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Effects of nature-based intervention in the treatment of depression: A multi-center, randomized controlled trial

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ABSTRACT

This research investigated the effects of a nature-based treatment on participants diagnosed with depression. Participants ($N = 136$) were randomized into nature-based ($n = 59$) or standard care-only ($n = 77$) groups. The participants in the nature-based group were offered 12 nature-based sessions once a week in addition to standard care. The participants in the nature-based group were on average 45.0 years (range 22–64 years) and participants in the standard-care only were on average 45.4 years (range 19–64 years). The nature-based groups took place in five towns across Finland. The observed effects of the intervention on participants in the nature-based group, when compared to the participants who received standard care only, included a greater decrease in psychological distress ($p < .05$) and an increase in restorative experiences ($p < .01$) as well as in the self-reported ability to work/study but only at post-measurement ($p < .05$). Nature sessions produced restorative experiences that mediated the decrease in depression. The depression scores of participants in both groups reduced significantly and no differences were observed between the groups. Thus, nature-based intervention can be a safe and beneficial form of short-term group treatment for depression in addition to standard care.

1. Introduction

Depression is a considerable burden to societies across the world. This can be seen in Finland, where mental health problems have been the leading cause of work disability retirement since 2019, with depression being the most prevalent issue (Finnish Centre for Pensions, 2020). Public health services are over-stretched and under-resourced, causing a need to develop new treatment models that ease symptoms and maintain balanced mental health independently. In our research, we investigated nature-based group treatment among participants diagnosed with depression. Our research was built on the growing research evidence pertaining to the well-being effects of nature (Bratman et al., 2019; Hartig et al., 2014; McMahan & Estes, 2015; Twohig-Bennett & Jones, 2018). Despite this research evidence, the well-being effects of nature are rarely intentionally incorporated in the treatment of depression among mental health professionals. Although there is evidence that nature-based interventions are related to a reduction in depression symptoms (Korpela et al., 2016; Kim et al., 2009; Lee et al., 2017; see also meta-analysis by Coventry et al., 2021), randomized controlled trials are rare in this field.

Our study addresses this research gap in the literature by utilizing a multi-center randomized controlled trial in which participants in the group involving nature-based treatment and treatment-as-usual (TAU) were compared to those participants who only received TAU. The results of our study can be applied to health care and used for care guidelines. The results can also be meaningful in developing the psychological understanding of depressive symptoms, and especially the role of nature-based therapeutic activities and the experience of restoration in alleviating symptoms.

1.1. Nature experiences and their well-being effects

Experimental studies with non-diagnosed groups have shown that restorative experiences – calmness, recovery of attentional capacities, physiological relaxation (Jiang et al., 2014; Ulrich et al., 1991), as well as increase in positive affect and a decrease in negative affect (Bowler

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et al., 2010) – are related to well-being (Africa et al., 2014; Hartig et al., 2014; Mygind et al., 2019). These restorative outcomes correspond to the outcomes presented in Attention Restoration Theory (ART; Kaplan & Kaplan, 1989) and Stress Recovery Theory (SRT; Ulrich et al., 1991), which are also the theoretical underpinnings of this research. According to ART (e.g., Kaplan & Kaplan, 1989), directed attention is a limited resource and is vulnerable to fatigue. If directed attention is fatigued, the attentional restoration is suggested to be supported by certain environments that have restorative qualities. In line with ART, restoration is more likely to happen when an individual becomes fascinated, and their attention is effortlessly drawn to an interesting element in the environment. Thus, the directed attention can replenish and the individual experiences attentional restoration. In addition to fascination, there are three other central elements in nature that contribute to attentional restoration: having the sense of being away, the extent to which the environment allows one to engage, and compatibility between oneself and the environment.

The physiological and affective changes observed in natural environments are explained by SRT (Ulrich et al., 1991). Natural environments impact stress recovery on several levels that can play a key role in well-being. Natural environments promote positive changes in affect and emotions (Bowler et al., 2010; McMahan & Estes, 2015). That is, natural environmental factors can facilitate stress recovery through autonomic nervous system changes that increase relaxation (Gladwell et al., 2012) and positive mood (e.g., Bowler et al., 2010).

