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Scientific results of the pilot project “Green Care | Nature & Mental Health” are now available

Strengthening mental health through mindfulness and relaxation activities in nature

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Introduction

The Berchtesgadener Land Biosphere Reserve and the Rhön Biosphere Reserve were designated by UNESCO as model regions for sustainable development in 1990 and 1991 respectively and are part of a global network of over 700 biosphere reserves. Both biosphere reserves are characterised by particularly distinctive natural and cultural landscapes that symbolise the harmonious coexistence of man and nature. Their recreational value is essential for nature-based health tourism, as well as for the health-related use of the natural environment by local residents. In addition, both regions have an important tradition of spa treatment with famous spas and health resorts. Recreation and health are important local factors, as evidenced by the fact that both biosphere areas have been recognised as "Health Regions Plus" (Gesundheitsregion^{plus}). One of the tasks of biosphere areas is to explore new ways of tackling societal and sustainability challenges and developing solutions. One such societal challenge is the increasing incidence of stress-related illnesses and depression, which not only places a financial burden on health care systems and businesses due to increased absenteeism, but also causes significant suffering and reduced quality of life for those affected. In order to help people suffering from depression and to support those looking for preventive measures against burnout and stress-related illnesses, the two Bavarian biosphere regions have combined their interdisciplinary expertise in the pilot project "Green Care – Nature and Mental Health" to scientifically study how guided nature experiences can benefit these target groups. Since November 2018, specific mindfulness and relaxation activities in nature have been developed, tested with groups in four-hour weekly sessions over a period of three to four weeks, and scientifically evaluated in order to provide recommendations on how these activities can be used meaningfully in the health sector in the future. Another question was whether these activities increased conservation behaviour. The focus was on patients with depression in the psychosomatic rehabilitation area and on individuals from the general population seeking to reduce stress and prevent burnout in the prevention area. Due to the high societal relevance of the research questions and the interdisciplinary approach, the Bavarian State Ministry for Health and Care [Bayerisches Staatsministerium für Gesundheit und Pflege] and the Bavarian State Ministry for the Environment and Consumer Protection [Bayerisches Staatsministerium für Umwelt und Verbraucherschutz] decided to jointly fund this project for the first time.

To ensure quality, the progress of the project and practical experiences were regularly discussed in an interregional project advisory working group. The working group included representatives of the governments of Upper Bavaria and Lower Franconia, the two ministries, various Bavarian universities, experts in spa medicine, the Bavarian State Chamber of Psychological Psychotherapists [Bayerische Landeskammer der Psychologischen Psychotherapeuten] and the Bavarian Association of Statutory Health Insurance Physicians [Kassenärztliche Vereinigung Bayern]. There was also a regular exchange at regional level with experts from the health and nature conservation area.

Independent scientific monitoring was provided from December 2019 to April 2023 by the evaluation team led by Prof. Dr. Elisabeth Kals, Chair of Social and Organisational Psychology at the Catholic University of Eichstätt-Ingolstadt. In addition to evaluating the group offerings by means of questionnaires, expert interviews rounded out the research design. The evaluation team presented its final report in May 2023. In addition to contributing to international research in the field of nature and health, the report is expected to provide insights for the practical implementation of nature-oriented health programmes in the local health sector of both biosphere regions and beyond.

Results

The results of the accompanying scientific research show that both patients with depression from rehabilitation clinics and healthy individuals from the general population seeking preventive measures for stress reduction benefited from activities in nature based on mindfulness and relaxation offerings. Analysis of the questionnaires showed that feelings perceived as beneficial were enhanced by the nature activities, while feelings perceived as stressful were alleviated through the offerings. This effect was still measurable three months after the group offerings, suggesting that the activities were integrated into the participants daily lives and had a positive and lasting effect. One reason for the ease of integration into daily life is that different types of natural and cultural landscapes were suitable for carrying out the activities. The same positive results were observed in remote forest areas as well as in smaller urban green spaces, wooded areas and meadows. In the clinical setting, patients with higher levels of depression on admission benefited most from the group offerings. The interviews with experts confirmed this finding. The results also indicate that the emotional connectedness to nature, which is a crucial prerequisite for the willingness to engage in nature conservation, increased as a result of the offerings. Accordingly, the study shows that the offerings provided are innovative and effective.

The research project is funded by the Bavarian State Ministry for Health and Care and the Bavarian State Ministry for the Environment and Consumer Protection with a total budget of EUR 868,000 and ran from November 2018 to September 2023.

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Green Care | Nature and Mental Health

Final report of the scientific monitoring study

The "Green Care | Nature and Mental Health" study is a scientific monitoring study commissioned by the administrative authorities of the UNESCO Biosphere Reserve Berchtesgadener Land and the UNESCO Biosphere Reserve Rhön, Bavarian part, as part of the "Green Care | Nature and Mental Health" project and awarded to the Chair of Social and Organisational Psychology at the Catholic University of Eichstätt-Ingolstadt. The scientific monitoring took place from December 2019 to April 2023.

Executive Summary

Background

Guided contact with nature has been shown to have positive effects on well-being. However, little is known about the feasibility and effectiveness of nature-based interventions in inpatient treatment for depression and their effects on mood, mental health, and environmental attitudes and engagement of healthy adults. A pilot was jointly launched by the UNESCO Biosphere Reserves Berchtesgadener Land and Rhön, Bavarian part to develop a model therapy and prevention offer that focuses on experiencing nature. The effectiveness of these mindfulness and relaxation-based nature interventions ("Greencare") as a supplement to psychosomatic rehabilitation treatment for depressive patients was investigated, and a group of healthy individuals were offered the mindfulness-based intervention. Treatments were compared to waitlist control groups. In the clinical setting, control groups received treatment in addition to the waitlist.

Methods

The study was divided in two settings: the clinical and the preventive setting.

In the clinical setting, inpatient psychosomatic rehabilitation inpatients with depression in two psychosomatic rehabilitation clinics were allocated either four sessions of a nature-based relaxation program (UNESCO Biosphere Reserve Rhön) or three sessions of a nature-based mindfulness training (UNESCO Biosphere Reserve Berchtesgadener Land) (Greencare; n = 116) or allocated to treatment as usual plus waitlist control group (TAU+WL, n = 111). TAU+WL patients received inpatient treatment plus a one- or two-day short intervention shortly before discharge. All patients received questionnaires at admission (T1) and before discharge (T2Greencare) or before the short intervention (T2TAU+WL). Greencare patients received follow-up questionnaires three months after the intervention (T3).

In the preventive setting, participants from the general population in the UNESCO Biosphere Reserve Berchtesgadener Land were allocated to three sessions of nature-based mindfulness training (Greencare, n = 84) or to a waitlist control group (WL, n = 49). Due to lockdown and health protection measures, 56 persons ultimately received the allocated Greencare intervention.

The main outcome was mood as assessed by the Positive and Negative Affect Schedule. Secondary outcomes were depression (clinical setting only), mindfulness, state self-compassion, nature-related mindfulness, emotional affinity towards nature, awareness of threats to nature, internal and external attribution of responsibility for the protection of nature, willingness to protect nature, nature conservation behavior, and contact with nature. Data were analyzed as intent-to-treat using mixed models repeated measures adjusting for propensity score and location.

Semi-structured expert interviews were conducted with 10 persons in the clinical setting and 7 persons in the preventive setting and analyzed using qualitative content analysis.

To evaluate the process of the interventions, questionnaires were completed after each session in the Greencare group, assessing well-being during the session and perceived effectiveness of intervention by the participants.

Results

In the clinical setting, group comparisons of the primary outcome between Greencare and TAU+WL revealed significant interactions of time*group, showing significantly greater increases of positive affect and greater decreases in negative mood in the Greencare group between T1 and T2. At follow-up (T3), the effects decreased by small effects in the Greencare group but remained significant compared to T1. Secondary outcomes analyses revealed significant interactions of time*group for self-compassion and emotional affinity towards nature and non-significant effects in the same direction for mindfulness. Groups did not differ in their amount of contact with nature. Subgroup analyses revealed more favorable follow-up effects on the primary outcomes for patients with higher levels of depression at T1 and with a childhood in a rural environment. Results showed that effects were independent of intervention location.

In the preventive setting, group comparisons of primary outcomes between Greencare and WL (T1 to T2) revealed significant interactions of time*group for the negative affect but not for positive affect. At follow-up, effects of negative affect decreased by small effects in the Greencare group but remained significant compared to T1. Secondary outcomes analyses revealed significant effects for nature-related mindfulness, emotional affinity towards nature, awareness of threats to nature, and internal and external attribution of responsibility for the protection of nature. These effects remained stable after three months. Subgroup analyses showed that positive affect improved particularly among individuals who had spent their childhood in urban settings.

Qualitative data from the interviews confirmed the effects of the interventions on psychological well-being, mental health, physical and social well-being. Experts rated the interventions a highly effective.

In the process evaluations, a large majority of the participants rated their well-being during the sessions and perceived effectiveness highly. The high ratings increased with the duration of the intervention.

Conclusions

Results provide evidence that participants in the clinical setting and healthy participants from the general population in the preventive setting benefit from a mindfulness- and relaxation-based nature intervention by improved affect, the main outcome variable. The effects are slightly reduced after three months. In the clinical setting, this reduction is smaller in patients with higher levels of depression at admission. Qualitative interviews with experts and process evaluation corroborate these effects. Results also show that in both settings, nature-related variables are positively influenced by the interventions. In the clinical setting, this is the case for emotional affinity towards nature, which is an important predictor of future conservation behavior. In the preventive setting, emotional affinity

towards nature and other nature conservation-relevant variables are positively influenced. This indicates that the interventions impact important predictors of nature-related behavior, even if they do not directly address conservation behavior. Overall, results show that the intervention was feasible and effective for patients and healthy individuals. The study Greencare - Nature and Mental Health was able to show that the realized offers are innovative and effective. A continuation of the project "GreenCare | Nature and Mental Health" is therefore expressly recommended from a scientific point of view.

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1 Scientific background

> *There can be no health without mental health. For individual citizens, mental health is a prerequisite for realising their intellectual and emotional potential and for finding and fulfilling their role in society.*
>
> (European Commission, 2005, p. 5)

The World Health Organisation (WHO) sees health not as the primary goal of life, but as a resource for everyday life (1986). Health is defined as "a state of complete physical, mental and social well-being and not merely the absence of disease" (WHO, 1948, p. 1). Therefore, by definition, the concepts of well-being and health are inherently interrelated. The biopsychosocial model base on Engel (1977) can be used to describe the complex relationships between these three facets of well-being. In this model, the functioning or health of an individual is understood as an interaction between physical, mental and social factors (ibid). Accordingly, health or well-being is seen as a dynamic biopsychosocial overall state of balance determined by multiple factors (Abraham et al., 2007; WHO, 1986).

With the onset of the COVID-19 pandemic, mental stress increased steadily (German Psychotherapeutic Association, 2021), and the percentage of people with moderate to severe symptoms of anxiety and depression rose sharply (Peters et al., 2020). However, the prevalence of mental illness had already risen significantly in the preceding decades. Mental illness is the most common cause of early retirement. Despite a dense network of treatment options for mental illnesses in Germany, patients have to wait an average of 19.9 weeks for a therapy spot (Bundespsycho-therapeutenkammer, 2018). The associated sick days, sickness absence and reduced productivity are not only an individual burden for patients, but also have a huge socio-economic impact on society. Existing treatment options, such as psychopharmaceuticals or psychotherapy, consistently show moderate efficacy (Leucht et al., 2012; Munder et al., 2019), but many questions remain unanswered. Not all patients respond to treatment options, and in the case of depression, for example, long-term relapse is possible despite short-term success in therapy (Burcusa & Iacono, 2007).

There are many reasons for the increase in mental illness. On the one hand, an individual's genetic predisposition to cope with environmental factors and critical life events plays a role. On the other hand, today's achievement-oriented society with its high workload and stress levels has become a significant risk factor for mental illness (Ensinger, 2016; Marschall et al., 2020; Polz-Watzenig, 2020). Stress and a lack of work-life balance are the result. In addition, processes of urbanisation and digitalisation are leading to an increasing alienation of people from the natural environment (Heise & Hallermayr, 2022; Marschall et al., 2020). In addition, many forms of therapy only aim to treat symptoms (Thom et al., 2019). However, it is equally important to find a healthy approach to the demands of everyday life. Therefore, not only therapy and rehabilitation of mental disorders, but also prevention are becoming increasingly important.

1.1 Influence of nature on biopsychosocial health

Nature, i.e., the inanimate part of the natural environment (e.g., rocks, water and air) and the high biodiversity of flora and fauna (Hartig et al., 2014), is particularly relevant as an intervention setting in this context. The literature provides numerous explanatory approaches for how the mechanisms of experiences in nature affect human well-being. Three of the most prominent theories are presented below. Although they differ in their approaches, explanations and effect conditions, they all postulate a positive relationship between being in nature and well-being.

- **Biophilia hypothesis** (from ancient Greek: bios "life" and philia "love"; Kellert & Wilson, 1993; Wilson, 1984): According to this theory, humans have a genetically encoded emotional affinity for nature. It is therefore a human need to connect with nature physically, emotionally and cognitively. Accordingly, contact with nature is crucial for building and maintaining quality of life and well-being and can positively influence behaviour, cognition and psyche (Keniger et al., 2013).
- **Attention restoration theory** (Kaplan & Kaplan, 1989): Contact with nature helps to restore the attention capacity that has been depleted by the stress of everyday life and the associated mental fatigue and exhaustion. Spending time in nature thus induces a sense of relaxation.
- **Psycho-evolutionary theory** (Ulrich, 1983) or stress management theory (Ulrich et al., 1991): Being in nature and observing elements of nature leads to recovery from psychophysiological stress by influencing the limbic system and triggering an evolutionarily conditioned sense of safety. This effectively reduces stress over the long term (Bröderbauer, 2015).

The findings on the effects that contact with or being in nature have on human well-being have been studied extensively (Kals, 1998; Kals et al., 2023). According to Cox et al. (2017) and Cervinka et al. (2014), nature has a high healing potential and can affect well-being in a preventive and rehabilitative way (Abraham et al., 2007; Bowler et al., 2010; Flade, 2018). In line with the three pillars of the biopsychosocial model, selected empirical findings are briefly outlined below.

- **Experiences in nature and mental well-being:** Experiences in nature can promote mental well-being by, among other things, having nature serve as a place of relaxation. As a result, they can reduce mental exhaustion (Berman et al., 2008; Berto, 2005) and improve concentration (Bratman et al., 2015; Hartig et al., 2003; Tennessen & Cimprich, 1995) and frustration tolerance (Cackowski & Nasar, 2003; Kuo & Sullivan, 2001). In contact with nature, positive emotions can be generated and negative emotions reduced (Ballew & Omoto, 2018; Bowler et al., 2010; McMahan & Estes, 2015; Russell et al., 2013). Likewise, experiences in nature decrease the occurrence of mental illnesses (Beyer et al., 2014; Cervinka et al., 2014; Cox et al., 2017).
- **Experiences in nature and physical well-being:** Experiences in nature can promote physical well-being at many levels, including by encouraging movement, relaxation and a sense of oneness with nature. Empirical studies show that contact with nature can reduce pain (Ulrich,

1984), discomfort (Kaplan & Kaplan, 1989) and stress (Ulrich et al., 1991) and improve sleep (Morita et al., 2011). It can also boost the immune system (Kuo, 2015).

- **Experiences in nature and social well-being:** Experiences in nature can improve social well-being, especially when shared with other people. Being in nature provides opportunities for social encounters (Coley et al., 1997; Kals et al., 1999; Maas et al., 2009), during which social interaction (Astles, 2015; Kweon et al., 1998; Nicolè & Seeland, 1999) and social skills can be promoted (Annerstedt & Währborg, 2011; Weinstein et al., 2009). As a result, social relationships can be established and feelings of isolation reduced (Kingsley & Townsend, 2006; Maas et al., 2009).

In summary, based on these selected findings, it can be said that when opportunities for experiences in nature are created, well-being in all its dimensions and thus biopsychosocial health can be promoted (Kals & Nisbet, 2019; Zieris et al., 2023). Furthermore, environmentally relevant behaviour is strongly influenced by emotions (Kals & Müller, 2012). Thus, emotional attachment to nature can promote pro-environmental and nature conservation attitudes and behaviour, which can also be promoted by positive experiences in nature (Müller et al., 2009; Müller et al., 2013). In this sense, experiences in nature can both help protect health and serve sustainability goals (Bruckbauer et al., 2022; Müller et al., 2014).

1.2 Nature-based interventions in therapy, rehabilitation and prevention

Given the theoretical assumptions presented and the existing empirical evidence on the relationship between nature and health, it is logical to utilise the diverse effects of contact with nature in the prevention, therapy and rehabilitation of mental disorders. Nature-based interventions, i.e., guided contact with nature, represent an approach to integrate the positive effects of experiences in nature into a psychotherapeutic framework (Annerstedt & Währborg, 2011). These interventions incorporate not only individual experiences but also the natural environment into the therapeutic process (Dienemann, 2020; Petzold et al., 2019). This approach adopts a holistic perspective with a focus on salutogenesis and prevention, using a method based on experience, resources and actions rooted in the tradition of the humanistic worldview and client-centred psychotherapy according to Rogers (1981). Nature-based interventions include forest bathing (Japanese: shinrin-yoku), forest therapies, garden therapies, forest education and Green Care. Green Care is a broad term that encompasses all approaches that contribute to maintaining and enhancing human well-being by involving nature (animals, plants, gardens, forests and landscapes) (Haubenhofer et al., 2010; Steigen et al., 2016).

Empirical research on the effectiveness of nature-based interventions is still in its early stages. However, there is evidence that even a single session in nature can have diverse effects on biopsychosocial well-being (Shanahan et al., 2019). In the review by Coventry et al. (2021), which examined the effectiveness of nature-based interventions for people with or without mental or physical health problems, including 50 studies, these interventions led to significant improvements in depressive mood, positive and negative affect, and anxiety. The most effective interventions were delivered over a period of 8 to 12 weeks, with an optimal duration of 20 to 90 minutes. In particular,

the combination of mindfulness activities and experiences in nature appears to have a positive impact on well-being (Djernis et al., 2019). The following is a review of recent research on the effectiveness of nature-based interventions. First, studies in the context of therapy and rehabilitation are presented, followed by those in the context of prevention.

1.2.1 Nature-based interventions in therapy and rehabilitation

The study by Bielinis et al. (2019) investigated the impact of forest bathing on the mental health of **inpatients with affective or psychotic disorders**. Patients were invited to participate in one-hour forest walks in groups of four to five people under the supervision of qualified therapists. Data were collected using questionnaires before and after the intervention. Patients with affective disorders showed improvements in mood on various mood scales, and their anxiety levels also decreased significantly. Patients with psychotic disorders also experienced a reduction in anxiety and an increase in vitality.

The meta-analysis by Grassini (2022) analysed studies on the effects of walks in nature on **people with depression and anxiety**. Six studies published between 2013 and 2020 were identified and met the inclusion criteria of pre- and post-testing and experimental and control conditions. The data showed that walks in nature were effective in improving mental health.

Keenan et al. (2021) also focused on **people with depression and/or anxiety** (n = 50). In an experimental design, participants were randomised to either the experimental group (walk in nature with the task of noticing three good things in nature (TGTiN)) or the control group (walk in the city). Both groups were instructed to walk for 30 minutes every day for five consecutive days. In addition to the data collection at the beginning and end of the five days, further data were collected six weeks later. In the experimental group, connectedness to nature and positive affect increased significantly more than in the control group in both the post-intervention and follow-up assessments. Negative affect decreased in the experimental condition, while well-being during the walk in nature was significantly greater.

The study by Hyvönen et al. (2023) also investigated the effectiveness of a nature-based intervention in **patients with depression**. Participants were randomised to the experimental group (n = 59, one nature-based session per week for twelve weeks in addition to standard treatment) or the control group (n = 77, treatment as usual). Pre-post measurements show that reductions in mental stress and increases in restorative experiences were greater in the experimental group than in the control group. Depression scores decreased equally in both groups.

Joschko et al. (2023) investigated the relationship between nature-based therapy, mental health and connectedness to nature **in patients with psychosomatic disorders** (n = 19). Over a four-week period, patients attended one-hour nature-based sessions three times a week. Data were collected before the first and after the last session. Significant improvements in mental well-being and connectedness to nature were reported, and participants in the study subjectively perceived the intervention as effective.

