature exposure are less easily captured. In this paper, we present a novel tool to do this. We describe our applied approach that captures the unique nuance and variety regarding how individuals perceive and experience nature exposure.

The ecological characteristics of natural spaces and level of biodiversity may also influence health outcomes. There is emerging evidence that different types of green space may also reduce loneliness [18]. However, we do not yet understand which characteristics of natural spaces are most beneficial for mental health or social connectedness [19]. There is a clear need for interdisciplinary approaches to deepen our understanding of nature contact and nature experiences and use this information to better inform research, evaluation, programs, and policy.

Our objective is to develop a nature dose tool that measures the key aspects for improving well-being and reducing loneliness through nature contact or nature-based activities. These aspects include both objective measures, such as time of exposure or actual biodiversity, and subjective measures, such as perception of nature, type of activities and individual characteristics. This unique approach will capture the complexity of nature dose, as studies typically only focus on one or a few of the elements that we measure with the tool. This study will analyze the impact of different elements of nature dose on health outcomes, and thus develop an index to measure the dose received. And, we will report on the key elements that a nature-based intervention to reduce loneliness and improve well-being must address in order to be effective.

## CORE NATURE DOSE INSTRUMENTS COMPONENTS

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### FRIENDS IN NATURE INTERVENTION PARTICIPANTS

**Friends in Nature group facilitators** 

Time in nature during the weekly session<sup>1</sup> (minutes)  0  15  30  60  
 90  120  more than 120

Type of nature activity completed/reason activity selected<sup>2</sup>

Weather<sup>3</sup>

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**Participants (all study sites)** 

Nature connection<sup>4</sup>

Description of feelings or mood experienced at study site that day, and characteristics of the site that inspired these feelings<sup>5,7</sup>

Accessibility of the intervention site<sup>5</sup> Strongly disagree     Strongly agree

Weekly total time in nature, outside of the weekly session<sup>1</sup> (minutes)  0  15  30  60  
 90  120  more than 120

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**Participants (Barcelona, Marseille, Cuenca, Melbourne)** 

Biodiversity perceptions: plants and trees, birds, animals other than birds, and insects<sup>5,8</sup>

Psychological distance to nature<sup>7</sup> Very distant     Very close

Perceptions of how "natural" the site is<sup>8</sup> Artificial    Natural

Satisfaction with quality, maintenance, safety, and visual appeal of natural environment/facilities<sup>5</sup> Very dissatisfied    Very satisfied

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### CONTROL GROUP

**Control group (RCTs sites - Barcelona, Helsinki, Prague)** 

Total time in nature that week<sup>1</sup> (minutes)  0  15  30  60  
 90  120  more than 120

Nature connection<sup>4</sup>

Type of activity

  Project funded by the European Union under the Horizon Europe programme

**Fig. 1.** Constructs included in nature dose tool.

- White, M.P., Alcock, I., Grellier, J. et al. Spending at least 120 min a week in nature is associated with good health and wellbeing. *Sci Rep* 9, 7730 (2019). <https://doi.org/10.1038/s41598-019-44,097-3>.
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## Method details

The constructs included in the nature dose survey instrument are depicted in the Fig. 1 and the tool is included in Supplement A. We are measuring nature exposure using a three-pronged approach measuring:

- 1) objective time and type of activities pursued in nature.
- 2) subjective perceptions of nature, biodiversity, and experiences.
- 3) actual biodiversity present at an intervention site.

### Survey development

We developed this tool within a European Commission funded project: Re-imagining Environments for Connection and Engagement: Testing Actions for Social Prescribing in Natural Spaces (RECETAS). The RECETAS project intervention is a group-based program promoting social engagement in nature-based activities, with three randomized controlled trials (RCTs) in Barcelona, Helsinki, and Prague, and 3 observational studies in Cuenca (Ecuador), Marseille, and Melbourne. The primary study outcomes are loneliness and health-related quality of life that are measured using the De Jong Gierveld Loneliness Scale [20] and the 15D instrument of health-related quality of Life [21].