Natural settings can also have an effect on the experience of the self (e.g., self-regulation, connectedness to nature, and self-acceptance) (Sahlin et al., 2015; Salonen et al., 2022). For instance, finding the natural environment to be suitable to oneself, and thus enhancing emotional and self-regulation, can be more relevant to psychological well-being than experiences of fascination and attention restoration (Korpela, 2012). Environmental self-regulation theory holds that by visiting a favorite place in nature an individual can regulate emotions and self-experience by easing negative experiences and processing experiences that threaten one's self-image, for example (Korpela, 2012). Negative emotions change to more positive ones, such as relaxation, enjoyment, and feeling invigorated in natural settings and in favorite places in particular (Berman et al., 2012; Korpela, 2012).

1.2. The effects of nature-based interventions on depression

Clinical depression is a psychiatric syndrome that is described by ten symptoms: low mood, a loss of interest or pleasure, fatigue, a decrease in self-confidence or having feelings of worthlessness, excessive feelings of guilt and self-blame, thoughts about suicide or self-harm, self-harming behavior, decreased concentration, either slowed or agitated movement, sleep disturbances, and changes in appetite or weight (ICD-10 diagnostic system; Finnish Current Care Guidelines, 2016[1]). To fulfill the criteria for the diagnosis, a person needs to have at least two of the first three symptoms and a total of four or more of these symptoms. The acute treatment of mild and moderate depression involves antidepressants or psychotherapies, and their combination is recommended in the Finnish Current Care Guidelines.

A recent meta-analysis has indicated that nature-based interventions were associated with a large and positive effect in terms of reductions in symptoms of depressive mood in randomized controlled trials (RCTs) including adults with or without mental and/or physical health problems (Coventry et al., 2021). Existing research also reports positive effects of rural walks on mood and an increase in the sense of enjoyment or control over personally important life tasks among people with or without mental health diagnoses (Roe & Aspinall, 2011). In this study, greater benefits of rural walks were observed especially among participants with poor mental health. However, RCT studies focusing on participants with clinical depression are still very scarce (Grassini, 2022).

A comparison of the effect of Cognitive Behavior Therapy on clinical depression applied in different settings in an arboretum, inside a hospital room, and in a control group receiving usual outpatient management in a 12-hour, 4-week program showed that the number of participants experiencing an alleviation of depressive symptoms was largest in the arboretum group (Kim et al., 2009). In a series of single-group studies on a 12-week therapeutic horticulture program with clinically depressed adults, a significant change for the better was found in symptoms of depression, anxiety, and stress, while positive affect also increased during the intervention (Gonzalez et al., 2009, 2010, 2011).

In another study, participants with a primary diagnosis of exhaustion syndrome or depression were treated with a 12-week nature-assisted rehabilitation program including gardening activities, relaxation exercises, and psychotherapeutic activities carried out mostly outdoors in a specially designed rehabilitation garden (Währborg et al., 2014). A significant reduction in the number of healthcare contacts, especially for primary healthcare and psychiatric care (inpatient days), was found one year after the start of the program when compared to the population-based, matched reference group.

Further research is also needed on the psychological mechanisms through which nature contact affects the well-being of people with depressive symptoms (Van den Bosch & Meyer-Lindenberg, 2019). A 12-study meta-analysis of nature walks indicated that nature walks were effective at reducing state anxiety but not generalized anxiety, and the effects concerning depression were inconsistent (Kotera et al., 2021). In depression studies, for example, individuals diagnosed with major depressive disorder were primed to ruminate prior to taking a 50-min walk in either a natural or urban setting at one-week intervals (Berman et al., 2012). Significant increases in working memory span and positive mood were perceived after the nature walk compared to the urban walk. Participants with more (rather than fewer) depressive symptoms showed no positive mood changes but a reduction in negative affect and stress after viewing videos of natural rather than constructed settings (Meuwese et al., 2021). A study with a normative student population confirmed that rumination mediates the association between nature contact and negative affect (Bratman et al., 2021). In a study including nature visits in the context of the Coping with Depression framework, restorative experiences mediated the increase in positive mental well-being from baseline to follow-up (Korpela et al., 2016). Positive mental well-being at the end of the intervention, in turn, mediated the decrease in depression.