The target group of the study by Corazon et al. (2018) consisted of **individuals diagnosed with binge eating disorder** (n = 20). The aim was to compare the effectiveness of a nature-based intervention with

self-help group meetings. The nature-based intervention took place once a week for three hours over twelve weeks, while the self-help groups met once a week for three hours over ten weeks. The mixed-methods approach shows that both actions led to an increase in overall mental well-being. However, participants found it easier to integrate the content of the nature-based intervention into their daily lives than the content of the self-help group meetings.

Choi et al. (2021) investigated the effects of mindfulness-based mandala colouring (MBMC) in nature on **people with chronic pain** (n = 36). Participants were randomly assigned to the experimental group (colouring) or the control group (city tour). Data was collected before and after the intervention. Participants in the experimental group showed significant improvements in depressive symptoms, anger and stress levels.

Han et al. (2016) also investigated the efficacy of nature-based interventions for **individuals with chronic pain** (n = 61). Participants were non-randomly assigned to an experimental group (two-day forest therapy programme) or a control group (no intervention). Data were collected before and after the study. Participants in the experimental group reported a significant reduction in pain and depression and a significant improvement in health-related quality of life. They also showed improvements in physiological parameters compared with the control group.

The study by Chun et al. (2017) focused on **patients with chronic stroke** (n = 59). It investigated the effects of forest therapy on depression and anxiety. Participants in the study were randomly assigned to the experimental group (four days of forest therapy) or the control group (the same programme as the experimental group in an urban setting). Data was collected before and after the intervention. The reduction in depression and anxiety was significantly greater in the experimental group than in the control group.

A review (Britton et al., 2020) systematically assessed the effectiveness of therapeutic interventions in the setting of outdoor water environments (Blue Care) on health and well-being. Thirty-three studies published between 2004 and 2017 were included, evaluating interventions for **individuals with (psycho)therapeutic needs**. The studies suggest that Blue Care can directly benefit mental health and psychosocial well-being. The relationships between Blue Care and various indicators of health and well-being are positive, but weak.

1.2.2 Nature-based interventions in prevention

Gittins et al. (2023) used a mixed methods approach to demonstrate that even a single nature-based intervention increases the likelihood of subsequent independent visits to a forest. They conducted a longitudinal questionnaire study (n = 120) and focus groups (n = 20). According to the authors, **nature-based interventions can serve as a "turning point"** (p. 4) for engaging with nature and reducing mental, emotional and socio-cultural barriers to spending time in nature.

In their review, Corazon et al. (2019) examined the **psychophysiological effects** of nature-based interventions on individuals' stress management. They included 36 studies that were published between 2010 and 2018. The results suggest that spending time outdoors and in nature has a positive

effect on various emotional parameters related to stress reduction. When it came to physiological effects, the results were mixed.

In their study, Martin et al. (2020) examined the relationships between different types of contact with nature, connectedness to nature and **subjective well-being**. They showed that only direct contact with nature (at least once a week) was associated with general health and environmentally friendly behaviour; however, spending time in neighbourhood green spaces or watching nature documentaries was not sufficient to produce this effect (n = 4,960). Emotional connectedness to nature moderated these connections. The authors concluded that interventions need to promote both contact with nature (nature-based interventions) and emotional connectedness to improve well-being.

Bailey and Kang (2022) examined the extent to which physical activity during a nature-based intervention influenced **cognitive performance and mental health** in a sample of 50 US students. Students were randomly assigned to a walking group (ten-minute walk in an adjacent park) or a rest group (ten minutes of sitting in an adjacent park). Cognitive performance was assessed using the Stroop test ten minutes before and after the intervention. Relaxation, attention and motivation were measured using EEG during the ten-minute intervention. Mindfulness and connectedness to nature were self-reported. The study found that cognitive performance improved equally in both groups. The level of relaxation during the intervention was the best predictor of later performance. Participants with high connectedness to nature and mindfulness showed less evidence of rumination. Finally, the walking group had higher levels of relaxation during the intervention than the sitting group.

In a proof-of-principle study, Owens et al. (2020) investigated the effectiveness of a nature-based intervention on **mental well-being**. Students were randomly assigned to one of three conditions: 20 minutes of meditation in nature (n = 23), 20 minutes of indoor meditation (n = 22), or an active control group (n = 23). Subjective depressive symptoms and well-being were assessed after the intervention and two weeks later. While depressive symptoms decreased in both meditation groups, well-being improved in the long term only in the nature-based intervention.

Huber et al. (2023) took a similar approach, investigating the effects of two nature-based interventions (forest therapy and mountain hiking) on **the mental and physical health** of couples with a sedentary lifestyle. Both interventions ($n_{\text{forest therapy}} = 23$; $n_{\text{mountain hiking}} = 22$) were carried out for three to four hours a day for one week. Data were collected at three different time points (before the intervention, on the seventh day of the intervention, and 60 days after the intervention). Both interventions led to improvements in the subjective mood and life satisfaction, as well as reductions in blood pressure.

In their randomised controlled study, Daniels et al. (2022) investigated the effects of a nature-based intervention on **mental health and perceived stress at work**. The experimental group (n = 25) participated in nature-based activities twice a week for two hours each time over the course of three consecutive weeks. The control group (n = 20) received no intervention. Analyses show that participants in the experimental group had lower levels of burnout and salivary cortisol and higher visual information processing speeds after the intervention as compared to those in the control group. Selective attention also improved in the experimental group. The authors concluded that nature-based interventions during work can reduce stress and improve cognitive performance.

The relationship between contact with nature and **mental well-being at work** was also investigated by Ho et al. (2022). A total of 90 university employees were randomly assigned to an experimental group (n = 48) or a control group (n = 42). Participants in the experimental group completed a 30-minute nature-based intervention during their lunch break on ten consecutive weekdays. The self-reported mental stress (anxiety, depression, and perceived stress) and mental well-being (including positive affect) were collected at the beginning of the study, after the tenth session, and three months later. Significant interaction effects of the intervention on mental stress and well-being were found, although these effects were no longer significant after three months.

In their randomised study, Oafsdottir et al. (2020) investigated the effects of nature-based interventions on the **mood and psychophysiological responses to stress**. Thirty Icelandic students participated in a roughly 40-minute intervention: walking in nature, watching nature on television, or running on a treadmill in a gym. Data were collected before and after the intervention, as well as after artificially induced stress. All the interventions led to a reduction in the stress hormone cortisol, with the greatest reduction observed after walking in nature. The mood of the participants in this group also improved more than in the other two groups.

The randomised controlled study by Ma et al. (2022) focused on the influence of mindful walking in nature on **sleep quality, mood and mindfulness** in British students. Participants were randomly assigned to the experimental group (n = 52; walking in a natural environment) or the control group (n = 52; walking in an urban environment). Both groups walked for 35 minutes each day for seven consecutive days and were surveyed on their subjective assessments at four time points (pre-intervention, after the first and last walk, and five days after the last walk). The participants in both groups reported improvements in mindfulness, sleep quality and mood.

In their study, Irvine et al. (2020), on the one hand, investigated the effects of a nature-based intervention on **mental and physical well-being** and, on the other, explored ways to increase motivation and commitment to participate in such interventions. Thirteen people participated in a twelve-week walking group. Data were collected by means of self-reporting and activity trackers for a pre-post comparison. After completing the intervention, participants reported improved sleep, more positive emotions, increased calmness and better concentration. An objective increase in physical activity was also observed.

While many studies of forest bathing (shinrin-yoku) focus on the physical effectiveness of the intervention, the studies by Kotera and colleagues investigated its effects on **mental well-being**. Kotera and Fido (2022) investigated the effectiveness of a three-day shinrin-yoku seminar on the mental well-being of Japanese students (n = 25). Participants' self-reports were collected immediately before, immediately after, and two weeks after the intervention, and included measures of mental well-being, self-compassion, and mindfulness. While mental well-being did not change, significant improvements were found in self-compassion and mindfulness. In addition, the review by Kotera et al. (2022) provided evidence that different elements of forest bathing (breathing, walking, yoga) can effectively reduce mental symptoms in the short term. This analysis included 20 studies published before November 2019 that aimed to reduce depression, anxiety and stress. Only longitudinal studies were

included, although most of them only included pre-post measurements and did not have follow-ups to examine long-term effects.

1.3 Aims of the scientific monitoring study

The evaluation research in the "Green Care | Nature and Mental Health" project pursues three aims:

- To verify the expected goals of the intervention, which can be derived from the theoretical foundations and previous empirical evidence.
- To fill the current gaps in scientific knowledge about the effectiveness of nature-based interventions, considering both therapeutic and rehabilitative settings as well as the preventive area. The focus is on human mood, with a secondary focus on the psychobiosocial health of individuals as a whole, as well as on pro-environmental and nature conservation attitudes and behaviour.
- To contribute to the strengthening of the reputation of nature-based interventions and the spread of nature conservation values.

1.4 Research questions

The scientific evaluation pursues two overarching research questions:

- How does nature affect individuals, and to what extent do nature-based interventions influence participants' mental health and attitudes towards nature? How do participants subjectively perceive and evaluate these effects? Can positive effects on health- and nature-related variables be demonstrated through an experimental scientific design?
- Are there long-term effects on their mental health and increased nature-related consciousness and behaviour?

Different samples, measurement methods and time points are used to answer two central research questions:

- Is the intervention effective in the short term and is it subjectively perceived as effective by the participants?
- Is the intervention effective in the long term, and do participants integrate what they have learned into their daily lives?

1.5 Principles of evaluation research

The study by the external evaluation team is based on the commitment to scientific independence. The impact evaluation is also committed to the four fundamental attributes and the corresponding

regulations established by the German Society for Evaluation (DeGEval - Gesellschaft für Evaluation e.V., 2016) as standards for good evaluation:

- Utility: Alignment with clarified evaluation purposes and related information needs
- Feasibility: Realistic, well thought-out, diplomatic and cost-conscious planning and implementation
- Fairness: Respectful and fair treatment of all stakeholders
- Accuracy: Producing valid information and results

2 Methods

2.1 Preconditions for the study

The study was approved by the Ethics Committee of the Catholic University of Eichstätt-Ingolstadt (No. 029-2020 on 26 August 2020). It has also been registered in the German Clinical Trials Register (Trial number DRKS00023369). The Universal Trial Number (UTN) registered with the World Health Organisation (WHO) is U1111-1260-7305.

All participants were informed about the aims of the study and gave written consent to participate in the study and to use their data.

2.2 Work schedule

An overview of the originally planned work schedule is shown in Figure 1. This figure illustrates the timeline as it was drawn up by the evaluation team at the time of submission of the application. During the course of the project, it was adapted to the prevailing circumstances in consultation with the responsible parties from the two UNESCO biosphere reserves.

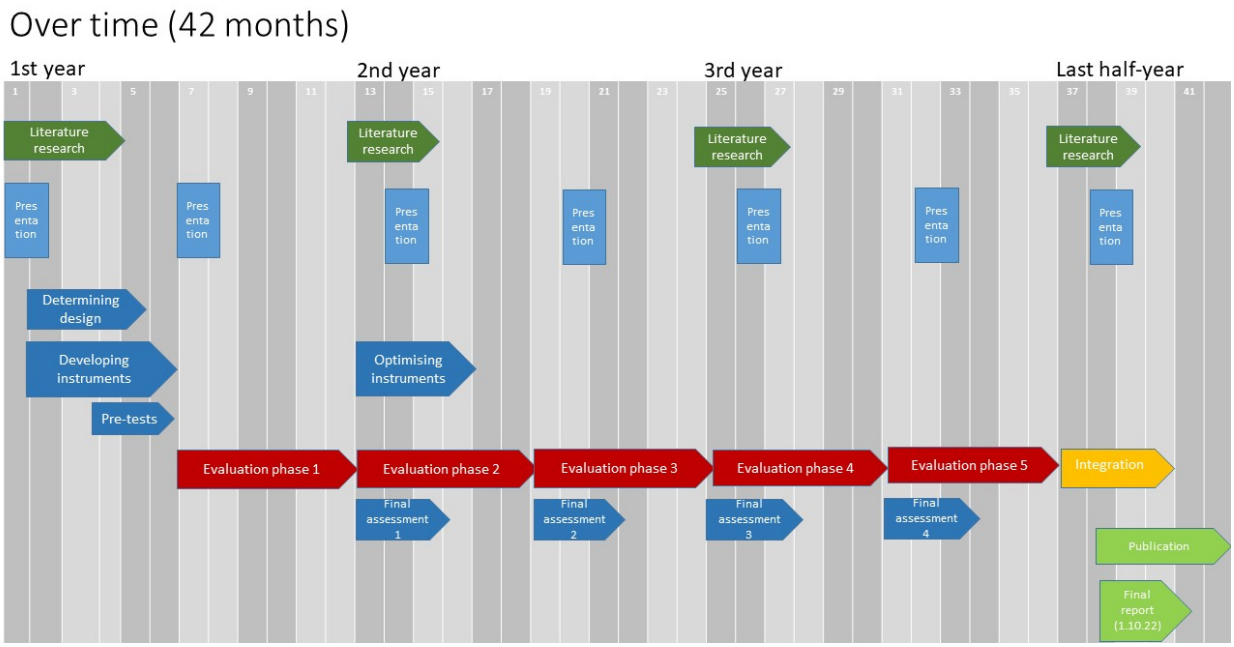


Figure 1. Planned timeline at the time of submission of application

The evaluation team carried out the following tasks in detail:

- Conducting a literature review and clarifying rights of use
- Designing the survey instruments
- Conducting the pretest
- Developing other key documents
- Drafting the ethics application for the evaluation of the intervention and submitting it to the Ethics Committee of the Catholic University of Eichstätt-Ingolstadt (after the description of the intervention had been prepared by the staff responsible for interventions in UNESCO biosphere areas)
- Coordinating with the project sites and continuous communication throughout the project
- Registering the study (drks.de)
- Supervising data collection
- Conducting data collection at the T3 follow-up point
- Conducting interviews
- Data processing
- Data analysis
- Presenting and discussing interim and final results at meetings of the Project Advisory Working Group (PAG)
- Writing the final report
- Writing scientific publications

2.3 Participants

Inclusion criteria: Participants of either gender could be included in the study.

For the clinical setting: Inclusion criteria consisted of depressive disorders (diagnosed by an initial medical assessment on admission to the clinic), adequate tetanus vaccination status, the presence of sturdy footwear and weatherproof clothing, and knowledge of the German language. The minimum age was set at 18 and the maximum age was initially set at 59. Due to the circumstances in the clinics, older people could also participate in the study in consultation with the medical staff.

For the preventive setting (general population): Inclusion criteria consisted of an age between 18 and 59 years, adequate tetanus vaccination status, possession of sturdy footwear and weatherproof clothing, and knowledge of the German language. Again, the upper age limit was raised in consultation with the intervention coordinators due to special circumstances.

Exclusion criteria consisted of manic episodes, delusional and other severe psychiatric comorbidities, physical impairments that limited mobility in the field, and inability to give informed consent. For the clinical setting, the selection of eligible patients for the offering was determined by the admitting senior physicians and case managers (UNESCO Biosphere Reserve Rhön) or the chief physician, senior physicians and/or case therapists (UNESCO Biosphere Reserve Berchtesgadener Land).

2.4 Data collection methods

2.4.1 Pilot study

In order to assess the quality criteria of the questionnaire instruments used, they were tested in a pilot study. An ad-hoc sample of *N* = 205 participants from the general population was recruited to complete an online questionnaire between 26 February and 4 April 2020. The data were then analysed using factor analyses, reliability analyses, correlation analyses, multiple regression analyses and mean comparisons using t-tests. The program SPSS Statistics 29 (IBM Corp., Armonk, NY, USA) was used for statistical analyses. The results confirmed the suitability of most of the scales for the project. The insufficient results prompted the decision to measure the constructs of social support and compassion using well-validated scales, specifically the ENRICHD Social Support Inventory (ESSI) (Cordes et al., 2009) for social support and the State Self-Compassion Scale Short Form (SSCS-S) (Neff et al., 2021) for compassion. As both scales already had data supporting their validity, further validation was not pursued within the project. In addition, the project team decided to use a measure of depression in the clinical sample (Patient Health Questionnaire (PHQ-9); Kroenke et al., 2001).

2.4.2 Questionnaire

Primary endpoint

The primary endpoint was the assessment of positive and negative affect using the *Positive and Negative Affect Schedule Short Form* (PANAS-SF; Mackinnon et al., 1999; Watson et al., 1988). The participants were asked to rate their current mood for five positive and five negative adjectives on a five-point Likert scale ranging from 1 (very low or not at all) to 5 (extreme). The means of the items were aggregated into Negative affect and Positive affect subscales.

Secondary endpoints

Depression was measured exclusively in the clinical setting using the nine-item *Depression Module of the Patient Health Questionnaire (PHQ-9)* (Kroenke et al., 2001). Each item is rated on a four-point Likert scale ranging from 0 (not at all) to 3 (almost every day). The total score was used as a continuous variable in the analyses of results. In addition, a cut-off of 0 to 9 (no or mild depression) and 10 to 27 (probable major depressive disorder) was applied (Meanea et al.; 2012) to differentiate between patients with low and high distress.

The other secondary endpoints were used in both the clinical and preventive settings.

Mindfulness was measured using the *Mindfulness Attention Awareness Scale (MAAS)* (Brown & Ryan, 2003). It consists of 15 items scored on a scale from 1 (almost never) to 5 (almost always) (sample item: “I could have a feeling and not realise it until some time later”). A total mean score was calculated from all items for further analysis.

Self-compassion was measured as a momentary state using the *State Self-Compassion Scale Short Form* (*SSCS-S*; Neff et al., 2021). The short form consists of six items (sample item: “I give myself the care and understanding that I need”). Responses were rated on a scale from 1 (does not apply to me at all) to 5 (applies to me quite a lot). The total score was calculated as the mean of all items.

Social support was measured using the *ENRICHD Social Support Inventory* (*ESSI*; Cordes et al., 2009), which consists of six items (sample item: "When you need to talk, is there someone who really listens to you?"). These items were rated on a five-point scale from 1 (does not apply to me at all) to 5 (applies to me a great deal).

Nature-related mindfulness was collected with five items (sample item: "In nature, I pay attention to sensations such as the sun on my face or the wind in my hair"; Wastlhuber, 2019). These and all subsequent items were measured on a six-point scale ranging from 1 (does not apply at all) to 6 (applies completely).

Emotional connection to nature (Kals et al., 1999; Wastlhuber, 2019) was measured with six items (sample item: "In nature I become more relaxed and feel uplifted").

Awareness of environmental threats (Blum, 2019) was assessed with three items (sample item: "If nothing fundamental changes, environmental threats will get worse in the coming years").

Attribution of responsibility for nature conservation (Blum, 2019) was measured with four items, with two items each for internal (sample item: "I feel responsible for actively contributing to nature conservation myself") and external responsibility (sample item: "The government is responsible for doing something about nature conservation").

Nature conservation attitudes (Blum, 2019; Wastlhuber, 2019) were assessed with five items (sample item: "I am generally willing to draw attention to the importance of nature conservation").

Nature conservation behaviour (Blum, 2019; Wastlhuber, 2019) was measured with three items (sample item: "In my everyday life, I generally act consistent with nature conservation").

In addition, single items were included to measure *childhood contact with nature* ("I spent most of my childhood and adolescence in an urban area") and *current contact with nature* ("I currently spend a lot of time in nature").

The questionnaire also includes additional questions on *demographic information* (gender: male, female, mixed; age in years; children yes/no) and *previous experience with training in nature or mindfulness training* (yes/no, and a free-response option to specify the context in which this training took place). Finally, participants were asked to provide a self-generated *code* that would allow the questionnaires to be matched in the case of multiple measures.

2.4.3 Process evaluation

In order to complement the summative evaluation with questionnaires by including data directly resulting from the interventions, individual evaluations were used as process evaluation instruments. This took the form of a one-page questionnaire completed by the facilitators after each session. Providing the group number assigned by the evaluation team made it possible to clearly assign individual evaluations to sites and groups. The instrument is divided into two sections: a) situational aspects and b) evaluation of the session by the intervention participants.

Situational aspects of the session included the location (name of the site and description of the natural environment), time (date and time), group size and weather conditions. Any special aspects of the session could also be noted.

For the participants' *evaluation of the session*, they were asked by the facilitator to rate their well-being during the session on a four-point Likert scale (1 = I did not feel comfortable to 4 = I felt very comfortable). They were also asked to rate the perceived effectiveness of the intervention session (1 = I did not find it effective to 4 = I found it very effective). The nature of the questions was left to the discretion of the facilitator.

The process evaluation instrument was used in all experimental groups (clinical trials at both sites and prevention trial). In addition, a process evaluation of the clinical control groups was carried out in the UNESCO Biosphere Reserve Rhön.