Between August 2022 and April 2023 our team, including researchers from each study site, co-designed a nature dose survey (Fig. 1, Supplement A) that was dynamic and flexible enough for diverse population cohorts and settings. Participating researchers examined existing nature dose protocols and agreed upon key nature exposure constructs to target. A preliminary survey instrument was then developed and piloted at each study site. The final instrument was refined based on study participant feedback from the pilot phase of the project.

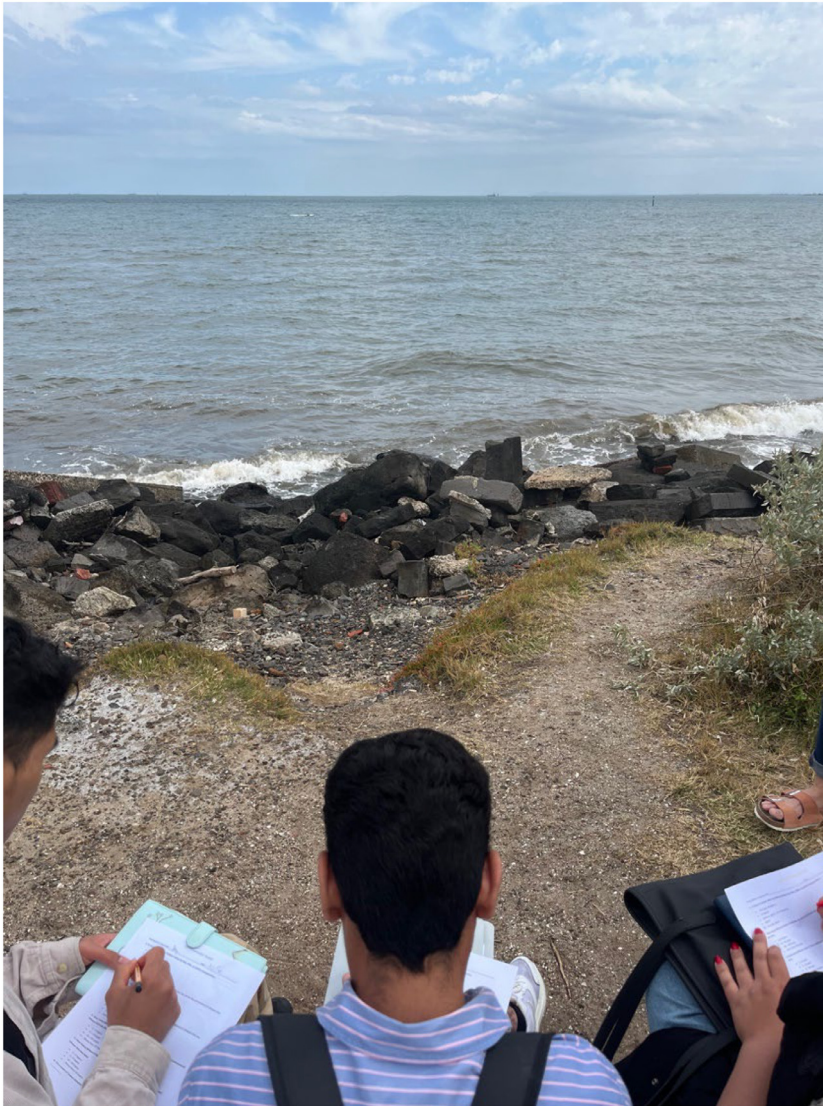
### Survey components and administration

RECETAS study participants in each study location are organized into groups and participated in weekly activities in natural or urban green environments of approximately two hours activities over 8 to 9 weeks. The RECETAS Friends in Nature intervention is detailed elsewhere [22]. After each session, intervention facilitators and/or researchers document basic information in the tool (Fig. 1, Supplement A) on a size A4 printed card about each activity site, the nature activities undertaken, total time spent in nature, as well as weather conditions. Study participants then complete the survey regarding their perceptions about the natural site and their experiences (Fig. 2).