1.3. Nature-based treatment in the present study

In addition to the aforementioned theories, the different dimensions of nature experiences outlined in the concept of Comprehensive Nature Experience (Salonen et al., 2020, 2022) were taken into account when developing and implementing the nature-based intervention called *Flow with Nature* (FWN) *treatment* (see Salonen et al., 2022). The concept of comprehensive nature experience includes negative and positive nature-related emotions, self-experiences and environmental characteristics of nature. FWN treatment is informed by psychotherapy research (e.g., group cohesion, empathy, feedback; Norcross & Wampold, 2018), the transtheoretical model of behavior change (Prochaska et al., 2020), and theories of cognitive behavioral therapy (e.g., Hayes et al., 2012) and creative arts therapies (e.g., Zubala & Karkou, 2018).

In FWN treatment, the awareness of the role of nature in psychological self-regulation, well-being and psychological processing has been emphasized in addition to social support (e.g., Korpela et al., 2016; Salonen et al., 2022). Therefore, the aim of FWN treatment is not only to expose participants to nature environments but also to encourage multisensory experiencing and connecting with favorite places and

[1] Finnish Current Care Guidelines, 2016: https://www.kaypahoito.fi/hoi50023.

symbolic nature elements to support psychological processing and self-regulation.

An accessible nature environment within walking distance is more likely to be used (Neuvonen et al., 2007) and therefore, in FWN treatment, we utilized nature environments near the health and rehabilitation centers. During COVID-19 restrictions, when face-to-face meetings were not possible, participants were encouraged to use nature environments near their home, workplace or holiday cottage. The FWN treatment approach was based on a previous five-week intervention (Salonen et al., 2020) that focused on promoting occupational well-being. In that previous research, the participants' positive emotions increased and negative emotions reduced during each group meeting.

1.4. Research questions

We utilized a multi-center study design to investigate the effects of nature-based treatment on depression symptoms among participants who were diagnosed with clinical depression. We compared individuals who received the nature-based treatment with those who received only treatment-as-usual (TAU-only). Participants in the nature-based treatment also continued with their usual treatment. We used a randomized controlled trial approach to study the effectiveness of the nature-based intervention period (12 weeks) on depression symptoms. We included a three-month follow-up measurement in our design to obtain information about the longitudinal effects of the intervention. To learn more about the underlying mechanisms, we investigated the experiences of restoration after each nature sessions. Our research questions were as follows.

1. Is the change in depression (Beck Depression Inventory-I; BDI-I), psychological distress (Clinical Outcomes in Routine Evaluation; CORE-10), restorative experiences (Restoration Outcome Scale; ROS), and self-reported ability to work or study (adopted from the Work Ability Index; WAI) different among participants in the nature-based treatment with standard care (nature-based + TAU) compared with those participants who receive standard care only (the control group; TAU-only)?
2. Do restorative experiences (ROS) enabled by nature and social contact during the group sessions mediate the change in depression symptoms (BDI-I)?

Previous research has shown that nature-based treatments alleviate symptoms of depression and other psychological symptoms (e.g., review by Annerstedt & Währborg, 2011). Based on those findings, we expected that the reduction in depression and other psychological symptoms among participants in the nature-based treatment group would be significantly greater than the change in the control group (H1). We also hypothesized that restorative experiences from the nature sessions will mediate the decrease in depression and other psychological symptoms (H2).

2. Methods

2.1. Recruitment procedure

The present research was funded by the Finnish Social Insurance Institution. The participants were randomly allocated to parallel groups: either to an *FWN* treatment group (nature-based group + TAU) or the control group (TAU-only). Those in the treatment group participated in the nature-based group between spring 2019 and spring 2020. The group sessions took place in five towns across the Pirkanmaa, Häme, and Central Finland regions. In addition, the participants in the control group also had the opportunity to attend nature-based treatment *after* their follow-up period in the same towns. Fig. 1 shows the progression of the participants through the trials.

Participants were recruited through public and private health services, which included outpatient clinics, student health services, occupational health services and psychiatrists in private health clinics. The possibility to participate in the research and nature-based treatment was also advertised in local newspapers and through social media. Those interested in taking part in the study contacted the researchers by phone or e-mail to book a time for a screening interview conducted over the phone between 2019 and spring 2020.