2.4.4 Interviews

Another component of the empirical data collection consisted of semi-structured, guideline-based interviews conducted with experts. Experts are defined as individuals who possess knowledge of the process, interpretation, practice and action in a specific context (Bogner & Menz, 2002). Their knowledge can be made useful for real-life circumstances and thus serve as recommendations for action in other instances with the same action context, in this case nature-based intervention.

The selection of interviewees was made in consultation with the staff of the two UNESCO biosphere areas. The target number of interviews to be conducted was based on the number of people involved and their willingness to participate in the interviews. The consent of the experts to participate in the interview and to record the conversation for later detailed data analysis was obtained in writing in advance and confirmed verbally at the beginning of the interview.

Two guidelines were developed by the evaluation team for conducting semi-structured interviews: a) a guideline for the clinical study (the names "UNESCO Biosphere Reserve Rhön" or "UNESCO Biosphere Reserve Berchtesgadener Land" were used where appropriate), and b) a guideline for the prevention trial. All interviews began with a welcome message explaining the purpose of the interview and the formalities (including assurances of anonymity and information on data protection).

General information about the person was then collected, including their role or function in the clinic (clinical trial) or within the intervention (prevention trial) and the age group of the experts (under the age of 30, between the age of 30 and 40, between the age 40 and 50, between the age of 50 and 60, above the age of 60). In both studies, knowledge of the intervention was assessed on a four-point Likert scale (1 = I know absolutely nothing about it to 4 = I am familiar with the offering). In the clinical trial, an additional four-point Likert scale (1 = I have almost no contact with patients to 4 = I have a lot of contact with patients) was used to assess how much contact respondents had with patients.

The content part of the interviews, based on five psychological constructs, was then initiated, and for each construct primary questions were formulated and presented to all interviewees. In addition, the guidelines included construct-specific secondary questions that could be used if the primary question posed to the interviewee provided limited information or if there was uncertainty. The wording of the

questions on constructs in the guidelines for the clinical trial and the prevention trial differed only with regard to the use of “patients” and “participants”.

For the construct of *interest in and popularity of the intervention*, respondents were asked about the extent to which the intervention was accepted by the target group (clinical trial: patients and clinic staff; prevention trial: participants) from their perspective.

In order to assess the *organisation and quality of the offering*, the interviewees were asked about the availability and transparency of information on the intervention, as well as their assessment of the cooperation between the intervention facilitator and the interviewee and the patients (clinical trial) or participants (prevention trial). There was also an opportunity to make suggestions for improvement regarding the quality of the offering and the cooperation.

The central construct was the *effectiveness of the offering on health-related variables*, which was discussed in the third part of the guideline. This part of the interview explored the effectiveness of the intervention on the biopsychosocial health of the intervention participants. Follow-up questions focused on short- and long-term effects and possible differences in the effectiveness of the intervention between participants.

The fourth construct was the *importance of the location of the intervention*. This asked how much the natural environment in which the intervention took place was important for its effectiveness. Secondary questions related to whether and to what extent participants made a connection between health and environmental protection, and whether participants expressed any related experiences during the nature-based interventions.

The construct relating to the *effectiveness of the offering on environmental variables* focused on the impact of the intervention on participants’ pro-environmental and nature conservation mindset and attitudes. Questions going into more depth focused on whether participants discussed nature or the particular UNESCO biosphere area during or after the intervention, or whether the intervention led to greater engagement with environmental issues.

The interviews concluded with an *overall evaluation of the offering*, where interviewees were asked to rate the effectiveness of the intervention on a four-point Likert scale (1 = I do not find it very effective to 4 = I find it very effective).

Before concluding the interview, the experts were given the opportunity to provide any additional information that had not been covered.

In addition to these data, a postscript was prepared for each interview to provide information not recorded on the tape for later analysis. This included the date and duration of the interview, situational aspects of the interview, relevant topics of conversation before and after the audio recording, and the focus and characteristics of the interview.

All the measurement instruments used in the study can be found in Annex A.

2.5 Interventions

The study was divided into four arms, two of which were implemented in the clinical setting in the two UNESCO biosphere areas. Two additional arms were offered as a preventive programme for the general population in the UNESCO Biosphere Reserve Berchtesgadener Land. A schematic representation can be found in Figure 2.

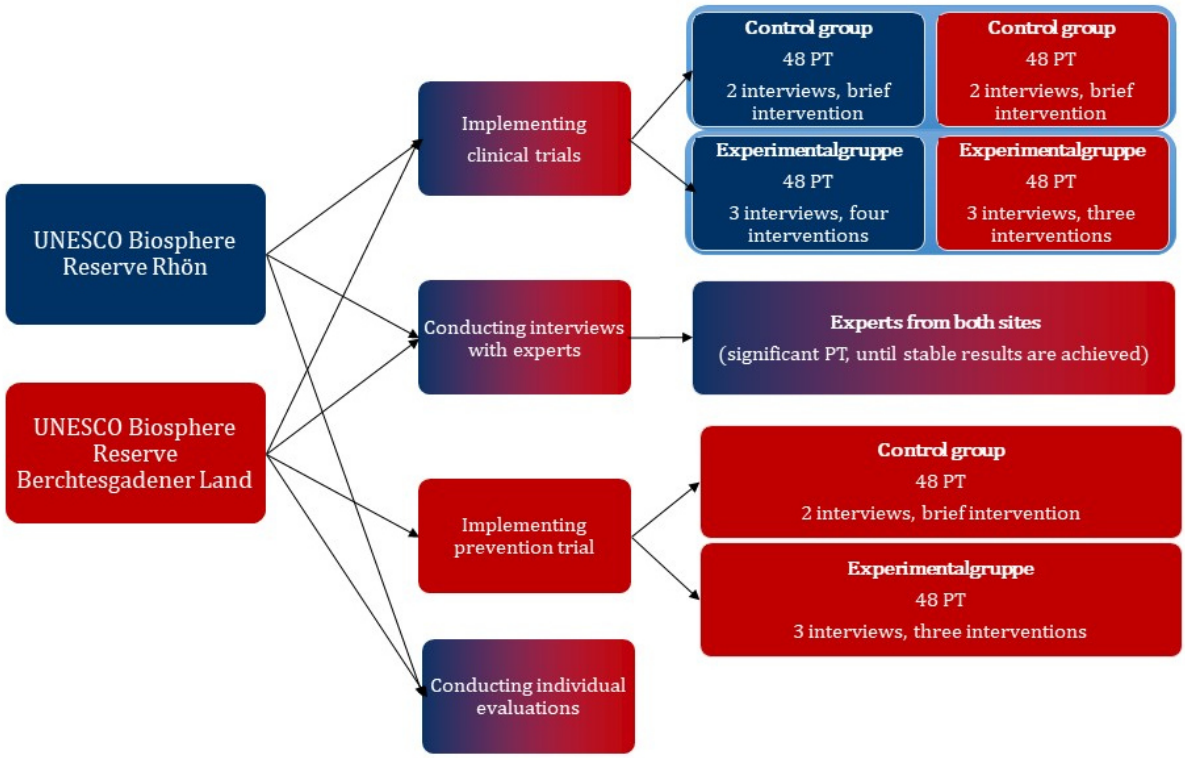


Figure 2. Design of the Green Care study

Arm 1

Contrary to the original plan, different interventions were offered at both sites. What they have in common is that they are based on guided contact with nature and emphasise experience in nature as a therapeutic factor. The content of the interventions was the responsibility of the respective UNESCO biosphere area staff.

In implementation, somewhat different focal points were set: The procedures used in the UNESCO Biosphere Reserve Rhön were relaxation-based ("nature-based relaxation offering"), while they were mindfulness-based ("nature-based mindfulness training") in the UNESCO Biosphere Reserve Berchtesgadener Land. These two terms are used in the site-specific evaluations. In the remainder of the final report, the term "Green Care" is used to describe the mindfulness- or relaxation-based interventions grounded in nature, in line with the scientific research.

The intervention offerings were designed for small groups with a maximum of 6 participants and were delivered once a week for 3 to 4 hours over a period of 3 weeks (UNESCO Biosphere Reserve Berchtesgadener Land) or 4 weeks (UNESCO Biosphere Reserve Rhön).

While the offering in the UNESCO Biosphere Reserve Rhön was carried out in closed groups, the intervention in the UNESCO Biosphere Reserve Berchtesgadener Land included ongoing groups. These structural differences were due to the different conditions of the cooperating clinics.

A detailed description of the respective methods can be found in the final report of the intervention team.

Arm 2

The second clinical arm corresponded to Treatment As Usual plus Waiting List (TAU+WL) with a shortened offering after the second data collection in the form of a Waiting List control. Although the offering for this group was significantly reduced, it is still appropriate to refer to it as a Waiting List because patients were informed of the offering at the beginning of the study and received it specifically as compensation for their willingness to participate in the study.

Arm 3

In the UNESCO Biosphere Reserve Berchtesgadener Land, the Green Care treatment programme ("nature-based mindfulness training") was also offered to the general population to the same extent as in Arm 1.

Arm 4

The fourth preventive arm was designed as a Waiting List control group (WL). Here, participants received the questionnaires at T1 and T2 and then a short offering after the second data collection.

2.6 Evaluation methods

2.6.1 Questionnaire

Statistical analyses were performed using SPSS Statistics 29 (IBM Corp., Armonk, NY, USA) and R (R Core Team, 2020).

Analyses were performed separately for the clinical and preventive arms. Linear mixed models with repeated measures (MMRM) were used to compare the trajectories of the dependent variables based on the factors time (T1 and T2) and group (Green Care and TAU+WL or Green Care and WL). In addition, the site (UNESCO Biosphere Reserve Rhön and UNESCO Biosphere Reserve Berchtesgadener Land) was used as a factor to control for potential differences between the two sites.

As follow-up data were only available for the Green Care groups, additional MMRM analyses were conducted with the dependent variables using the Green Care groups and the time factor (T1, T2 and T3), again controlling for site.

All MMRM analyses used were analysed with fixed effects and random intercepts. Model estimation was based on full information maximum likelihood. The significance level is set at $p < .05$ for all calculations. Trends are indicated when results reach a significance level of $p < .10$ and are associated

with a hypothesis. This approach can provide directions for further research while mitigating the problem of post-hoc interpretation.

To balance the two groups (Green Care and TAU+WL or Green Care and WL) and to compensate for the shortcomings of a non-randomised sample, a propensity score was calculated for each participant. This score was defined as the predicted probability of choosing the Green Care treatment using available sociodemographic and psychometric assessments through logistical regression analyses. Each participant received a score ranging from 0 (control group) to 1 (Green Care group). This score was then used as a covariate in the MMRM analyses.

In further sensitivity analyses (cf. chapters 3.4 and 4.3), variables such as depression (only in the clinical sample), gender, urban vs. rural environment in adolescence, and previous experience with similar training were included in subgroup analyses.

2.6.2 Process evaluation

Data from the process evaluation regarding participants' subjective well-being during the intervention and the subjective effectiveness of the intervention were analysed using Microsoft Excel (Microsoft Corporation). Means were calculated and the standard deviation was used as a measure of scattering.

In the clinical study in the UNESCO Biosphere Reserve Rhön and in the prevention trial, both variables could be analysed over time for each session group: well-being and effectiveness in the first, second and third session and, in the UNESCO Biosphere Reserve Rhön, in the fourth. This was not possible in the clinical study in the UNESCO Biosphere Reserve Berchtesgadener Land due to the continuous intervention groups. Here, the average well-being and effectiveness from the perspective of the intervention participants were calculated across all session dates.

SPSS Statistics 29 (IBM Corp., Armonk, NY, USA) and R (R Core Team, 2020) were used to integrate the process evaluation into the subgroup analyses. Relevant variables included session group size, weather conditions (sunny vs. cloudy), and temperature during the session.

Other situational aspects were used to provide a more detailed description of the intervention setting.

2.6.3 Interviews

The interview data from the clinical trial and the prevention trial were analysed separately. The audio material was transcribed according to the recommendations of Flick (2017) and Dresing and Pehl (2015). The written material was then evaluated with a summarising content analysis involving inductive category formation according to Mayring (2016). The content of the interviews was reduced in such a way that all essential information was retained, resulting in a corpus (category system) that clearly represented the source material. This category system was supplemented with definitions and anchor examples for each category, an approach that is part of scaling structuring within structured content analysis (Mayring, 2016). Coding rules were established for categories that were difficult to distinguish from each other.

In a first step, two randomly selected interviews for the clinical and prevention trials were analysed in this way, creating at least one category system for each construct under investigation. The material

from the remaining interviews was then integrated into these category systems. Additional categories were created and existing categories were adapted as necessary. To enable a quantitative analysis of the interview data, the frequency of mentions for each category created and the number of experts who expressed an opinion about it were determined in absolute and percentage terms. Finally, the categories of a category system were arranged in order of frequency of mention.

The postscripts of the interviews were used to check whether any bias in the data could be expected due to situational aspects or topics of conversation that occurred before or after the recording. This was not the case, so all interviews could be included in the data analysis.

2.7 Study quality

The quality of quantitative studies is assessed on the basis of the three central quality criteria of test theory: objectivity, reliability and validity (Döring & Bortz, 2016).

- Objectivity of the study: Through the use of standardised questionnaires, the results of the study are independent of the person conducting the investigation, which indicates *objectivity in the implementation*. In addition, the data collected yield the same results when analysed by different evaluators, thus ensuring the *objectivity of the evaluation*. Finally, the evaluation of a statistical value is not influenced by the interpretation of the evaluator, thus ensuring the *objectivity of the interpretation*.
- Reliability of the study: The accuracy and precision of the measurement is confirmed using Cronbach's Alpha.
- Validity of the study: As the scales and items have been formulated and operationalised on the basis of theory and, where possible, existing scales have been used, there is an adequate level of *content validity*. *Construct validity* is confirmed by factor analyses. Ecological validity is demonstrated by the similarity of the study setting to the natural environment and the transferability of the study findings to everyday life and practice.

The quality of the qualitative study is assessed on the basis of Steinke's (1999) seven criteria for evaluating qualitative research: (1) the data collection and analysis procedure is intersubjectively comprehensible, (2) there is an indication of the use of a qualitative research approach, (3) the study is empirically grounded, (4) limitations of the study are reported, (5) the subjectivity of qualitative research is reflected, (6) coherence is considered, and (7) the relevance of the study topic is reported.

3. Clinical trial results

3.1 Description of the sample

A total of 251 patients were invited to participate in the trial at both centres (cf. Fig. 3). Of these, 21 (8 per cent) declined to participate and three individuals did not meet the inclusion criteria. There were 116 patients allocated to the Green Care group and 111 patients allocated to the TAU+WL group. These patients will be included in the intent-to-treat analysis in future assessments, even if incomplete data are available. In the Green Care group, 13 people did not receive the intervention, resulting in a drop-out rate of 11 per cent. In the TAU+WL group, 8 patients (7 per cent) dropped out.

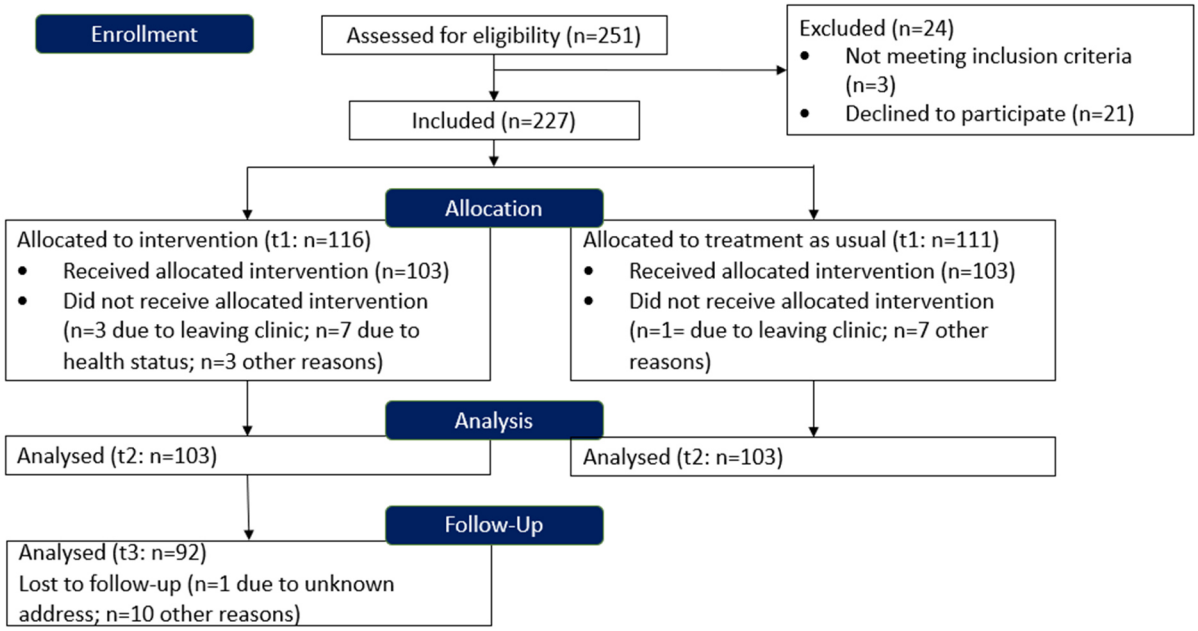


Figure 3. Clinical trial flow chart

In the end, 103 patients in both the Green Care and TAU+WL groups received the intervention. Completed questionnaires at T2 are also available for these patients.

For the follow-up three months after the intervention, only the 103 participants in the Green Care group who completed the training were contacted. Of these, 92 returned completed questionnaires, resulting in a response rate of 89 per cent.

Demographic and clinical data at baseline T1 are shown in Table 1.

Table 1
Characteristics of the clinical sample at baseline

	Green Care group (n = 116)	**TAU+WL group (n = 111)**
Gender	61.2% f, 38.8% m	55.0% f, 44.1% m, 0.9% unknown
Age	*M* = 52.25; *SD* = 8.51; MIN = 29; MAX = 65	*M* = 50.95; *SD* = 10.45; MIN = 19; MAX = 64
Children	69.0% yes, 31.0% no	66.7% yes, 32.4% no
Training	17.2% yes, 81.0% no, 1.7% unknown	20.7% yes, 78.4% no, 0.9% unknown
Positive affect	*M* = 2.46, *SE* = 0.08	*M* = 2.50, *SE* = 0.08
Negative affect	*M* = 2.98, *SE* = 0.08	*M* = 2.88, *SE* = 0.08
Depression	*M* = 12.32, *SE* = 0.50	*M* = 12.31, *SE* = 0.51

Experts for the interviews

Ten experts in the clinical setting participated in the interviews for the qualitative evaluation of the intervention (70 per cent female). The professional backgrounds of the interviewees were diverse, with some having multiple qualifications: The experts interviewed included the two project facilitators, two chief physicians, three (neuro)psychologists, a reference therapist, a nurse, a psychotherapist, two mindfulness trainers and a ranger. The age distribution of the experts is shown in Table 2. On average, the respondents had frequent contact with patients in the clinic (*M* = 3.00; *SD* = 0.77; Table 3) and were well informed about the intervention (*M* = 3.20; *SD* = 0.87; Table 4). According to the experts, the intervention is highly effective (*M* = 3.70; *SD* = 0.46; Table 5).

Table 2
Age distribution of experts in the clinical trial

	< 30	**30-40**	**40-50**	**50-60**	**> 60**
N	2	2	2	4	0

Note. Age in years

Table 4
Contact of experts with patients in the clinical trial

	1	**2**	**3**	**4**
N	0	3	4	3

Note. 1 = I have almost no contact with patients. 4 = I have a lot of contact with patients.

Table 3
Clinical trial experts' knowledge of intervention

	1	**2**	**3**	**4**
N	0	3	2	5

Note. 1 = I know absolutely nothing about it. 4 = I am familiar with the offering.

Table 5
Overall evaluation of the offering by experts in the clinical trial

	1	**2**	**3**	**4**
N	0	0	3	7

Note. 1 = I do not find it very effective. 4 = I find it very effective.

3.2 Main results

3.2.1 Questionnaire

Mixed models with repeated measures (MMRM) were used for the main data analyses, i.e., the group comparisons between the Green Care and TAU+WL groups at T1 and T2. Time point, group and site, along with their interactions, were included in the analyses as fixed factors. A random intercept was also included in the analyses. The propensity score was used as a covariate to account for differences between groups due to non-randomised group allocation. According to the research questions, it was expected that there would be significant interactions between time point and group, but not between time point, group and site.