Participants then estimate the length of time spent in natural spaces (green or blue) over the previous seven days, disregarding the time spent in the intervention activity. In addition to the exposure to nature described above (time in nature, type of activity, weather), we use the tool to assess a range of participant perceptions regarding site access, quality, naturalness, psychological distance to nature, and biodiversity, thus informing the ‘experience’ aspects of nature dose (Fig. 3).



Fig. 2. Nature dose data collection in Barcelona.



**Fig. 3.** Nature dose data collection in Melbourne.

#### *Actual biodiversity measurement*

Researchers in our study also assess the actual biodiversity exposure for participants in the intervention groups in Barcelona and Melbourne, where ecological expertise was present in the team. For this, we use existing databases to develop the biodiversity assessment including geo-located datasets on plants and animals. Furthermore, for the Melbourne study site we collected information on plant, bird, plant structure, and mammal diversity.

To characterize the ecological characteristics of sites we targeted these taxonomic groups: trees, shrubs, grasses, birds, other mammals and insects. Other remote sensing data such as Normalized Difference Vegetation Index (NDVI) or habitat types and geometry of parks are included. We will estimate different biodiversity indices for each urban green space visited by study participants. Using these indices, biodiversity exposure assessment will be estimated for each participant considering the actual green spaces visited and the amount of time spent in each space. The data collected from existing biodiversity datasets will be used to construct a ‘situational’ map. Subsequently, the NDVI will be used to quantify the health and density of vegetation.

#### *Data analysis*

After data cleaning and preparation, the biodiversity indicators will be compared with both quantitative and qualitative data from the study participants including their loneliness and health-related quality of life levels, perceptions of biodiversity, natural sites access and quality, and various sensations present in the selected areas such as sounds, smells, and sights.

Descriptive analyses will be conducted to assess actual and perceived biodiversity data in each of the selected areas in Barcelona and Melbourne. We will also develop a principal components analysis to identify potential axes and important factors when differentiating each of the studied areas. Collinearity between biodiversity data (NDVI data, geolocated datasets on plant and animal diversity, participant perceptions of biodiversity), and other environmental factors (season, temperature, weather) as well as intervention characteristics (time spent in nature, type of activity, participant connection to nature, mood, perceptions of green or blue area, loneliness, health-related quality of life) will be also assessed (Fig. 1). Considering the outcomes of this first analysis, we foresee the development of a nature-dose index to sum all the exposure factors. To build this index we will A) normalise the data in order to harmonise it, B) weight each of the exposure factors based on the pre-analysis developed here as well as on findings from previous studies and C) compute the index, and D) validate the index with a representative sample of the studied population.

To analyse the associations between the nature-dose index and loneliness data, we will conduct a multiple linear regression model. We will adjust our models for sex, age and other demographics variables at individual and neighbourhood level. We will also conduct stratified analysis and an interaction test with all the covariates (such as sex, age, socio-economic status).

Open-ended, qualitative survey question responses will be aggregated and analyzed for repetition, pattern, and theme using ATLAS.ti 2 qualitative analysis software, specifically ATLAS' Query tool, Word-list clouds, and Code Co-occurrence tables.

## Conclusions

The nature dose tool described in this paper (Fig. 1, Supplement A) captures novel range of aspects of nature contact and experience. It aims to advance our understanding of the nature dose needed to reduce loneliness, facilitate social connections and improve health across diverse populations in different geographic contexts [14,23]. By collaborating across social, health and ecology disciplines, and integrating qualitative and quantitative approaches, we present an interdisciplinary approach to measuring nature dose, which reflects the myriad ways the natural world is embodied and experienced [24]. Our tool builds on the current nature exposure literature by proposing a nature-dose index that is easily attainable, reproducible, and understandable. It captures a more complete range of human experiences in nature that may reduce loneliness and promote health-related quality of life [5,25].