The aim of the screening interview was to consider applicants according to the inclusion criteria of the study. First, each participant needed to have a diagnosis of depression (ICD –diagnostic system), a BDI-I score 10 or above (cutoff score for mild depression), and a treatment contact in a health care service. Second, the researchers checked whether participants were of working age (18–65 years old), motivated to commit to a 12-session treatment group meeting in nearby nature environments, and able to communicate adequately in Finnish in order to participate. The exclusion criteria were: 1) active suicide ideation, 2) psychotic symptoms, and 3) substance misuse at a critical level (audit questionnaire scores above 10). Also, people who had pain-related problems that restricted daily life and moving independently in a nature environment were not admitted to the study. Participants who were pregnant were excluded from the study since they would not be able to participate throughout the study period. Some participants also had other mental health diagnoses in addition to a diagnosis of depression. However, participants were admitted onto the study only if their primary diagnosis was depression.

Participants were given an information leaflet regarding participation in the study and were asked to sign a consent form. The potential advantages, disadvantages, and unintended effects were outlined in the information leaflet given to the participants. The participants were informed that it was possible that they would not benefit from the treatment. The participants were also told that the nature-based methods are safe, participation does not require physically demanding exercises, and the groups were facilitated by experienced health professionals. The disadvantages of participation for the participants included the time required for responding to the surveys and that they were attending the group on their own time. The unintended effects of participation could relate to the process of working through difficult feelings or experiences in treatment. The participants were encouraged to discuss their experiences in the group or if they were uncertain about continuing in the group with the therapist, researchers, or their doctor. Tampere University Hospital Ethics Committee has affirmed the present research with a favorable statement (R18162). The research is registered and posted on the ClinicalTrials.gov public website (NCT04897685).

The researchers contacted the suitable participants to inform them once they were randomly selected to either the treatment group or the control group. Eleven of the participants in the treatment group dropped out during the treatment period for reasons such as changes in life circumstances since the screening interview, or the meeting times of the group not being suitable. There were no dropouts in the control group. In the first stage, our study focused on 136 participants who were randomly allocated to either the treatment group ($n = 59$) or the control group ($n = 77$).

The nature-based treatment was offered to the participants of the control group after the three-month follow-up period. Of the control group participants, 29 attended the nature-based treatment. In the second stage, our analyses included these 29 participants and participants who had already completed the treatment in the first stage ($n = 59$). That is, the total number participating in the nature-based intervention was 88 at pre, 79 at post, and 77 at follow-up. Of these participants, 64% participated in in-person group meetings, whereas 36% participated online or in hybrid meetings during the COVID-19 restrictions in 2020.

At baseline, before the nature-based intervention commenced, 99% of the participants ($n = 134$) responded to an electronic survey. The post-treatment measurement was conducted immediately after the intervention and the response rate was 92% (125 participants). The follow-up measurement was conducted three months after the