Primary outcomes: Positive and negative affect

When comparing the two groups at time points T1 and T2, significant Time*Group effects were observed for the two PANAS subscales, Positive affect and Negative affect (Positive affect: $F = 7.15$, $df = 1/207.15$, $p = .008$; Negative affect: $F = 10.52$, $df = 1/211.83$, $p = .001$). The interaction of Time*Group*Site was not significant for either variable. Figure 4 shows the estimates of the scores from the analyses. The effect sizes indicate that the Green Care group had strong effects (Positive affect: $d = 1.13$, Negative affect: $d = 1.04$), while the TAU+WL group also showed significant effects, but with medium effect sizes (Positive affect: $d = 0.76$, Negative affect: $d = 0.59$).

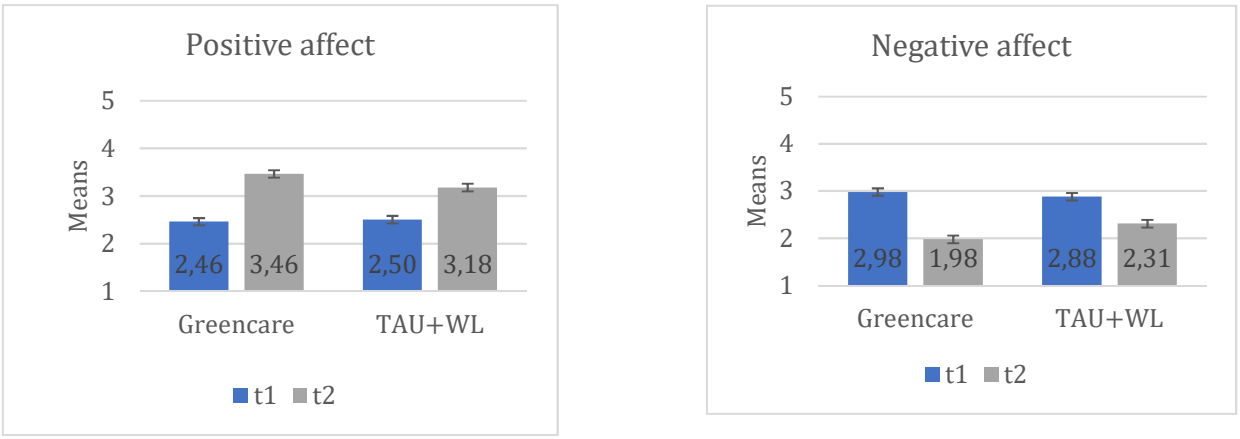


Figure 4. Positive and negative affect in the clinical trial: comparing the Green Care and TAU+WL groups from T1 (admission) to T2 (discharge)

Looking at the longitudinal analysis of the Green Care group (Fig. 5), a significant effect was also observed after three months (T3) compared to the baseline (T1). However, the effects decreased slightly compared to the second time point immediately after treatment (decrease in positive affect: small effect with d = 0.23, decrease in negative affect: small effect with d = 0.21).

Figure 5. Positive and negative affect in the Green Care group of the clinical trial (T1-T2-T3)

Secondary outcomes

Significant interactions were found for the secondary outcomes of self-compassion and emotional connectedness to nature. For both variables, significantly larger effects were observed in the Green Care group compared to the TAU+WL group. Medium effects also remained at the three-month follow-up.

Non-significant interactions were found for depression, mindfulness, social support, nature-related mindfulness, awareness of hazards, attribution of responsibility, nature conservation attitudes and behaviour, and current contact with nature. However, there are clear trends towards a larger effect size for mindfulness (p = .098) in the Green Care intervention. These trends would need to be further investigated in a study with greater statistical power. It is worth noting the equality of effect sizes for current contact with nature. Green Care and TAU+WL patients did not differ in the frequency of contact with nature at T2. Thus, the difference in experiences in nature seems to be related to the quality of the experiences in nature, not the frequency of the time spent in nature. In the Green Care group this is characterised by guided contact with nature.

Detailed tables and figures with the results of the primary and secondary outcomes can be found in Annex C.1.

3.2.2 Process evaluation

Based on the data from the process evaluation, it becomes clear that the Green Care interventions in the clinical trial were carried out under very different conditions. Nevertheless, (highly) significant effects can be experimentally demonstrated, indicating the high efficacy of nature-based interventions in a clinical setting.

Overall, the sessions took place throughout the year, although in the UNESCO Biosphere Reserve Berchtesgadener Land the period was limited to June to November due to weather conditions. The

interventions took place at different times (between 8:00 am and 5:30 pm). The average group size was 6 people, with a range from 2 to 12 participants. The interventions were conducted at temperatures ranging from -13°C to 32°C, and weather conditions included sunshine, fog, clouds, wind, storms, rain showers, thunderstorms and snowfall.

96 per cent of the patients in the Green Care group reported feeling comfortable during the sessions (*M* = 3.68; *SD* = 0.55). Across all sessions, 94 per cent of the patients rated the interventions as effective (*M* = 3.55; *SD* = 0.63). The experimentally demonstrated effectiveness, as evidenced by quantitative data from questionnaires and expert ratings of the effectiveness of the interventions in interviews, is also confirmed from the patients' perspective by the process evaluations.

3.2.3 Interviews

The main findings from the interviews with experts in the clinical trial, which focused primarily on the effectiveness of Green Care, are provided below. To start with, the project characteristics considered relevant to success are presented, followed by the effectiveness of the intervention on biopsychosocial health and environmental behaviour. The factors influencing the individual and intervention levels, as well as the influence of the intervention site (nature), conclude the presentation of the interview results. Complete category systems with anchor examples, frequency of experts who made statements on the category and, where necessary, coding rules for the presented primary and secondary constructs can be found in Annex B.1.

Success-relevant project characteristics

The experts have a nuanced understanding of the factors that influence whether the intervention can be implemented successfully (see Fig. 6).

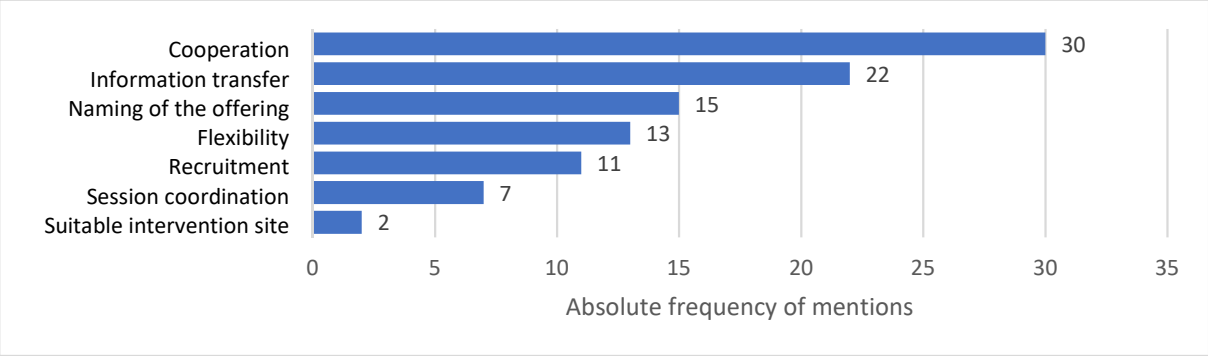


Figure 6. Success-relevant project characteristics of a nature-based intervention in the clinical setting

Good *cooperation* between project staff and clinics is seen as the most important prerequisite for successful implementation of the intervention (e.g., E8: "The activity facilitator and I [clinic staff], we give each other space to work well together. Tolerance, scheduling, agreements, etc. work quite well"). The effective *exchange of information* between the participants is also considered important, which includes both the documentation of relevant information (e.g., E6: "In the documents I received, I found that what is wanted, what it's about, is very transparent. I found the information sufficient, but not overwhelming.") and the early notification of the clinic staff about the upcoming intervention (e.g., E3: "Of course, it took some time for it to trickle down, so to speak, to actually inform the doctors and the treating psychotherapists").

Considered relevant for success are also an appealing and appropriate *naming of the offering* (e.g., E3: "The first thing I tell them is not to call it forest bathing."), *flexibility* in the implementation of the intervention depending on the participants and situational conditions (e.g., E7: "We always adapt. We talk again the evening before the intervention, and after the intervention, after the lunch break, we check it again, and it is always adjusted."), as well as an organised and structured *recruitment* of the participants (e.g., E5: "Only patients who meet the inclusion criteria and are eligible for the project are informed during the recruitment week that they are suitable for this project and whether they can imagine participating in it.").

Finally, the aspect of *coordinating the timing* of the intervention with other clinic offerings or therapies is mentioned (e.g., E13: "Originally, the offering was four hours long. This was difficult because, for example, the meal times in the clinic were extended because of corona ... and so the time had to be shortened a little"). These organisational factors are complemented by the choice of a *suitable intervention site* for implementing the offering. This site must be easily accessible to the patients and provide a suitable environment for the nature-based intervention.

Effects on mental well-being

In total, the experts mention 16 different categories of mental well-being in which they observe changes due to the Green Care intervention (see Fig. 7).

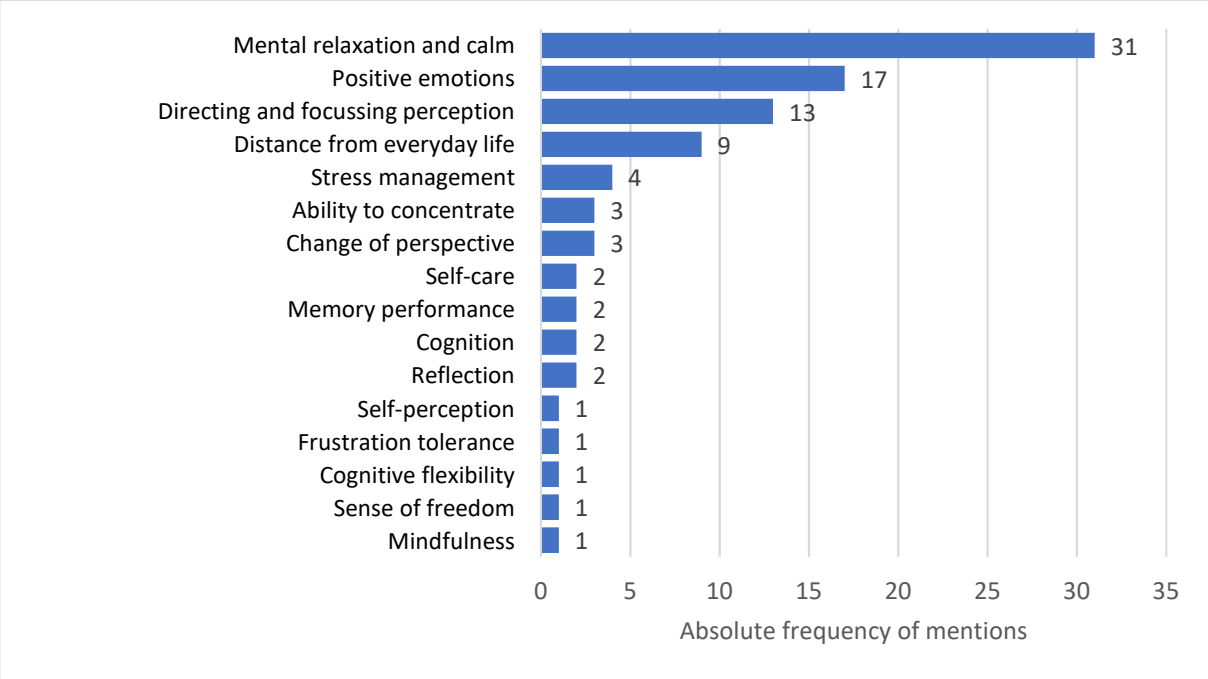


Figure 7. Effects of the intervention on mental well-being in the clinical setting

In particular, according to the experts, Green Care induces *mental relaxation and calmness* (e.g., E5: "This is very beneficial for the patients; somehow it relaxes them."), builds *positive emotions* (e.g., E8: "Mood improves."), as well as a *directing and focusing of perception* (e.g., E3: "... this altered perception, and indeed also this systematic attention guidance"). Furthermore, the intervention is seen as a measure through which patients can *distance themselves from their everyday lives* (e.g., E5: "... where you really notice how the patients step out of their usual daily routines or even the clinic routine here").

In addition to these effects, there are a number of other effects of the intervention that are also perceived by the experts, albeit less frequently. These pertain to the areas of *stress management* (e.g., E3: "... in order to possibly avoid stressors or engage in a form of stress management.") and *concentration* (e.g., E2: "What patients reported, was, for example ... concentration."), *self-care* (e.g., E2: "Self-care was also promoted."), *cognition* (e.g., E3: "I firmly believe that this offering also has effects on cognition.") and *reflection* (e.g., E10: "And a lot of it came naturally through reflection."). Effects on *self-perception, frustration tolerance, cognitive flexibility, sense of freedom and mindfulness* are reported by one respondent each.

Concerning the applicability of the intervention to patients with mental disorders, the suitability for patients with *depression* is mainly mentioned (e.g., E3: "...an offering that is primarily designed for affective disorders or depressive disorders. Therefore this sample benefited the most from the

offering"). Furthermore, there are other mental illnesses for which the intervention is perceived as suitable and effective (see Fig. 8).

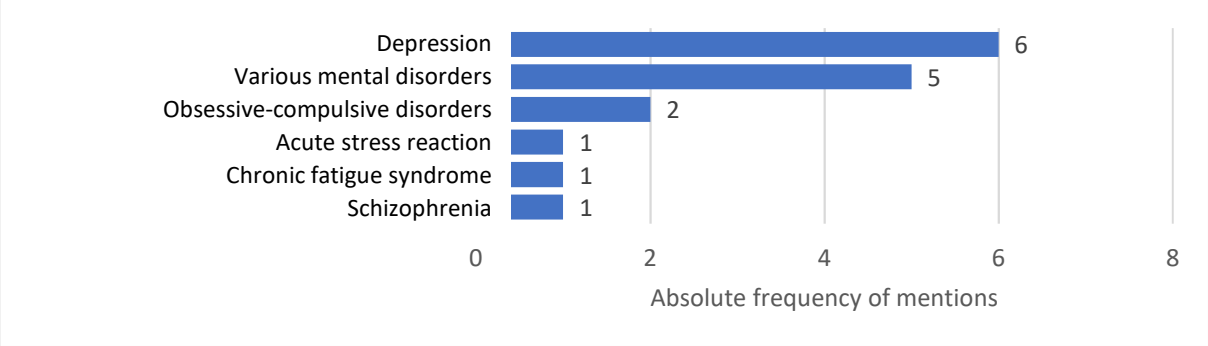


Figure 8. Applicability of the intervention to diverse disorders in the clinical setting

This applies firstly, in general terms, to patients with *different mental disorders* (e.g., E3: "In general, I actually think that the offering would be suitable for almost all mental disorders ..."). In particular, mention is made of *obsessive perfectionism* (e.g., E3: "We've had a handful of people so far who, at least from my perspective, have had some difficulties with the pursuit of perfectionism ... and especially with this symbolic work I've had very good results with these specific patients."), *acute stress reactions*, *chronic fatigue syndrome*, and *schizophrenia*.

Effects on physical well-being

The experts identified eight areas of physical well-being that were affected by Green Care (see Fig. 9).

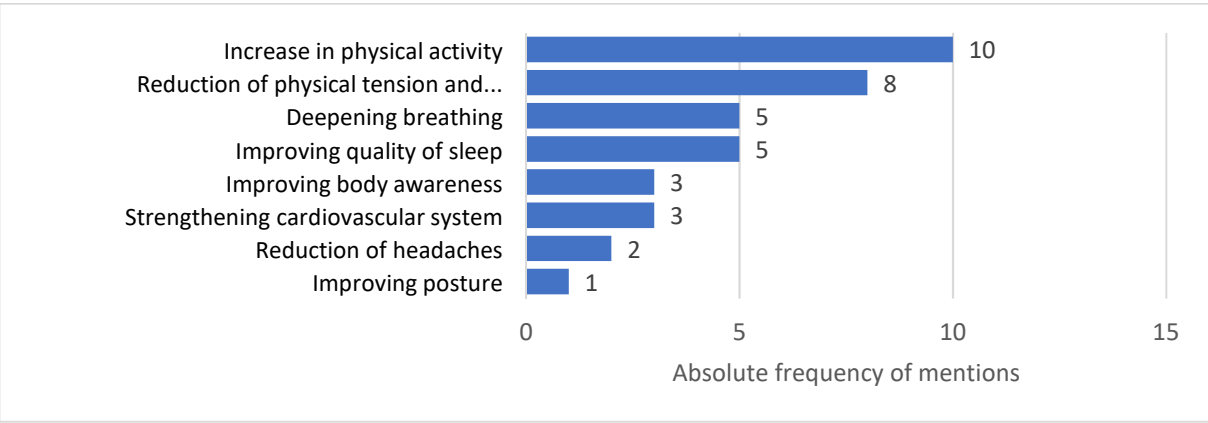


Figure 9. Effects of the intervention on physical well-being in the clinical setting

The intervention is perceived as motivation to *increase physical activity*, which has an impact during the sessions (e.g., E3: "... it's not about getting from A to B quickly, but rather everyone goes at their own pace ...It can take as long as necessary for individuals, and there's no performance pressure.") and beyond (e.g., E13: "Some patients saw it as a motivation to do this more often because they noticed that it was physically beneficial for them").

At the same time, a number of other effects were observed: a *reduction in physical tension and restlessness* (e.g., E2: "On the physical side, four hours in the forest, i.e. in a low-stimulation environment, contributed a lot to relaxation"), *deepening of breathing* (e.g., E3: "Breathing is also

often reported by the patients as calmer and more controlled, also more balanced."), as well as an *improvement in sleep quality* (e.g., E13: "Patients often reported that they slept better after the offering; many have sleep disorders, and it was better right after the offering; they could sleep better at night.") and *body awareness* (e.g., E2: "Body awareness ... was also promoted.").

Similarly, the experts have observed effects of the intervention concerning the *strengthening of the cardiovascular system* (e.g., E13: "... because they noticed that it benefits them physically, that it strengthens their circulation"), a *reduction in headaches* (e.g., E3: "One participant said that she no longer had headaches") and an *improvement in posture*.

Effects on social well-being

In terms of social well-being, the experts mentioned five effects of the intervention in their interviews (see Fig. 10).

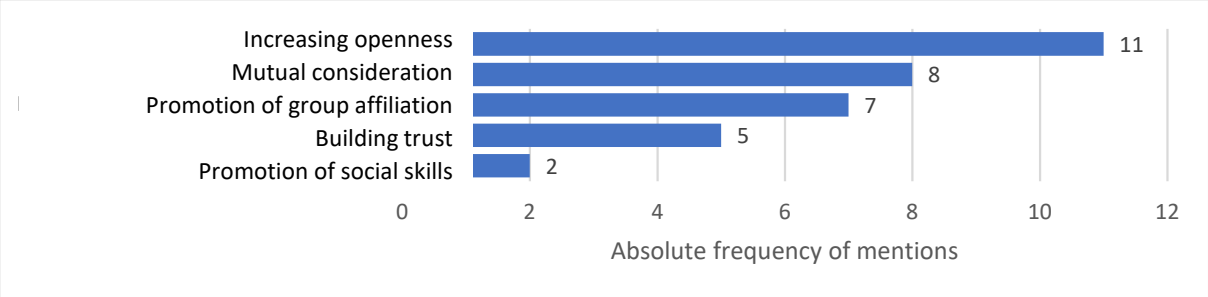


Figure 10. Effects of intervention on social well-being in the clinical setting

During the sessions, the experts observe an *increasing openness* (e.g., E2: "They are also more open and willing to talk, even ready for intimate talks.") and *mutual consideration* among the patients (e.g., E5: "... then they also look at each other very attentively and respectfully."). In their opinion, *a sense of belonging to the group* was promoted (e.g., E8: "They know each other from the project and then, in the clinic during meals, or anywhere else, they have a different connection to each other than those who did not participate in the project") and *trust among the patients was built up* (e.g., E2: "Therefore, patients who are more reserved were more relaxed, and patients who are anxious were also calmer"). In general, *social skills are promoted* (e.g., E3: "We have an element that we do every time for four weeks, which is definitely meant to strengthen social skills").

Effects on pro-environmental and nature conservation behaviour

The experts' statements indicate that the intervention influenced four pro-environmental and nature conservation behaviour (see Fig. 11).