In the study of restorative environments, 'nature' has often been considered as a simplistic, uniform typology, such as a quantifiable amount of greenspace. However, different green space designs and nature experiences can deliver diverse benefits with respect to wellbeing and loneliness [19]. Current research does not sufficiently explain how biodiversity may influence wellbeing [26]. A fledgling body of research connects biodiversity with social connectedness and loneliness [27]. The data generated by using this novel tool will provide critical insights into this emerging topic of how biodiversity affects a range of health and social conditions. Developing and testing biodiversity-based strategies for wellbeing is a novel and compelling way to demonstrate the relevance of biodiversity to society.

Our approach contributes to the understanding of how social connection outdoors may serve as a mechanism underlying the positive relationship between nature and wellness. Studies have linked the availability of green space to neighborhood social cohesion and social ties between neighbors. Yet, there is no clear direction as to how much or what type of nature exposure or experiences may motivate bonding, reduce loneliness, or influence other health related outcomes such as depression or anxiety [18]. The nature dose data collected with our tool will be analyzed with loneliness and health related quality of life datasets from study participants to advance this understanding.

With mental health issues such as loneliness, stress, anxiety, and suicide on the rise globally, applied, multidisciplinary solutions are urgently needed. Our nature dose tool will facilitate the provision of more reliable evidence supporting the mechanisms and the characteristics of the natural spaces, activities, and exposures that benefit wellbeing. Researchers and practitioners alike can use this tool to generate an evidence base and inform program design. The tool considers a broad range of dimensions needed to capture the key facets of nature-dose that can reduce loneliness and improve health-related quality of life. Using this tool, we aim to develop recommendations for the optimal nature dose in interventions designed to reduce loneliness and improve quality of life.

## Method validation

Data sharing is not applicable to this article as the studies are in process, and no public datasets have been generated thus far.

## Limitations

The six-related but independent studies piloting this tool have been designed to share the same objectives and approach, while applying the same framework. However, the nature-based intervention and assessments are adapted to the local context and target populations. The nature-dose tool may be more applicable for one or the other population.

## Ethics statements

All procedures performed in studies involving human participants are in accordance with the ethical standards of the institutional research committees and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. Ethics approval was granted by the Institutional Review Boards at each study site (Barcelona, Helsinki, Prague, Cuenca, Marseille, Melbourne). Informed consent was obtained from all individual participants in the study. The data presented in this study will be available on request. The data are not yet publicly available due to privacy concerns for research participants.

## Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

## CRediT authorship contribution statement

**Ashby Lavelle Sachs:** Conceptualization, Methodology, Writing – original draft, Writing – review & editing, Supervision, Project administration. **Montse Maso-Aguado:** Conceptualization, Methodology, Writing – original draft, Writing – review & editing. **Albert Bach:** Conceptualization, Writing – original draft, Writing – review & editing. **Nerkez Opacin:** Conceptualization, Methodology, Writing – original draft, Writing – review & editing. **Nicholas Hill:** Conceptualization, Writing – original draft, Writing – review & editing. **Lucie Cattaneo:** Conceptualization, Writing – review & editing. **Laura Coll-Planas:** Writing – review & editing, Funding acquisition. **Katherine Johnson:** Writing – review & editing. **Laura Hidalgo:** Writing – review & editing, Visualization. **Carolyn Daher:** Conceptualization, Writing – review & editing, Funding acquisition. **Jill Litt:** Conceptualization, Methodology, Writing – review & editing, Supervision, Funding acquisition. **Sarah Bekessy:** Conceptualization, Methodology, Writing – original draft, Writing – review & editing, Supervision.

## Data availability

No data was used for the research described in the article.

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## Supplementary materials

Supplementary material associated with this article can be found, in the online version, at [doi:10.1016/j.mex.2024.102969](https://doi.org/10.1016/j.mex.2024.102969).

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