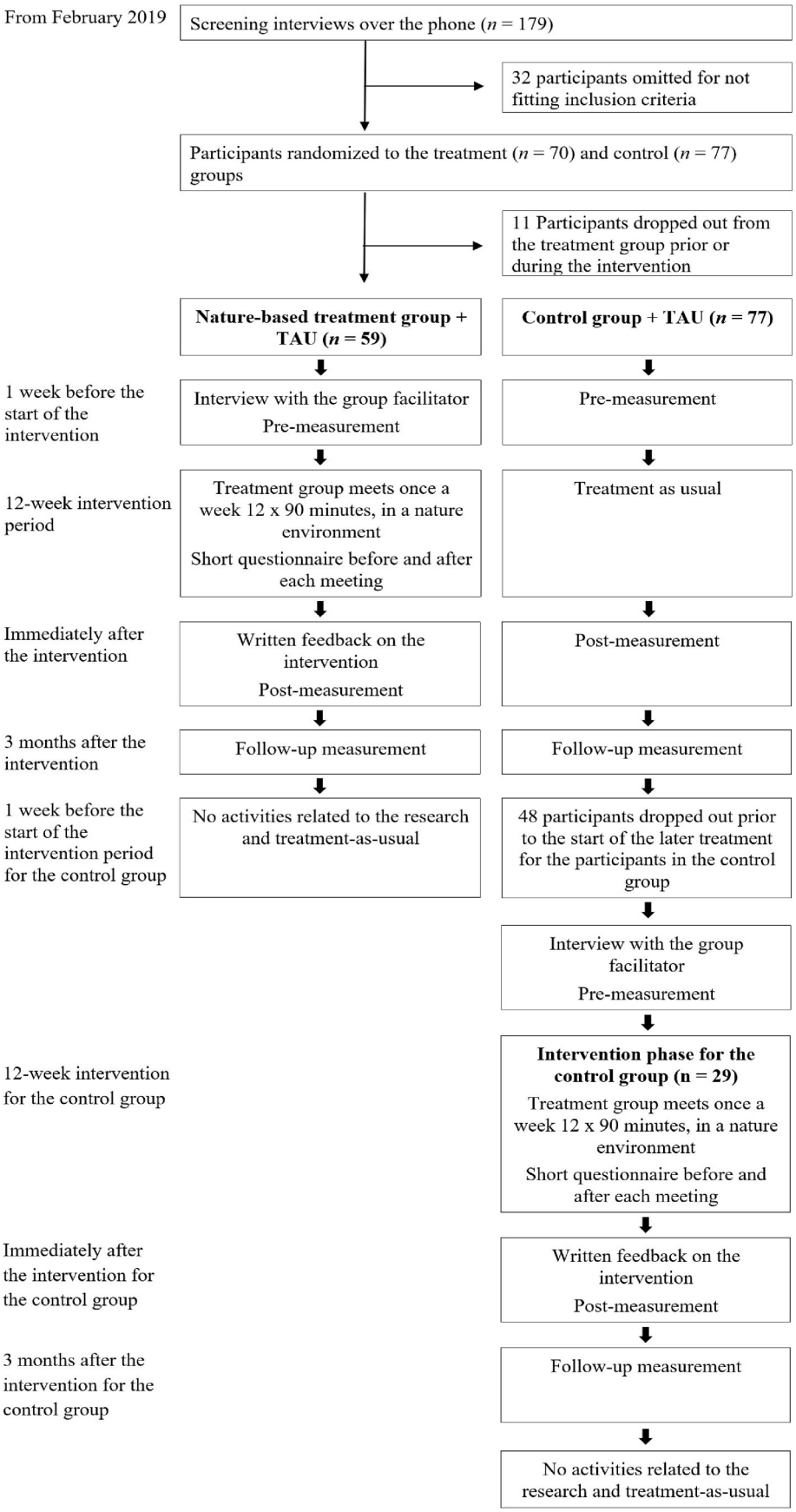

Fig. 1. *The Progression of Participants Through the Trials and Measurements.*

intervention and the response rate was 82% (111 participants). In addition to pre, post, and follow-up measurements, the participants responded to a short questionnaire about their experiences (restorative experiences, psychological symptoms, and group therapy alliance) before and after each group meeting. Before the COVID-19 pandemic restrictions, the participants responded using printed questionnaires during the meetings. From March 2020, participants responded to such questions electronically[2]. All participants continued their "treatment as usual" (TAU) during the research.

The demographic information of the participants and other treatment they received during the research is shown in Table 1. The participants in the treatment and control groups were compared in terms of demographical characteristics in order to test whether there were significant differences between the groups at the pre-treatment measurement time. No differences were observed between these two types of groups. There were no differences between participants in the treatment and control group in other treatment that they received in the beginning of the study. About 40% of participants attended one-on-one counselling or therapy sessions every one to two weeks and nearly 30% of participants reported attending every three to four weeks. Almost the same percentage of participants attended one-on-one counselling or therapy sessions every five weeks or less often. It is possible that the participants had treatment contacts in different services (e.g., specialized mental health service, student health services, or a rehabilitation center). In addition, less than 10% of participants attended other treatment groups. There were also no differences between participants in the treatment and control groups in the frequency of one-on-one counselling or therapy sessions that they reported at post-measurement. The other treatment groups that participants reported typically consisted of group meetings from 60 min to 120 min once a week with between five and 11 other group members.

Table 1
Demographic description of the participants in the study.