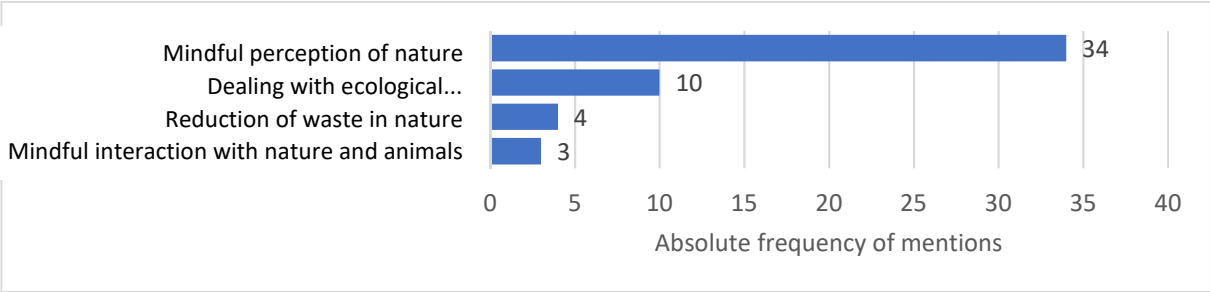


Figure 11. Effects of the intervention on pro-environmental and nature conservation behaviour in a clinical setting

The central effect of the intervention on pro-environmental and nature conservation behaviour is the observation of a *more mindful perception of nature* (e.g., E5: "Then, in the next step, one becomes more aware that this is also worth protecting"). Furthermore, there is an encouragement for *engagement in ecological behaviour* (e.g., E7: "...everyone is thinking about the trash ... and everyone notices that it's increasing, and there are discussions about how to change that.") and patients also pay more attention to *reducing litter in nature* (e.g., E2: "...bottles were found, and the participants removed them voluntarily and disposed of them"). Finally, patients are observed as being more *mindful in their interactions with nature and animals* (e.g., E10: "... during the activities in the forest, care was taken to ensure that nothing was damaged or torn down").

Overall effectiveness

A category system can also be created for the experts' assessment of overall effectiveness (see Fig. 12).

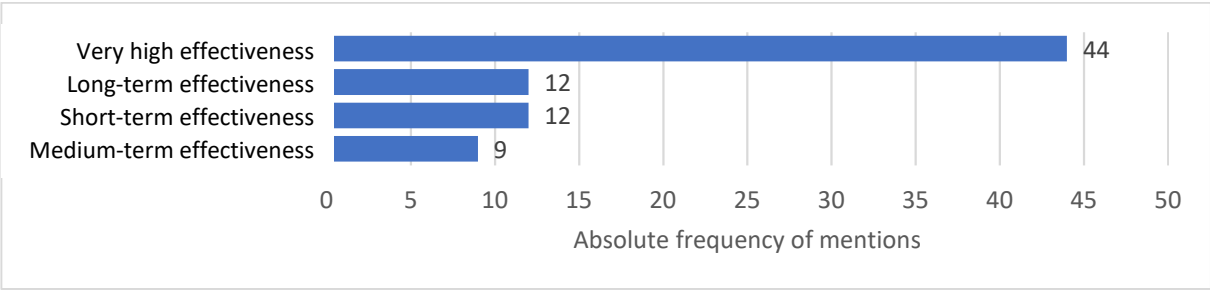


Figure 12. Assessment of the overall effectiveness of the intervention in the clinical setting

In the interviews, there are several statements that indicate that the intervention is perceived as *very effective* (e.g. E3: "...overall I believe that this is a very effective and beneficial thing."). A difference is specifically made between *short-term* (e.g., E8: "...already after the first time, the patients started to benefit from it."), *medium-term* (e.g., E2: "I would say ... a medium-term effect.") and *long-term effectiveness* (e.g., E5: "That could also be a long-term effect.").

Individual determinants of effectiveness

The experts mention several factors that influence the reported effectiveness. At the patient level, nine such determinants can be identified (see Fig. 13).

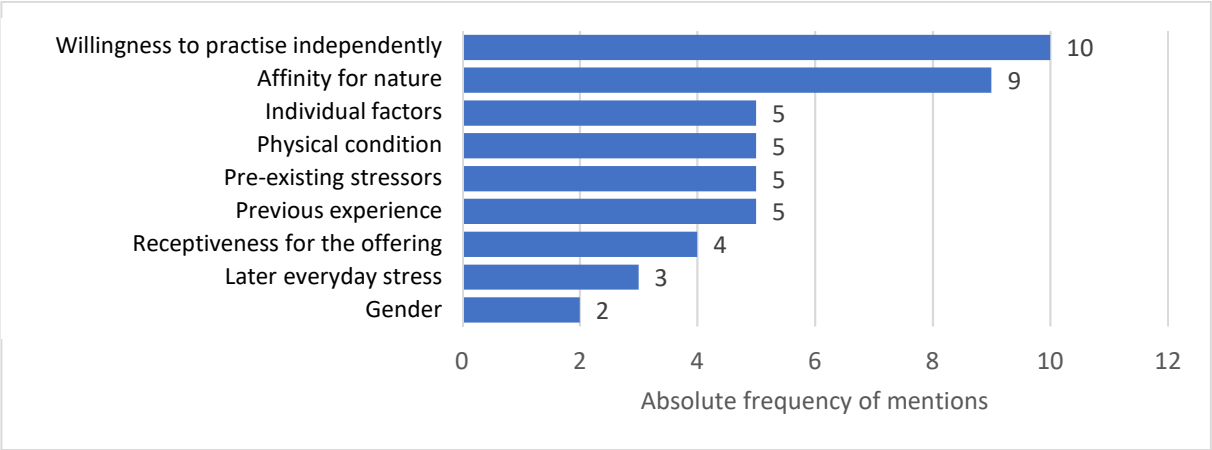


Figure 13. Determinants of individual-level effectiveness of the intervention in the clinical setting

Here, the *willingness to independently practice* what was learned is highlighted (e.g., E7: "...I notice that they are thinking, thinking early on: how can I integrate this into my everyday life at home?") and a pre-existing *affinity for nature* (e.g., E3: "... there is a connection between how much someone was already in nature before or not.") are mentioned as a contributing factors.

Furthermore, *individual factors* in general (e.g., E2: "I can imagine that it depends on the person."), the *physical condition* of the patients (e.g., E13: "There were also individual patients whose physical condition was not so good for the offering. For example, patients who were very overweight and found the walk too long. Also, patients with post-Covid who had major lung problems."), *pre-existing stressors* (e.g., E5: "So, how acutely stressed the person is at the moment, because it can be harder to set aside current issues and engage in the offering."), and *previous experiences* (e.g., E3: "And I have the feeling that for those who are relatively new to it, it could possibly have a greater effectiveness because they are new to this nature theme and may be more fascinated by it.") were identified as determinants of the effectiveness of the offering.

Finally, factors influencing the effectiveness of the intervention include the *receptiveness of the patients for the offering* (e.g., E8: "... whether the patients are receptive or not."), *subsequent daily stress* (e.g., E2: "... after these projects, I had to return to the daily stress right after lunch, and the effect was not particularly significant."), and *gender* (e.g., E13: "One difference I noticed between men and women: men often expressed that they experience a sense of freedom in the forest.").

Intervention-related determinants of effectiveness

At the intervention level, the experts report four different parameters that influence the effectiveness of Green Care (see Fig. 14).

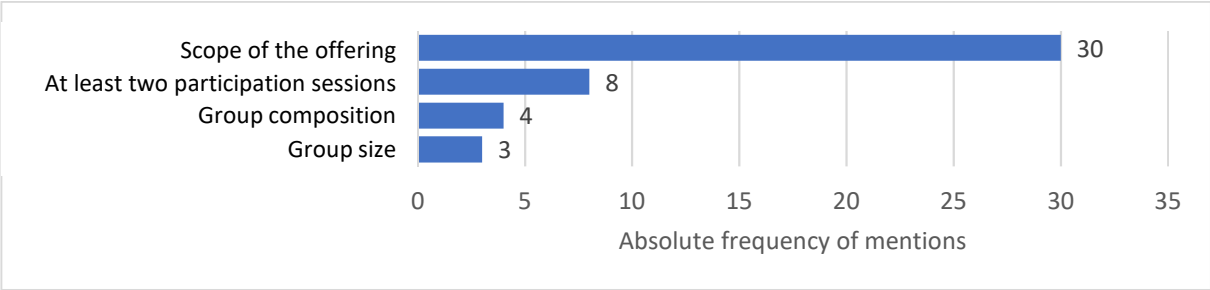


Figure 14. Determinants of session-level effectiveness of the intervention in the clinical setting

From the experts' point of view, the *scope of the offering* is crucial for the effectiveness of the intervention. They believe that a minimum number of sessions should be required (e.g., E3: "I think that a minimum of four sessions should be required. I think that three or two are not enough.") and that a maximum number of sessions should not be exceeded (e.g., E3: "... therefore I think that doing it once a week is a good plan"). The duration of each session also has an impact on effectiveness (e.g., E7: "If it's less than four hours, then it's useful"). A *minimum of two-time participation* in the intervention is recognised as necessary (e.g., E3: "... in the second week, often right at the beginning, even before it starts, the patients already come with a completely different mindset").

On the group level, the *composition of the groups* (e.g., E3 "... that has a lot to do with the composition of the groups, whether such a dynamic develops.") and *group size* (e.g., E2: "The group was quite small, so it was a bit more intense") are perceived as factors contributing to the effectiveness of the intervention.

Effectiveness due to the natural setting

In addition to these individual and organisational factors, the experts mention aspects arising from the setting of the intervention in nature and its influence on effectiveness (see Fig. 15).

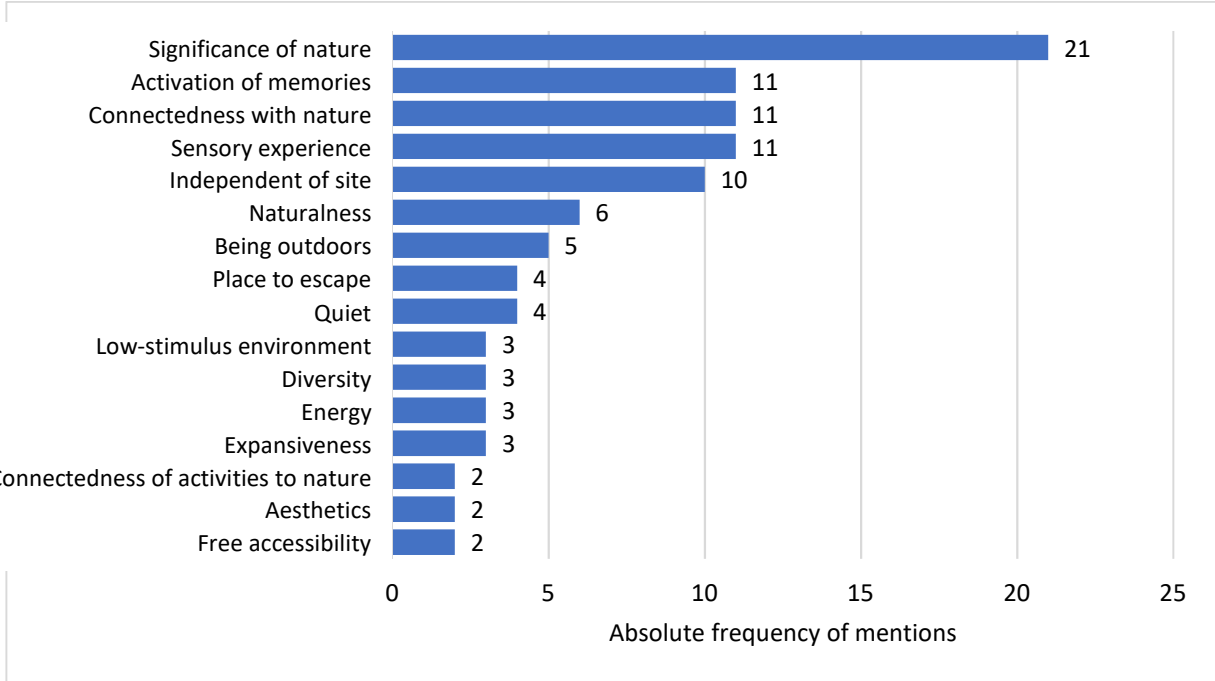


Figure 15. Determinants of intervention effectiveness due to the natural environment in the clinical setting

Nature as the site at which the intervention takes place is considered to be of great importance and special *significance* (e.g., E3: "But ultimately this natural environment is decisive; it provides nature; it provides space"). Spending time in nature awakens *memories* of the past (e.g., E13: "... that there are links to childhood, for example"). The intervention is also effective because there is an innate *connectedness to nature* (e.g., E8: "I am convinced that we all have these aspects within us, this connection to nature. These aspects are more or less hidden in us human beings").

The specific *design* of the natural environment is perceived as less crucial (e.g., E5: "If we were to do the whole thing 500 metres further away, I assume it would work just as well"). More relevant for effectiveness are *sensory experiences* in nature (e.g., E7: "These are different sounds, it smells different, it looks different every day."), the *naturalness* of the intervention site (e.g., E5: "It's about the fact that this is nature, where nature is left as it is.") and *being outdoors* in itself (e.g., E3: "... it can never be as good as when you see it on site. That's why I think it's very different from being in a room").

According to the experts, this is because nature can serve as an intimate *retreat* (e.g., E3: "... so it was something personal for her that she shared with the others, this place."), which is *quiet* (e.g., E1: "... to enjoy this peace even more in the forest.") and *low in stimuli* (e.g., E10: "I think the significance of it was that there was just no other habitat present. It was just the forest. For me it was a kind of sensory deprivation, low in stimuli"). At the same time, nature harbours great *diversity* (e.g., E7: "... that it can be so different, can look different.") and *energy* (e.g., E1: "This place is characterised by a special kind of energy and, in my view, also has an effect on the human psyche, it is purely energetic.") and enables

the experience of *vastness* (e.g., E3: "... is not closed at the top like an indoor space, but because the tall trees form this roof, so to speak").

Furthermore, the elements of the intervention have a *strong connection to nature* (e.g., E3: "There are also approaches to nature-based interventions that take place indoors in bad weather, for example, that would not work at all with our offering, that would do nothing."); nature can have an *aesthetic* effect (e.g., E7: "...when we are sitting in the 'beautiful' forest.") and is in principle *freely accessible* (e.g., E5: "Anyone can be in nature, and it doesn't require special skills or knowledge."), which favours its effectiveness.

3.3 Clinical trial results by site

In order to better understand the effects of the interventions in the two UNESCO biosphere areas, the results will be discussed separately for each site. First, it should be noted that there were no significant differences between the sites in the effectiveness of the Green Care interventions on the primary outcome measures. This means that the effectiveness of the intervention was demonstrated for both sites. When analysed separately, there is less statistical power to detect smaller effects, which means that individual differences may not always be statistically significant. Nevertheless, separate analysis can provide a more detailed picture.

In this section, analyses have been carried out separately for both sites. The focus of the discussion is on the primary outcome measures (positive and negative affect), but the secondary outcome measures are addressed briefly. Detailed results can be found in Annex C.1.

3.3.1 UNESCO Biosphere Reserve Rhön

Primary outcomes: Positive and negative affect

Group comparison between T1 and T2

In the UNESCO Biosphere Reserve Rhön, there was a significant Time*Group interaction for the primary outcome measure of Positive affect (F = 7.28, df = 1/98.34, p = .008). Positive affect increased significantly in the "Nature-based relaxation offering" group with a very large effect ($d_{\text{Nature-based relaxation offering}}$ = 1.44) and in the TAU+WL group with a large effect ($d_{\text{TAU+WL}}$ = 0.91). For the primary outcome measure of Negative affect, the Time*Group interaction was not significant (F = 3.67, df = 1/105.64, p = .058). However, there was a trend confirming that the effect was greater in the "Nature-based relaxation offering" group than in the TAU+WL group ($d_{\text{Nature-based relaxation offering}}$ = 1.21 vs. $d_{\text{TAU+WL}}$ = 0.83; see Fig. 16).

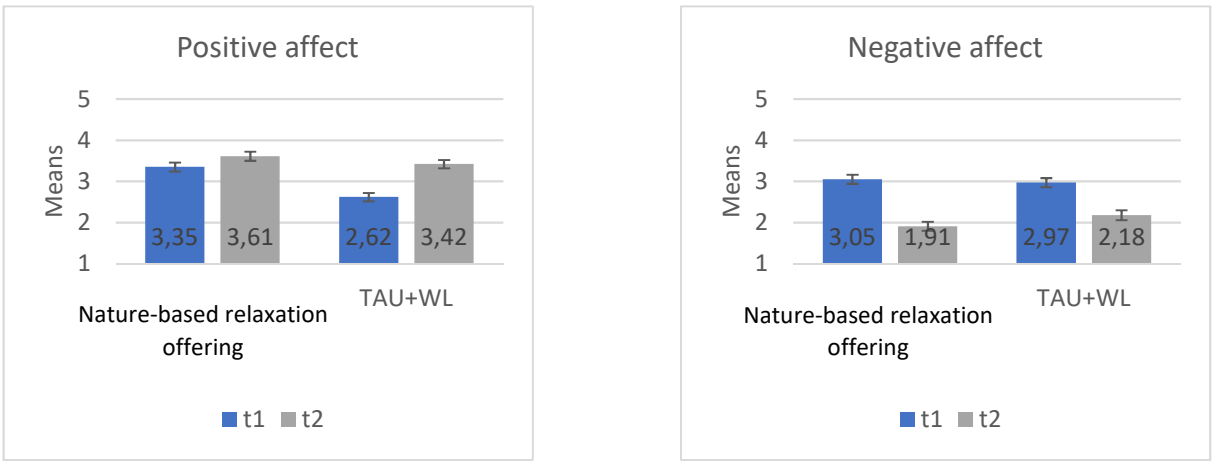


Figure 16. Positive and negative affect in the clinical study (UNESCO Biosphere Reserve Rhön): comparison between "Nature-based relaxation offering" group and TAU+WL group from T1 (admission) to T2 (discharge)

Follow-up in the "Nature-based relaxation offering" group

For Positive affect variable, a large effect remained in the comparison of T1 to T3 (d_{T1T3} = 0.88). The decrease from T2 to T3 was not significant (p = .177). For Negative affect, a medium effect remained in the comparison of T1 to T3 (d_{T1T3} = 0.64, see Fig. 17). The decrease from T2 to T3 was significant (p = .040).

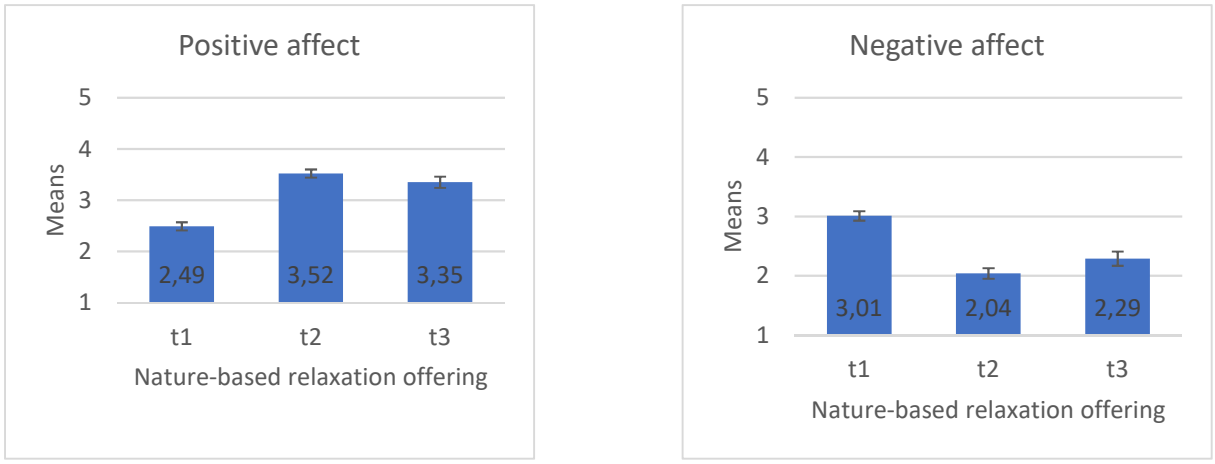


Figure 17. Affect T1-T2-T3 in the clinical trial (UNESCO Biosphere Reserve Rhön)

Process evaluation

The closed groups allowed for an in-depth analysis of the process evaluation to be conducted, focusing on subjective well-being and subjective effectiveness on a session-specific basis. It is found that patients felt very comfortable during the intervention from the first session onwards (M = 3.51; SD = 0.38), and this perception continued to increase until the last session (M = 3.94; SD = 0.10). A similar trend was observed for the effectiveness of the intervention from the patients' perspective: The offering was already perceived as effective after the first session (M = 3.37; SD = 0.40), and even more so after the fourth and final session (M = 3.85; SD = 0.22; see Fig. 18).