	Treatment	Control	Total	χ^2-statistic
	$n = 59$	$n = 75$	$N = 134$	
Gender (%)				1.48, ns
Female/Male/Other	79.7/18.6/1.7	84.0/16.0/0.0	82.1/17.2/0.7	
Age in years				−0.23[1], ns
Average	45.0	45.4	45.2	
Min.	22	19	19	
Max.	64	64	64	
Education (%)				2.76, ns
Primary school	0.0	1.3	0.7	
Secondary education	33.9	33.3	33.6	
Vocational school	18.6	17.3	17.9	
Lower university degree	32.2	25.3	28.4	
Higher university degree	11.9	20.0	16.4	
Other (e.g., other training or courses)	3.4	2.7	3.0	
Employment situation (%)				8.85, ns
Full-time employment	25.4	22.7	23.9	
Part-time employment	10.2	10.7	10.4	
Laid-off	0.0	1.3	0.7	
Unemployed	6.8	14.7	11.2	
Disability pension	8.5	13.3	11.2	
Studying	1.7	8.0	5.2	
Other (e.g., work placement, carer)	47.5	29.3	37.3	
Antidepressant medication (%)				0.92, ns
Yes/No	62.7/37.3	72.0/28.0	67.9/32.1	
Other treatment (TAU; %)				0.72, ns
Individual sessions every 1–2 weeks	38.8	40.6	39.8	
Individual sessions every 3–4 weeks	28.6	28.1	28.3	
Individual sessions every 5 weeks or less	28.6	25.0	26.5	
Weekly treatment group	8.2	4.7	6.2	
Self-initiated hobbies and leisure groups	18.4	20.3	19.5	
Previous depression episodes (%)				0.73, ns
Yes/No	84.7/15.3	77.3/22.7	80.6/19.4	

Note. Age was tested with *t*-statistic.

In the attrition analyses, the responses of those who participated in the study ($N = 136$) were compared to those of individuals who dropped out before or during the intervention ($n = 11$). No differences were found between study participants and dropouts regarding age, previous depression episodes, or depression symptoms. However, the respondents who dropped out were less likely to have used antidepressant medication than study participants, χ^2 (1) = 4.48, $p = .03$. Their mean depression scores were also four points lower on the BDI-I. Although this difference did not reach statistical significance, it is possible that some of the participants dropped out due to less perceived need for engaging in a treatment group.

2.2. Nature-based treatment group: Flow with nature

The *Flow with Nature* treatment (FWN; Salonen et al., 2022) included 12 sessions lasting 90 min each. The treatment groups met once a week in nearby nature areas, such as parks, urban and rural forests, and water areas. The locations were decided on together in the group. The groups took place in different seasons and weather conditions, except during dangerous storms or the coldest winter months of January and February, when no groups took place. During spring 2020 when the COVID-19 pandemic started and restrictions were put in place, the meetings were also conducted as online or hybrid meetings. Some group meetings were online only (during restrictions in spring 2020) and once group meetings were allowed (after May 2020), some group meetings were in-person or conducted as hybrid meetings, in which some members met together and some participants joined the group online. During online and hybrid meetings, those participants who joined the group meeting via video call chose their own favorite place in nearby nature and shared their experiences and received support via video call to the whole group. The number of participants in each group varied between three and 10. There was a total of 16 groups (including the treatment groups for control group participants) in different cities across Finland. The groups were facilitated by eight licensed healthcare professionals (e.g., psychologist, occupational health nurse) who attended the 12-day intervention training and were provided supervision during the intervention period.

There were key principles that were taken into consideration in each group meeting. The aims of the group meetings was to offer regular social support, as well as psychological and physical safety. This included respect for other groups members as well as toward nature. The FWN exercises are considered flexible, so that the exercises done in the nature can be adjusted according to the participants' needs. The exercises of the treatment group encourage participants to sense nature environment with many senses and therefore direct the attention to nature and to recognize its well-being effects. The aim of the group is also to strengthen participants' connection to nature so that they can feel interconnected with the surrounding natural environment. In addition, symbolism is a key element of the exercises done in the group which

[2] Digitalization of the Group Session Rating Scale (GSRS) was given by special permission from the developer. Only licensed vendors may digitize the Measures. The Performance Metrics licensing agreement strictly forbids it. Information about authorized, evidence-based systems for administering, aggregating, and interpreting can be found here: https://www.scottdmiller.com/fit-software-tools/.

encourage the participants to identify nature elements that reflect and symbolize their experiences. In this way, the surrounding nature environment can support the participants to find words to describe, reflect on, and share these experiences with others. The details of the intervention structure and methods as well as the experiences of the participants have been reported in a study by Salonen et al. (2022).