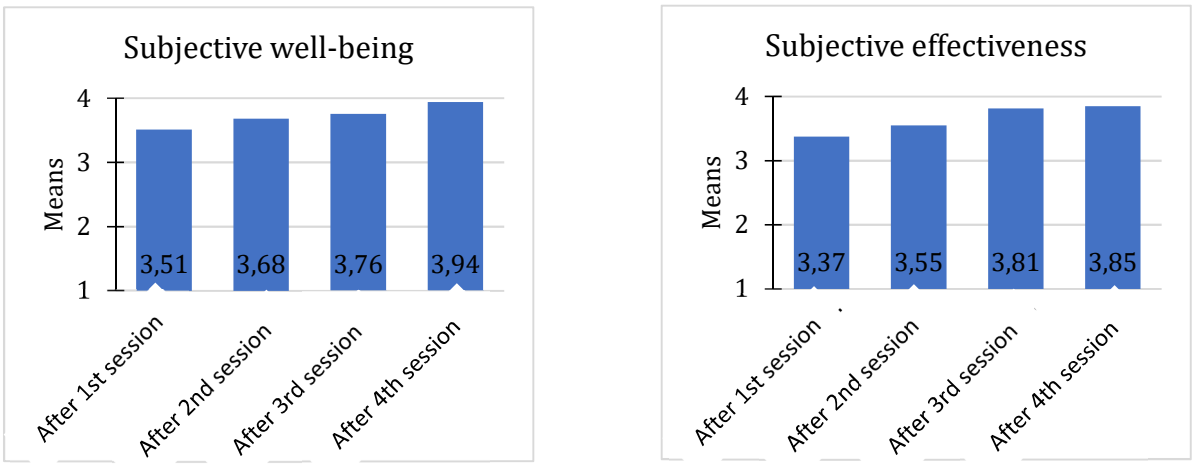


Figure 18. Subjective well-being and subjective effectiveness of the intervention over time from the perspective of the clinical trial participants.
(Data from UNESCO Biosphere Reserve Rhön; 1 = I did not feel comfortable; 4 = I felt very comfortable; 1 = I did not find it effective; 4 = I found it very effective.)

Process evaluations were also carried out in the control groups. These evaluations showed that patients in the shortened interventions, consisting of two sessions, felt very comfortable overall (M = 3.91; SD = 0.19) and perceived the sessions to be effective (M = 3.78; SD = 0.27). Subjective well-being was already high in the first session, with a minimal further increase (1st session: M = 3.90; SD = 0.22; 2nd session: M = 3.93; SD = 0.13). Regarding the effectiveness of the nature-based relaxation offering, there was a significant increase between the first and second session (1st session: M = 3.69; SD = 0.29; 2nd session: M = 3.93; SD = 0.13).

3.3.2 UNESCO Biosphere Reserve Berchtesgadener Land

Primary outcomes: Positive and negative affect

Group comparison between T1 and T2

In the UNESCO Biosphere Reserve Berchtesgadener Land, there was no significant Time*Group interaction for the primary outcome measure of Positive affect (F = 1.22, df = 1/107.52, p = .271). However, it was observed that Positive affect increased significantly in the "Nature-based mindfulness training" group with a large effect ($d_{\text{Nature-based mindfulness training}}$ = 0.83) and in the TAU+WL group with a medium effect ($d_{\text{TAU+WL}}$ = 0.61). For the primary outcome measure of Negative affect, the Time*Group interaction was significant (F = 7.10, df = 1/106.09, p = .009). In this case, the "Nature-based mindfulness training" group showed a large effect, whereas the TAU+WL group showed a small effect ($d_{\text{Nature-based mindfulness training}}$ = 0.87 vs. $d_{\text{TAU+WL}}$ = 0.35; see Fig. 19).

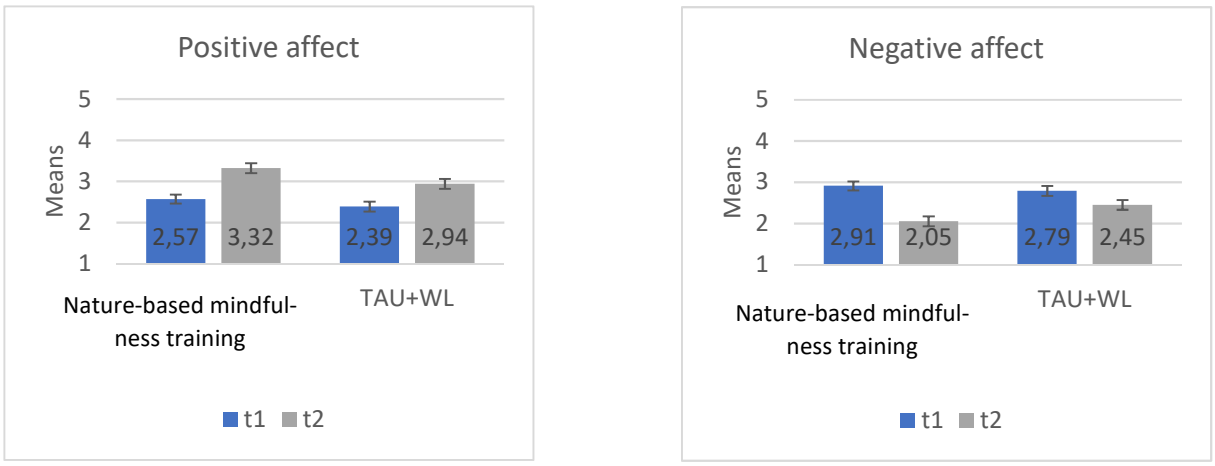
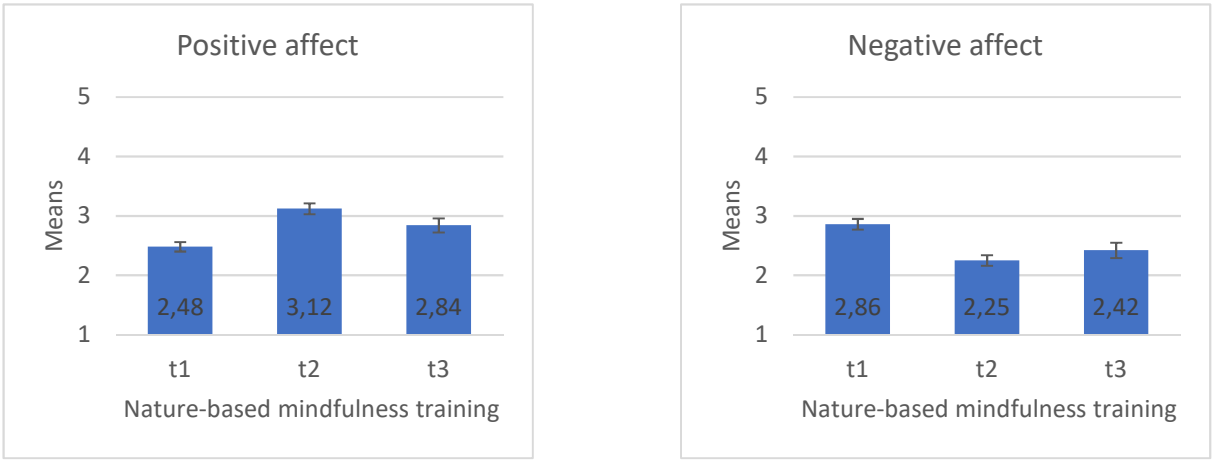


Figure 19. Positive and negative affect in the clinical trial (UNESCO Biosphere Reserve Berchtesgadener Land): comparison between "Nature-based mindfulness training" group and TAU+WL group from T1 (admission) to T2 (discharge)

Follow-up in the "Nature-based mindfulness training" group

For Positive affect variable, a small effect remained in the comparison of T1 to T3 (d_{T1T3} = 0.40). The decrease from T2 to T3 was significant (p = .030; see Fig. 20). For Negative affect, a medium effect remained in the comparison of T1 to T3 (d_{T1T3} = 0.48). The decrease from T2 to T3 was not significant



(p = .259).

Figure 20. Affect T1-T2-T3 in the clinical study (UNESCO Biosphere Reserve Berchtesgadener Land)

3.4 Subgroup analyses

To assess the validity of the results for different subgroups, it is necessary to consider them in subgroup analyses. Methodologically, this presents the challenge of reduced statistical power to detect effects and the risk of accumulating errors. The latter can lead to non-existent effects becoming statistically significant by chance. To avoid this error, two measures were taken: firstly, the analyses were restricted to the primary outcome variables of the PANAS, and secondly, the accepted significance level was corrected to p = .01. This is indicated in the discussions of effects below.

Depression

The PHQ-9 scale was divided based on the cut-off score of 10, following the recommendations of Meanea et al. (2012). Individuals with a score of less than 10 were categorised as “no or mild depression”, whereas those with a score of 10 or more were categorised as “possible major depression“. The resulting binary variable was included in the analyses.

In the group comparison of Green Care vs. TAU+WL, there were no significant interactions for the primary outcome variables (Positive and Negative affect): Patients with low and high levels of depression benefited equally from the interventions.

In the longitudinal analysis, considering only the Green Care group, significant interactions were found for the primary outcome measures (Positive affect: $p < .001$; Negative affect: $p < .001$). The results are a product of two circumstances: Firstly, at T1, more highly distressed patients had significantly less favourable values in clinically relevant variables, leading to an even more pronounced improvement. Secondly, the results suggest that the effects are more stable in more depressed patients, as the values between T2 and T3 do not significantly differ for this group, whereas in the group of patients with lower levels of depression, these values slightly decrease again or, in the case of Negative affect, slightly increase. In summary, it can be said that more highly distressed patients particularly benefited from the program.

Childhood residence

The Childhood residence variable was used as a binary variable (urban/rural) in the analyses. In a group comparison of Green Care vs. TAU+WL, the results showed no significant difference for the primary outcomes. This means that the origin of the participants had no direct influence on the effectiveness of the intervention.

In the longitudinal analysis, including the follow-up measurement time point, there was a significant interaction for Negative affect: Here, more stable effects were found at T3 for people from an urban environment. This means that the values for this group did not differ significantly between the time of discharge and three months after treatment.

Gender

The Gender variable was asked in three categories in the study (female, diverse, male). As none of the people in the questionnaire classified themselves as “diverse”, this category is not considered further in the analyses. The results also show for the gender variable that no significant differences were found in the primary outcome measures.

Previous experience

The “Previous experience” variable asked about previous experience with mindfulness training or training in nature. There was no significant effect for the primary outcome measures, either in the T1-T2 group comparison or in the longitudinal analysis for the Green Care group.

Age

Age was included as a binary variable by using a median split (median = 55 years). No significant results were found for the primary outcome measures, either in the comparison of Green Care vs. TAU+WL or in the longitudinal analysis for the Green Care group.

Children

In the questionnaire, participants were asked whether they had children, with the response options yes and no. This variable showed no significant effects on the primary outcome measures, both in the comparison of Green Care vs. TAU+WL or in the longitudinal analysis for the Green Care group.

Weather

The influence of weather was examined using process evaluation data. Two factors were taken into account: firstly, whether the sun was shining predominantly during the intervention (dichotomous variable), and secondly, the temperature during the intervention (the highest temperature during the intervention was chosen in each case). These variables were then correlated with the results of the process evaluation (well-being and effectiveness). Only very small and non-significant correlations were found ($r_{\text{Sunshine well-being}}$ = .11, p = .41; $r_{\text{Sunshine effectiveness}}$ = .08, p = .55; $r_{\text{Temperature well-being}}$ = -.13, p = .37; $r_{\text{Temperature effectiveness}}$ = -.06, p = .68).

4 Results of the prevention trial

The prevention trial was carried out in the UNESCO Biosphere Reserve Berchtesgadener Land. Therefore, the evaluations refer only to this site.

4.1 Description of the sample

A total of *N* = 146 people expressed interest in the study (cf. Fig. 21). Of these, 13 individuals (5 per cent) were not included in the study due to inclusion criteria (8) or other reasons (5). In the end, 84 people were assigned to the "Nature-based mindfulness training" group and 49 people to the WL group. These individuals are included in the intent-to-treat analysis in further assessment, even if incomplete data were available. In the "Nature-based mindfulness training" group, 28 people ultimately did not receive the intervention. Of these, 17 people (20 per cent) were unable to participate in the programme because of a lockdown imposed to contain the SARS-COV2 virus. A further 11 people (13 per cent) were unable to take part in the programme at short notice because of their health condition. There were no premature withdrawals from the trial in the WL group.

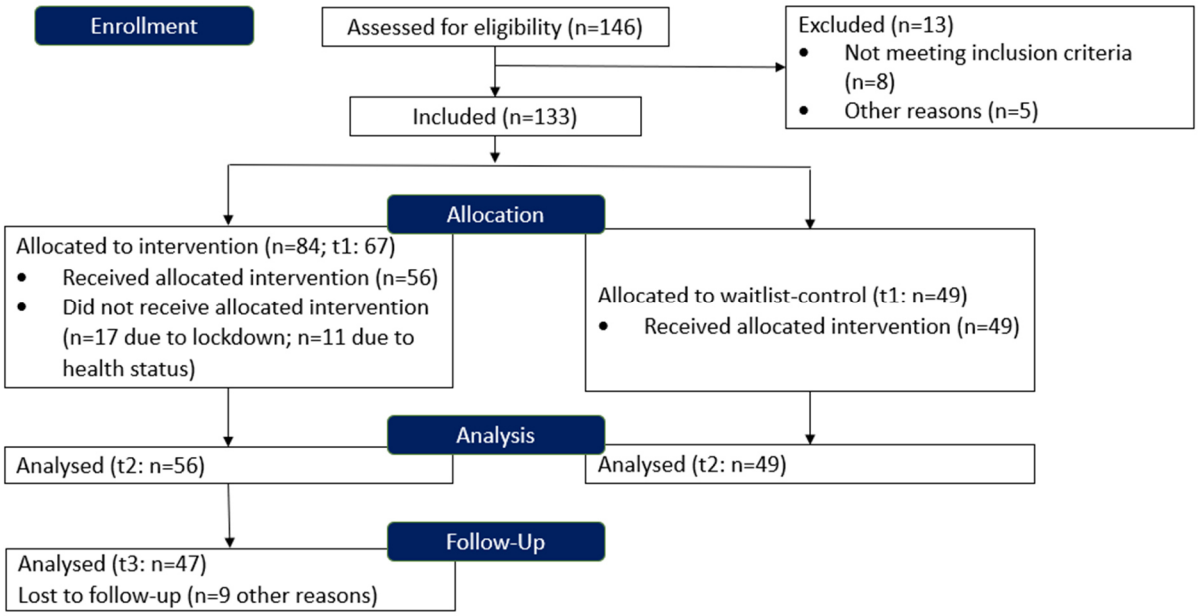


Figure 21. Flow chart of the prevention trial

In the end, 56 people in the "Nature-based mindfulness training" group and 49 people in the WL group received the intervention. Fully completed questionnaires were available for these individuals at T2.

For the follow-up three months after the intervention, only the 56 participants in the "Nature-based mindfulness training" group who completed the training were contacted. Of these, 47 returned completed questionnaires, resulting in a response rate of 84 per cent.

Demographic and relevant psychometric data at baseline (T1) are presented in Table 6.

Table 6
Characteristics of the prevention sample at baseline

	"Nature-based mindfulness training" group (n = 67)	**WL group (n = 49)**
Gender	86.6% f, 13.4% m	71.4% f, 28.6% m
Age	*M* = 48.72; *SD* = 11.22; MIN = 24; MAX = 68	*M* = 42.76; *SD* = 17.20; MIN = 18; MAX = 85
Children	74.6% yes, 25.4% no	51.0% yes, 49.0% no
Training	40.3% yes, 59.7% no	32.7% yes, 67.3% no
Positive affect	*M* = 3.07, *SE* = 0.10	*M* = 3.06, *SE* = 0.11
Negative affect	*M* = 2.47, *SE* = 0.09	*M* = 2.30, *SE* = 0.11

Experts for the interviews

Seven experts (71 per cent female) took part in the interviews as part of the prevention trial. People with different roles in the intervention and different professional qualifications were recruited for the interviews, including the project facilitator, a landscape planner, a nature coach, a mental psychotherapist and a health educator. The age distribution of the experts is shown in Table 7. The interviewees are well informed about the intervention (*M* = 3.43, *SD* = 0.73; Table 8) and subjectively perceive it as highly effective (*M* = 3.71; *SD* = 0.45; Table 9).

Table 7
Age distribution of experts in the prevention trial

	< 30	**30-40**	**40-50**	**50-60**	**> 60**
N	1	1	4	0	1

Note. Age in years

Table 9
Overall evaluation of the offering by experts in the prevention trial

	1	**2**	**3**	**4**
N	0	0	2	5

Note. 1 = I do not find it very effective. 4 = I find it very effective.

Table 8
Prevention trial experts' knowledge of intervention

	1	**2**	**3**	**4**
N	0	1	2	4

Note. 1 = I know absolutely nothing about it. 4 = I am familiar with the offering.

4.2 Main results

4.2.1 Questionnaire

Mixed models with repeated measures (MMRM) were used for the main data analyses. Fixed factors included time point of measurement, group and their interactions in the analyses. A random intercept was also included in the analyses. The corresponding propensity score was used as a covariate to adjust for differences between the preventive groups due to non-randomised group assignment. According to the research questions, significant interactions between time point and group were expected. It should be noted that the slightly smaller sample size compared to the clinical arms is expected to result in lower statistical power.

Primary outcomes: Positive and negative affect

When comparing the two groups at time points T1 and T2, there was no significant interaction between time point and group for the Positive affect subscale of the PANAS, although a trend can be observed at a significance level of p = .097. In the "Nature-based mindfulness training" group, there was a significant difference between T1 and T2 with a mean effect size of *d* = 0.59, while the difference in the WL group was smaller and not significant. For Negative affect, however, a significant interaction between time and group was found (*F* = 21.36, *df* = 1/106.12, *p* < .001). Here a medium effect was observed in the "Nature-based mindfulness training" group with *d* = 0.56, while the difference from T1 to T2 in the WL group was not significant. Figure 22 shows the estimates of the scores from the analyses.

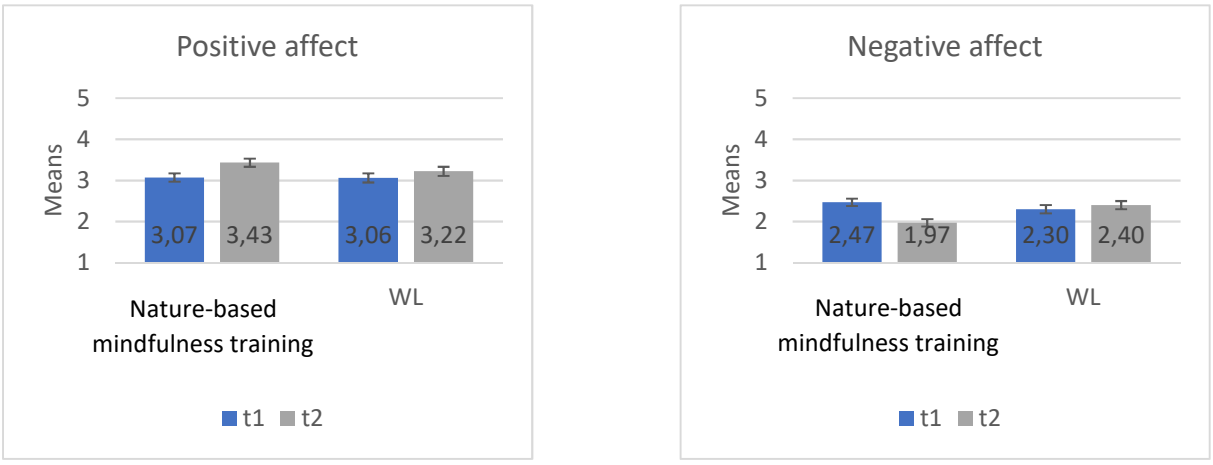
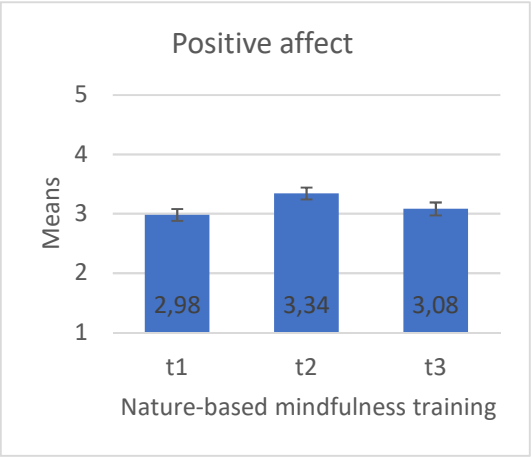


Figure 22. Positive and Negative affect in the prevention trial: comparison of the "Nature-based mindfulness training" group and the WL group from T1 (before the first session) to T2 (after the last session)

Looking at the longitudinal analysis of the "Nature-based mindfulness training" group (Fig. 23), no significant effect was found for Positive affect even after three months (T3) compared to the baseline (T1; *p* = .326). For Negative affect, the effects decreased slightly compared to the second time point immediately after the training (small effect with *d* = 0.22).



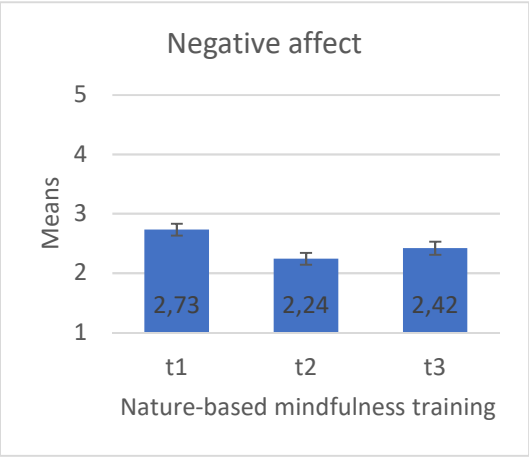


Figure 23. Affect T1-T2-T3 in the prevention trial

Secondary outcomes

Significant interactions were found for secondary outcomes related to nature-based mindfulness, emotional connectedness to nature, awareness of environmental threat, and internal and external attributions of responsibility for nature conservation. For all these variables, significantly larger effects were observed in the "Nature-based mindfulness training" group than in the WL group. Medium effects also remained at the three-month follow-up.

Non-significant interactions were found for self-compassion, mindfulness, social support, nature conservation attitudes and behaviour, and current contact with nature. However, tendencies towards larger effect sizes for the "Nature-based mindfulness training" group can also be observed for the Mindfulness variable (p = .0998). These trends would need to be further investigated in a study with greater statistical power. It is worth noting that, as in the clinical arms, the effect sizes for current contact with nature were similar. Participants in the "Nature-based mindfulness training" group and the WL group also did not differ in the frequency of contact with nature at T2.

Detailed tables and figures showing the results of the primary and secondary outcomes can be found in Annex C.2.

4.2.2 Process evaluation

The process evaluations show that the individual sessions in the prevention trial were conducted under different situational conditions. Nevertheless, the effects of the intervention can be experimentally demonstrated, indicating the high effectiveness of the offering. The sessions took place from May to November, with most starting in the early morning (9:00 am) and a few in the afternoon (3:00 pm). The average group size was 6 people, with a minimum of 4 and a maximum of 10. Temperatures during the sessions ranged from 1°C to 28°C, and the "nature-based mindfulness training" took place in a variety of weather conditions, including sunshine, clouds, rain, fog, wind and storms.

99 per cent of participants felt comfortable during the sessions (*M* = 3.78; *SD* = 0.46), and the same percentage found the intervention effective (*M* = 3.67; *SD* = 0.53). Both subjective well-being and perceived effectiveness were very high after the first session and continued to increase over time (see Fig. 24).

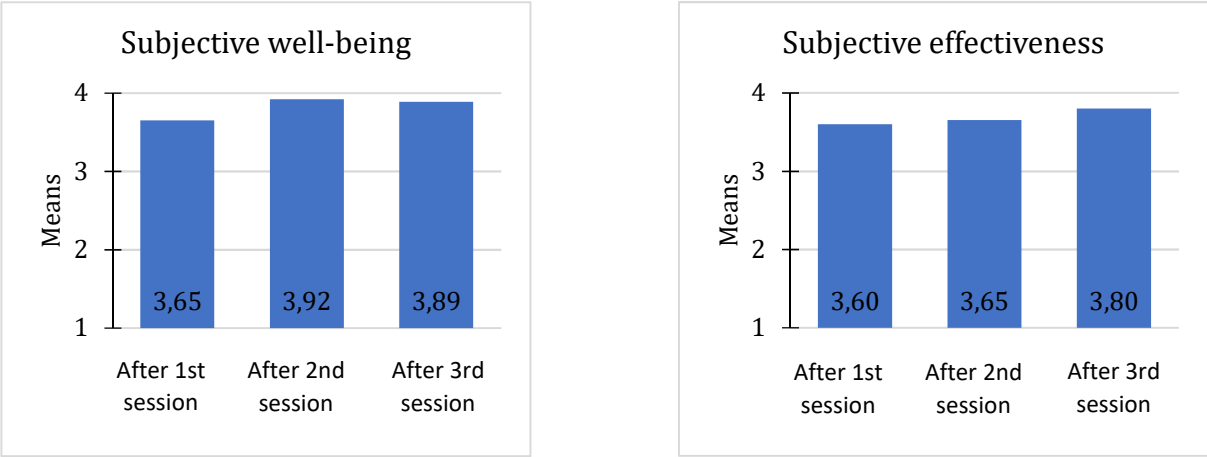


Figure 24. Subjective well-being and subjective effectiveness of the intervention over the course of the intervention from the perspective of the participants in the prevention trial.
(1 = I did not feel comfortable; 4 = I felt very comfortable; 1 = I did not find it effective; 4 = I found it very effective.)

The effectiveness, experimentally proven in the questionnaires, is reflected and validated by the subjective experiences of the participants.

4.2.3 Interviews

The results of the interviews from the prevention trial, focusing on the effectiveness of "nature-based mindfulness training", are provided below. The discussion covers the project characteristics necessary for successful implementation from the perspective of the experts, the effectiveness of the intervention in terms of mental, physical and social well-being, nature conservation behaviour, and the assessment of overall effectiveness. This is followed by determinants of effectiveness at the individual and session level, and factors influenced by the implementation site in nature. The category systems with anchor examples, the frequencies of experts who commented on the categories, and the necessary coding rules for these and other secondary constructs can be found in Annex B.2.

Success-relevant project characteristics

Based on the experts' statements, nine characteristics were identified as necessary for the successful implementation of a nature-based intervention in a preventive setting (Fig. 25).

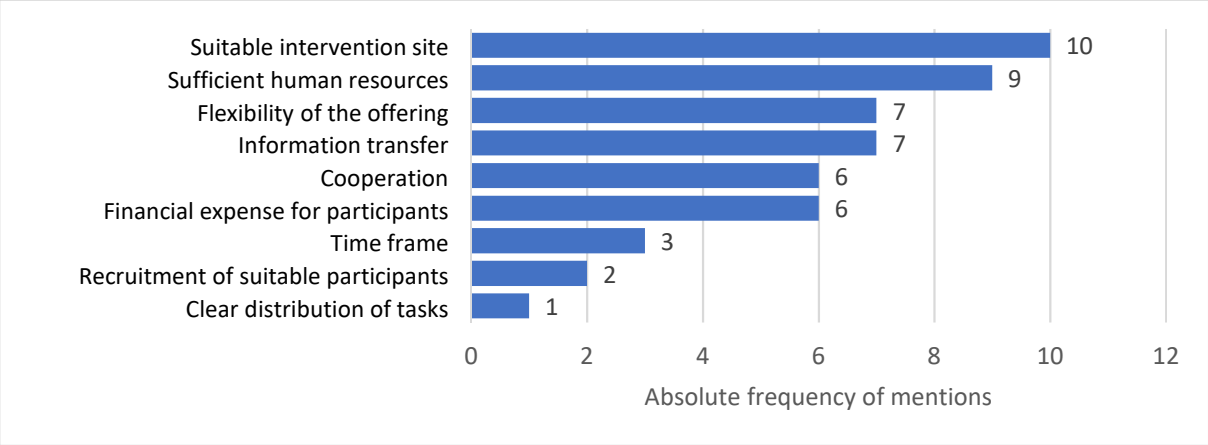


Figure 25. Success-relevant project characteristics of a nature-based intervention in the preventive setting

The most important criterion for the successful implementation of the intervention is seen as the selection of a *suitable location* that is easily accessible (e.g., E9: "Simply finding suitable places in the region is certainly a bit of a challenge.") and at the same time is sufficiently secluded (e.g., E4: "... at the same time it has to be a place that is not frequented by tourists, and then the choice in the southern district becomes very narrow. Because the areas that are easily accessible are often heavily frequented by tourists").

Sufficient *human resources* must also be available (e.g., E4: "... unfortunately, that's not the case with us, we don't have another person who can contribute labour to the project. And it is a disadvantage or simply additional stress if I always have to think of everything for the groups."), and despite a structured organisation of the intervention, it must be possible to *respond flexibly* to situational conditions (e.g., E9: "...they are guided through this intervention very well, so they have many opportunities to ask questions and reflect").

Sufficient *information* must be provided both before and during the intervention (e.g., E4: "I set up e-mail distribution lists for each group and sent out regular information to everyone in advance, and it worked well"), and cooperation with all those involved in the intervention must be maintained (e.g., E4: "It is important to make it very clear to the forest owners, or to request such information in advance, so that we can move to another area if necessary. Or whether the work with wood could perhaps take place at a different time").

The *financial cost* of the intervention has to be considered as an offering for private individuals (e.g., E9: "At the moment it is offered free of charge, or ... the whole thing is offered effectively for free"), as well as the *time commitment* for the intervention (e.g., E11: "But the problem is that they do not have time for the three sessions. This is an obstacle where some dropped out. Where some ... said: A friend also wanted to do it, but three sessions were too much"). Participants must be *recruited* based on inclusion and exclusion criteria (e.g., E4: "... of those who are interested, many do not quite fit into

the sample, especially in terms of age. Because we have this requirement between 18 and 59 and there were a lot of older people involved"). There needs to be a clear *division of labour* within the intervention team.

Effects on mental well-being

According to the experts, the intervention has a variety of potential effects on the mental well-being of the participants (see Fig. 26).

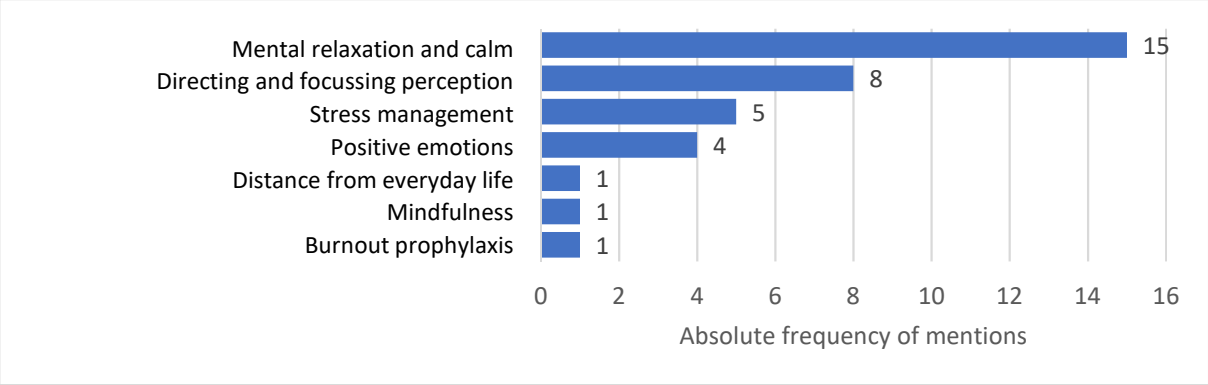


Figure 26. Effects of the intervention on mental well-being in the preventive setting

From the outside, the participants appeared *more relaxed and calmer* after the interventions (e.g., E6: "... but also realised that they were already more relaxed emotionally after the implementation"). The experts report that the intervention simultaneously leads to a *directing and focusing of attention* (e.g., E12: "After a few hours in the forest, it is clearly noticeable to everyone, it is clearly palpable ... that a different level of perception has been addressed.") and also contributes to *stress reduction* (e.g., E9: "It's good for them to be able to cope better with all the stress that arises in everyday life because of the coronavirus situation").

Through the intervention, the participants experience *positive emotions* (e.g., E4: "I can say that everyone was in a good mood afterwards.") and *distance themselves from everyday life*. The experts note that the intervention promotes *mindfulness* and counteracts the risk of *burnout*.

Effects on physical well-being

According to the experts, the intervention affects the physical well-being of the participants in two ways (see Fig. 27).

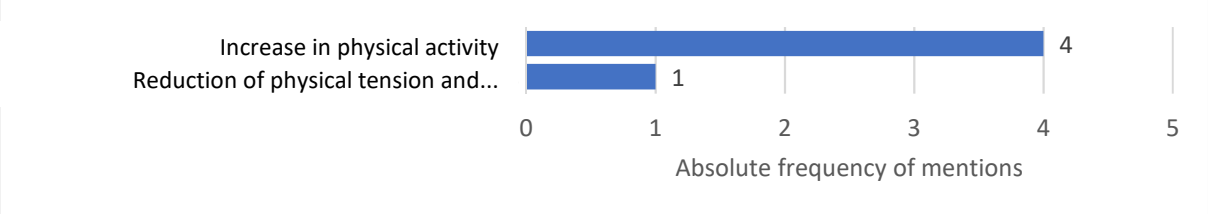


Figure 27. Effects of the intervention on physical well-being in the preventive setting

The intervention leads to *physical activation* of the participants, both during the sessions (E9: "Then there are stretching exercises that you do on the tree."), as well as beyond that (e.g., E12: "... the encouragement and the desire to go out into nature more often ..."). At the same time, the intervention *reduces physical tension and restlessness*.

Effects on social well-being

According to the experts, the intervention also has an impact on the social well-being of the participants (see Fig. 28).

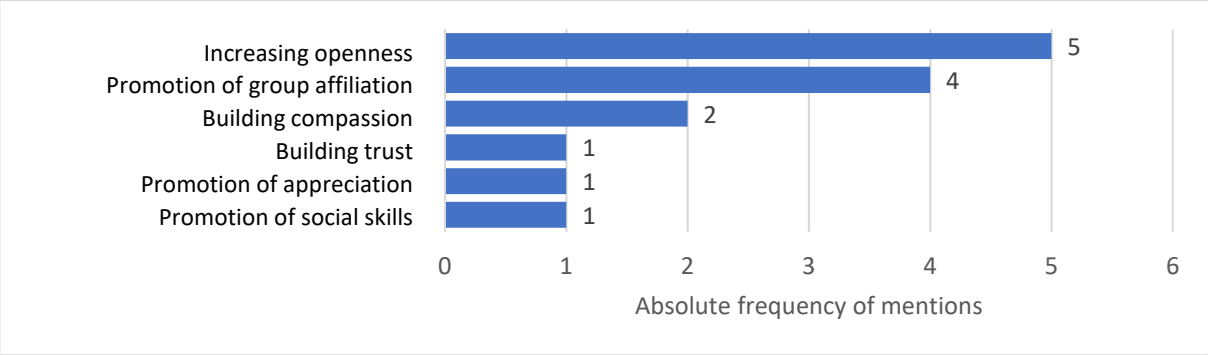


Figure 28. Effects of the intervention on social well-being in the preventive setting

In the course of the intervention, the participants showed very quickly that they were *open* to the experiences (e.g., E9: "... that people were open with each other, very quickly open, that there was such open togetherness right away"). *Group cohesion* is promoted (e.g., E12: "It creates ... a sense of community ..."), and *compassion* for each other is built up (e.g., E4: "I've noticed a change in myself because it's all about compassion"). At the same time, *trust is built* between the participants, mutual *appreciation* is promoted, and there is a general improvement in *social skills*.

Effects on pro-environmental and nature conservation behaviour

The experts' statements indicate that two pro-environmental and nature conservation behaviour are influenced by the intervention (see Fig. 29).

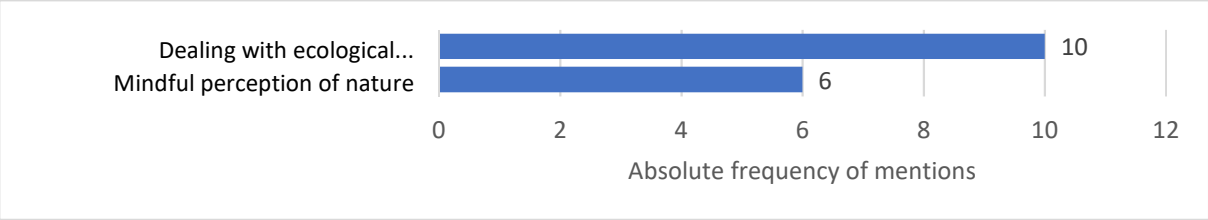


Figure 29. Effects of the intervention on pro-environmental and nature conservation behaviour in the preventive setting

The intervention initiates an intensive *examination of ecological behaviour* in the participants (e.g., E12: "Some ... started to behave differently in nature. This change in attitude was very noticeable to me. ... this encouragement to behave and move differently in nature, or this desire to engage more intensively with nature and become active. So not just 'I'll do it at some point', but 'I'll really go out and do it'."). In addition, a *mindful perception of nature* is encouraged (e.g., E11: "The participants who

were there were mostly very mindful of protecting nature. They were kind of confirmed in their attitude").

Overall effectiveness

As regards the assessment of the overall effectiveness of the intervention, four categories can be found in the experts' statements (see Fig. 30).

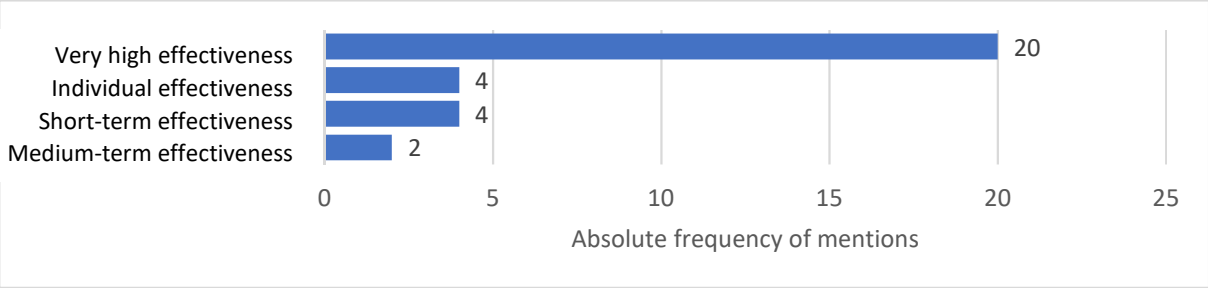


Figure 30. Assessment of the overall effectiveness of the intervention in the preventive setting

The *effectiveness* of the intervention is rated as *high* (e.g., E6: "I think that there are few interventions, if I'm talking about psychology, psychotherapy, prevention, that really have such a high effect."), a finding that is consistent with the overall quantitative assessment by the experts, the experimental findings and the subjective assessment of the participants.

In a differentiated view, *individual elements* are perceived as having different effects for different people (e.g., E14: "Although it is true that not every activity is always equally good for everyone."), but this does not diminish the overall effect of the intervention. Their effectiveness is seen both in the *short-term* effects (e.g., E6: "... the effects could be seen right at the end of the day after the intervention") and in the *medium-term* effects (e.g., E14: "... and that people also say that they definitely notice that it has an impact on their everyday lives").

Individual determinants of effectiveness

According to the experts, the participants themselves also influence whether and to what extent the intervention can be effective (see Fig. 31).

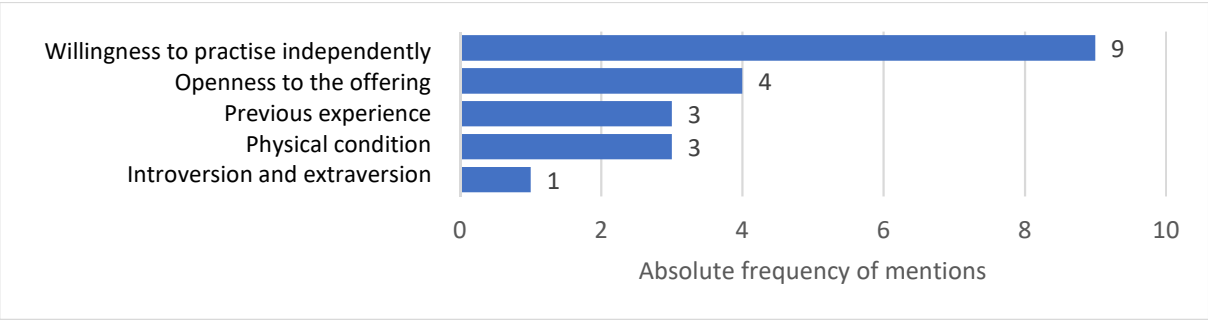


Figure 31. Determinants of intervention effectiveness on the individual level in a preventive setting

In particular, the willingness to *practise* the learned content *independently* (e.g., E4: "... people who are willing to practise daily, for example to do a short meditation every day or to really pause while

eating or walking and pay attention to their own breathing, to their own perception in the present moment, will probably benefit the most.") is considered important.

Openness for the offering (e.g., E4: "... as far as the activities are concerned, ... it is of course good if you are as open as possible to getting involved in activities.") and possible *previous experience* (e.g., E12: "Someone who already has more experience has a wider range of perception.") also influence the effectiveness of the intervention. The *physical condition* (E13: "... someone who is very overweight or has severely restricted mobility would not even register for the course.") and the degree of *introversion and extraversion* must also be taken into account.

Intervention-related determinants of effectiveness

According to the experts' statements, in addition to the individual determinants of effectiveness, factors on the intervention level should also be considered (see Fig. 32).

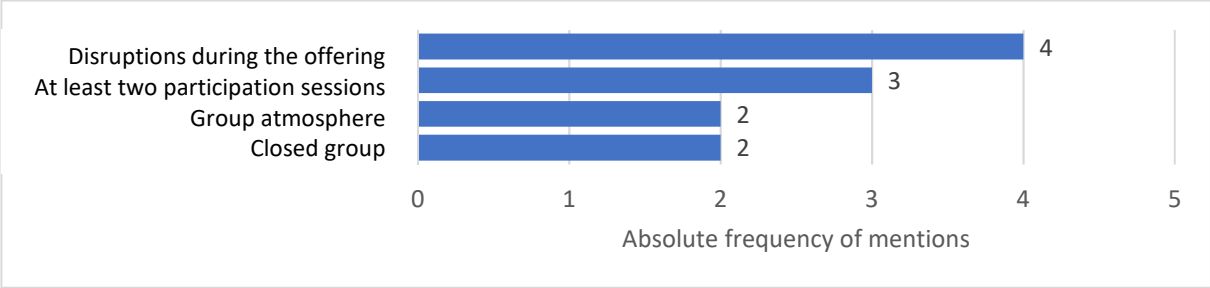


Figure 32. Determinants of intervention effectiveness on the session level in the preventive setting

This starts with possible *disturbances during the offering* (e.g., E4: "... and that was very loud and that is something that really disturbed the group. Even the participants said that it disturbed them a lot."), which might reduce effectiveness. *Attending the intervention at least twice* is considered necessary (e.g., E9: "The second time it was generally quieter").

On the group dynamic level, the *atmosphere in the group* (e.g., E9: "... that this group is also so uncomplicated and that it was so open to each other right away.") and the *cohesiveness of the group* (e.g., E9: "It is of course a closed group, which is ... very good since you are always together with the same people for these four sessions.") are experienced as important factors contributing to effectiveness.

Effectiveness of the natural environment

Finally, according to the experts, the setting of the intervention, i.e., the natural environment, influences the extent to which the intervention is effective (see Fig. 33).

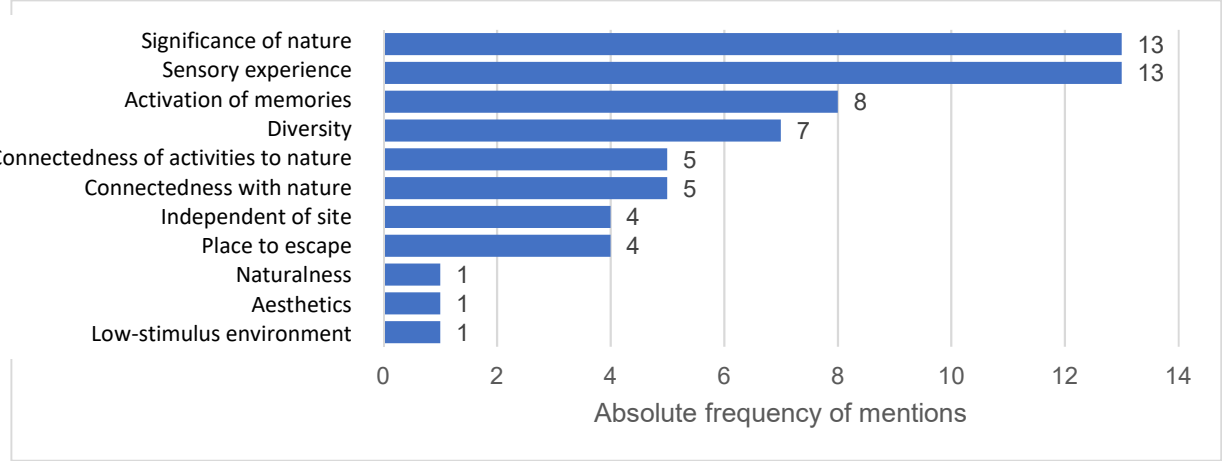


Figure 33. Determinants of the intervention effectiveness of the natural environment in the preventive setting

High importance is attached to nature as the site of intervention (e.g., E9: "I simply feel different when I am ... in a forest or on a meadow, compared to when I am in a room"). This is because a comprehensive *sensory experience* is made possible there (e.g., E4: "Just feeling rain, cold, heat, sun on your skin, consciously smelling, hearing, even touching, it would be very time-consuming if you wanted to do that indoors.") and *memories* of the past are activated (e.g., E14: "In addition, past experiences that came up during the activities are also discussed. For example, childhood memories, specific experiences in nature").

The *diversity* of nature also contributes to effectiveness (e.g., E12: "A place that shows different trees, that has both open spaces for activities and the opportunity to be very close to trees"). In addition, the *activities' connection to nature* (e.g., E6: "...if only because many activities cannot be carried out without nature.") and the *emotional connection* with nature (E2: "...this aspect that we are part of nature.") promote effectiveness.

The intervention is perceived as being feasible and effective *regardless of* site (e.g., E4: "So of course I need a space, an area, where the group can be, a meadow, a forest, a bit of variety in the landscape. But I don't think it would make any difference whether this training took place near Freilassing or in the Rhön."), as long as nature is experienced as a *place of retreat* (e.g., E12: "A place ... that creates a sense of security."), is *naturally* available in its *design*, is *aesthetically pleasing* and offers a *low-stimulus environment*.

4.3 Subgroup analyses

Subgroup analyses were also calculated for the preventive arms. The report here focuses on the primary outcomes, the two subscales of Positive and Negative affect of the PANAS. In addition, the significance level for the subgroup analyses of the preventive samples was set at p = .01 (Bonferroni correction for five subgroup analyses: 0.05/5 = 0.01).

Childhood residence

The Childhood residence variable was used as a binary variable (urban/rural) in the analyses. A significant interaction of Time*Group*Childhood residence was observed for Positive affect (F = 11.226, df = 1/115.028, p = .001). Post-hoc comparisons revealed a significant increase in Positive affect only in the "Nature-based mindfulness training" group among the group of people who had spent their childhood in a rural environment. However, this effect diminished significantly in the longitudinal analysis. For Negative affect, the effect was not significant when the significance level was adjusted (F = 4.45, df = 1/120.29, p = .037). However, the direction of the effect was similar to that for Positive affect: individuals from rural backgrounds experienced a greater decrease in Negative affect. In the longitudinal analysis, the significances exceeded the critical level of p = .01, so no significant effects can be claimed here.

Gender

In the prevention group, the Gender variable was also divided into three categories, with no individuals identifying as "diverse". There was no significant interaction with gender for the Positive and Negative affect from T1 to T2. In the longitudinal analysis, a significant interaction was observed only for Positive affect (F = 4.36, df = 3/113.17, p = .006). The analysis of the estimates for the individual measurements showed a decrease in Positive affect at the follow-up time point T3 back to baseline only for female participants.

Previous experience

Participants with previous experience did not differ significantly from participants without previous experience in the primary outcomes of Positive and Negative affect. This was observed both in the group comparison of "Nature-based mindfulness training" vs. WL and in the longitudinal analysis of the "Nature-based mindfulness training" group.

Age

Younger and older participants did not differ significantly in the effects of the intervention on Positive and Negative affect. This was true for both the group comparison of "Nature-based mindfulness training" vs. WL and in the longitudinal analysis of the "Nature-based mindfulness training" group.

Children

Participants with children did not differ from participants without children in the effectiveness of the "Nature-based mindfulness training", both in comparison to the WL group and in the longitudinal analysis of the "Nature-based mindfulness training" group.

5 Discussion of the results

5.1 Discussion of the results in relation to the research questions

The Green Care study, a mindfulness- and relaxation-based nature intervention for depressed inpatients in psychosomatic rehabilitation centres and healthy adults, aimed to compare the effects of a nature intervention (four sessions of a "Nature-based relaxation offering" in the UNESCO Biosphere Reserve Rhön or three sessions of a "Nature-based mindfulness training" in the UNESCO Biosphere Reserve Berchtesgadener Land) with standard treatment plus a Waiting List control group (TAU+WL) in the clinical setting and with a Waiting List control group (WL) in the preventive setting (three sessions of a "Nature-based mindfulness training" in the UNESCO Biosphere Reserve Berchtesgadener Land).

Clinical setting

In the clinical setting, patients were divided into two groups: a Green Care group, which received the interventions in addition to their standard treatment, and a control group, which did not receive the intervention during their inpatient stay, but were offered a short one- or two-day intervention after the second data collection before discharge. Both participating centres were located in UNESCO biosphere areas, ensuring that all patients had access to nature in the form of parks and forests. This ensured that the effects were not solely due to different levels of contact with nature.

Comparison of the groups at admission (T1) and at discharge (T2) shows that the Green Care intervention had a greater positive effect on patients' mood compared with standard treatment, with large effects in comparison to medium to large effects in the TAU+WL group. These effects were found in the primary outcomes of the study, the scales of Positive and Negative affect of the PANAS, and were independent of the study centre. Sensitivity analyses showed that these effects did not depend on the level of depression, gender, age, previous experience with nature interventions or mindfulness training, childhood residence, or whether or not the patients had children.

In terms of secondary outcomes, self-compassion showed a significant effect in the health-related variables, similar to the PANAS. Depression and mindfulness did not change significantly, but the direction of the effects was similar to the primary outcomes. With mindfulness, it was possible to identify a trend in the sense that the significance level was below $p = .010$. Importantly, contact with nature did not change significantly between groups, and there was no notable trend between groups. This suggests that contact with nature alone, without professional guidance, may not be a critical factor in the effectiveness of the intervention.

In terms of nature-related variables, a significant effect was observed in patients' connectedness to nature. Differences in nature-related mindfulness, nature conservation attitudes and behaviour were not statistically significant. This may be related to the fact that patients in an inpatient setting have limited opportunities outside of daily life to demonstrate nature conservation behaviour or to establish behavioural changes. However, the results show that connectedness to nature can be significantly improved by the intervention. Previous research suggests that connectedness to nature is a good predictor of future nature conservation attitudes and behaviour (cf. Kals & Nisbet, 2019).

Patients in the Green Care group were contacted for a follow-up assessment three months after the intervention. The low drop-out rate of 11 per cent – with 92 out of 103 people responding – demonstrates the high level of patient interest in the Green Care programme. The data show that the effects were reduced compared to discharge (T2), but remained high compared to admission (T1). Sensitivity analyses showed that patients with higher levels of depression did not show significant differences in affect from T2 to T3, suggesting that this group of patients continued to benefit from the Green Care intervention after three months. Patients with high levels of distress, as indicated by high scores on the depression scale, are often challenging in therapy and treatment. The study provides promising results that this group of patients can benefit from the programme in the long term.

Another variable that moderated the longitudinal analysis results was childhood residence (urban vs. rural). Patients who had spent their childhood in an urban environment did not show a significant increase in Negative affect three months after discharge compared with immediately after discharge.

Preventive setting

In the preventive setting, two groups were also established: the Green Care group, which received three sessions of nature-based mindfulness training, and the Waiting List control group (WL), which received no intervention initially but could participate in a nature-based intervention session after completing the questionnaires at T2. This part of the study was conducted exclusively in the UNESCO Biosphere Reserve Berchtesgadener Land. Therefore, the sample size in the preventive setting was smaller, resulting in less statistical power in the analyses. This means that existing effects are recognised as significant with lower likelihood.

The comparison between the Green Care group and the WL group at T1 and T2 shows that mood improved in the Green Care group. There was a significant difference in Negative affect compared to the WL group. The comparison of Positive affect did not yield significant results in the analysis, but there is a tendency that participants in the Green Care group benefited more than those in the WL group. The longitudinal analysis confirms these trends. Subgroup analyses show that there is indeed a significant difference in Positive affect, but only among people who grew up in an urban environment. Men also appear to benefit more from the intervention in the longitudinal analysis, as they continue to experience more Positive affect. The data suggest that the Green Care programme seems to be particularly suitable for people from urban areas in a preventive setting. The effectiveness is somewhat lower for people from rural areas, but still noticeable.

For secondary outcomes, significant effects were found, especially for nature-related variables, but not for self-compassion. For mindfulness variable, there are trends that may not have reached the point of significance due to the slightly smaller sample size. The consistent direction of the (non-significant) effects showing a greater effectiveness of the Green Care intervention relative to the WL group supports this assumption. In the case of nature-related variables, significant effects were found for nature-related mindfulness, emotional connectedness to nature, awareness of environmental threats, and internal and external attributions of responsibility, but not in the case of nature conservation attitudes and behaviour. However, no significant effect on nature conservation mindsets can be reported here as well. Environmental psychology has been able to demonstrate that emotional

attachment to nature is a central factor for engagement and behaviour in the context of nature conservation, while internal attribution of responsibility, which means accepting personal responsibility for nature conservation, can be viewed as another central predictor (cf. chapter 2).

Process evaluation

Comprehensive process evaluations are available for the sessions in both the clinical and preventive settings, including data on session conditions (environment, weather, temperature, group size, incidents) as well as participant feedback on subjective well-being and perceived effectiveness. The analysis shows that participants in all groups felt very comfortable and rated the intervention as highly effective. These ratings were high from the first session and increased as the interventions progressed. The longer a person took part in Green Care, the more they appreciated its effectiveness and their well-being. There is considerable variability in weather and temperature conditions, but the analyses show that there is no measurable relationship between these conditions and subjective ratings of effectiveness and well-being. This means that Green Care offerings are effective in a wide range of weather conditions. No differences were found in terms of the natural environment in which the interventions took place. However, it should be noted that in almost all sessions a forest was visited as a natural environment (mixed forest, beech forest, riparian forest, pine forest), so there is not enough data for a more in-depth analysis. This would require further research.

Qualitative results

The interviews in both the clinical and preventive settings provide additional, differentiated insights into the success factors of the programme. The guidelines covered a wide range of relevant topics, starting with structural characteristics, themes of effects on mental, physical and social well-being, on nature conservation aspects, as well as on the global level. Factors influencing effectiveness at the individual level, the intervention itself and the natural environment were also addressed. In terms of the global level, the interviews with the experts show a similar direction to the quantitative data, indicating high effectiveness and acceptance of the interventions. The subjective perception of the experts is largely consistent with the experimentally demonstrated results. In addition, the interviewees identified highly significant factors that are necessary for successful implementation of the interventions in both clinical and preventive settings. On the structural level, these include successful collaboration with treating professionals in the clinical setting, equipment and personnel resources, and the availability of suitable natural spaces for the intervention. On the individual level, willingness to practice independently and openness to nature were frequently mentioned. With regard to the intervention itself, it was seen that not only the group, but also above all the scope of the intervention turned out to be a significant factor. According to the experts, a more significant reduction of the offering – in the project three to four sessions were offered – is not recommended.

Regarding possible discrepancies between qualitative and quantitative findings, it should be noted that qualitative designs allow for inductive exploration and comprehensive analysis of research field, delving deep into the subject matter. Quantitative studies, by contrast, use standardised measurements to test theories and hypotheses deductively, with the aim, among other things, of explaining causal relationships. Combining these two methods, as was done in the present evaluation

research, allows the strengths of both research approaches to be combined and the weaknesses of each to be compensated for by the other. Findings from qualitative and quantitative studies that allow for different conclusions, such as the effectiveness of the intervention on nature-related mindfulness, are therefore expected in multimethod study designs and can be seen as a reason for further research.

5.2 Discussion of strengths and limitations

Strengths

The study has several strengths that are worth highlighting. While there has been some research on the effects of nature-based offerings investigated under controlled conditions, the present study took place in the real-world context of psychosomatic clinics and adult education centres. This allows a better assessment of the feasibility and effectiveness of the offering in terms of ecological validity.[1] Overall, the study demonstrated the feasibility of nature-based interventions in both clinical and preventive settings. In the clinical setting, the programmes were successfully integrated into the treatment plan. In the preventive setting, the Green Care offering received a strong positive response and attracted many participants. The study found a high level of interest in the programmes, as evidenced by the very low dropout rate in the treatment or training groups and the high participation rate in the Waiting List control groups.

The offerings, both clinical and preventive, took place in easily accessible and well-located natural settings, mostly in forest areas. This suggests that the interventions could be applied in other settings. The specific design of the interventions allows for flexibility if professional planning and guidance is provided.

The results of the summative and process evaluations, as well as the results of the interviews by experts, provide a clear picture of the effectiveness of the interventions through a multi-method approach. Participants in all groups expressed a high level of satisfaction. Interviews and experience of implementing the programmes in the clinical setting also showed a high level of interest and acceptance among clinical staff for the programme. Subgroup analyses also accounted for potential influential factors (weather, previous experience, children, etc.), which did not affect effectiveness.

A 3-month follow-up of the Green Care groups showed slight decreases in some variables, but still indicated the stability of the results, especially for highly distressed patients in the clinical setting.

Limitations

Despite all efforts to create a practical and attractive offering for participants, the study has some limitations.

Firstly, it was not a randomised trial, but a controlled trial. In the clinical arm, because all patients interacted and shared information during treatment in the clinic, individual randomisation was not possible. To control for allocation to the study arms, a propensity score was used in all analyses to

[1] Ecological validity is understood as the validity of psychological statements for the real-life context and everyday event (Bortz & Döring, 2016).

statistically adjust for differences between the groups. In addition, the prospectively registered study clearly distinguished between primary and secondary outcomes, ensuring transparency in the criteria for study success, which could not be influenced retrospectively by arbitrary selection of significant *p*-values.

Secondly, the two treatment programmes differed slightly at the sites, with a greater focus on relaxation and mindfulness and slightly different techniques used in each session. In addition, the clinical arms in both centres had to take into account the circumstances of the clinics (closed vs. open groups, four vs. three treatment sessions, weather-related restrictions). However, the analyses showed no significant differences between the centres, confirming the effectiveness of both programmes.

Thirdly, no follow-up data could be collected for the control groups. These groups were implemented after the Green Care interventions, so a follow-up study would not have been possible until after the end of the project. In addition, the Waiting List offering could only have been implemented later, after the follow-up measurement, which would not have been realistic given the long distances that many patients and participants had to travel.

Finally, for organisational, environmental and ethical reasons, it was not possible to collect additional data on clinical patients and preventive participants, such as detailed clinical differential diagnoses, health status, and experiences and personal practices outside the offering and after the training. As contact with nature decreased slightly in the Green Care groups at the time of the follow-up, it can be assumed that many participants only minimally integrated the activities into their daily lives. The application of the practical activities in daily life should receive special attention in further training, especially in the clinical context.

6 Conclusion

The study, with its comprehensive parts, showed that the interventions were very practicable and feasible in real-world settings, despite numerous challenges such as pandemic-related measures and associated restrictions:

- Good feasibility in clinical practice was confirmed. On the one hand, integration into treatment processes seemed challenging at first, as clinical routines left little room for it. On the other hand, the high level of commitment of those responsible in the clinics demonstrated acceptance and feasibility.
- The proximity of the natural environments visited in the offerings is another important point. In order to implement a successful Green Care programme in the long term, it is not absolutely necessary to undertake extensive trips that require additional planning and supervision.
- The study has shown that certain prerequisites are important for the successful implementation of the programme. Contact with nature alone does not have an effect;

rather, a professionally managed Green Care programme is essential. In the trials, participants in the Wait List control groups and the Green Care groups had similar levels of contact with nature. If contact with nature alone were effective, no group differences would have been expected. It is therefore likely that high-quality and professionally led programmes are very important for the effectiveness of the intervention.

- The individualised design of the training allows for flexibility; and the programmes were shown to be effective at both sites. However, it is always important to align the structure and focus of the training with theoretical knowledge and empirical scientific evidence.
- The experiences from the offerings, especially those of the actors at the two sites, can and should inform the development of multiplier programmes. This could be achieved, for example, by standardising the programme and training the trainers.

The “Green Care – Nature and Mental Health” study has shown that the offerings implemented are innovative and effective. From a scientific point of view, the continuation of the “Green Care | Nature and Mental Health” project is strongly recommended.

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