2.3. Measures

The following measures were investigated at the beginning (pre) and end (post) of the 12-week treatment period and for the three-month follow-up (follow-up).

The *Beck Depression Inventory* (BDI-I; e.g., Beck et al., 1988) measures depressive symptoms with 21 items and is frequently used in clinical assessment. Each item is scored from 0 to 3 and sum scores are calculated on the basis of participant responses. The total sum score can range from 0 to 63. A score from 0 to 9 indicates no or very few depressive symptoms, from 10 to 18 indicates mild depression, from 19 to 29 moderate depression, and from 30 to 63 severe depression. The Cronbach alphas for the BDI-I were 0.89 at pre, 0.92 at post, and 0.93 at follow-up.

CORE-10 is based on the original 34-item Clinical Outcomes in Routine Evaluation – Outcome Measure (CORE-OM; Evans et al., 2002), which measures participants' mood and distress. CORE-OM and CORE-10 are also highly correlated and the shorter CORE-10 measure has good psychometric properties (Connell & Barkham, 2007). The CORE-10, which was administered at the three measurement times (pre, post and follow-up measurements), comprises 10 items and four dimensions, namely well-being, problems, life functioning, and risk of aggressive/suicidal behavior. The items are scored from 0 to 4 and are summed so that the total score ranges from 0 to 40. The higher the score, the more severe the respondent's symptoms. The Cronbach alphas for CORE-10 were 0.83 at pre, 0.86 at post, and 0.86 at follow-up.

Restorative experiences in the moment were measured using six items from the Restorative Outcome Scale (ROS; Korpela et al., 2016). Three items describe relaxation and calmness (e.g., "I am calm"), one item reflects attention restoration ("I am focused and alert"), two items reflect clearing one's thoughts (e.g., "I am able to forget everyday worries"). Responses were given on a seven-point scale from 1 = *not at all* to 7 = *completely*. A higher score in ROS indicated higher restoration. The Cronbach alphas for the ROS were 0.86 at pre, 0.92 at post, and 0.92 at follow-up.

Self-reported ability to work or study was measured with one question: "Assume that your work/study ability at its best has a value of 10 points. How many points would you give your current work/study ability?" The question has been modified from the Work Ability Index (WAI; Rautio & Michelsen, 2014), in which the participant is asked to make a subjective evaluation of their current work ability compared to lifetime best, where a value of 0 means that you currently cannot work at all and a value of 10 refers to work ability at its best.

The following scales was administered after each group meeting: Restorative experiences (ROS), brief test version measuring psychological distress (CORE-5), and Group Session Rating Scale (GSRS). The same measure for restorative experiences (ROS) was used after each group meeting as in the pre, post, and follow-up measurements (see above).

CORE-5 is also based on the original 34-item Clinical Outcomes in Routine Evaluation – Outcome Measure (CORE-OM; Evans et al., 2002). CORE-5 comprises five items and can be used to measure symptoms at each session (Barkham et al., 2015). In our research, CORE-5 was administered after each session. The items are scored from 0 to 4 and are summed. The CORE-5 sum score is multiplied by two so that the total score ranges from 0 to 40. The higher the score, the more severe the respondent's symptoms.

Group Session Rating Scale (GSRS; Duncan & Miller, 2007) was used to measure group therapy alliance with four items after each group meeting. The measure has been shown to be a reliable and valid measure for group therapy (Quirk et al., 2012). The items include participants ratings on relationships, goals and topics, approach or method and their overall group experience which were rated on a scale from 0 to 10. The exact wordings of the bipolar axis of the continuum used for these items are presented by Duncan and Miller (2007). The items are summed and the total score can range between 0 and 40, where a higher score indicates better group therapy alliance. The means of the Cronbach alphas for the sum scores of the session-wise measures (CORE-5; ROS; GSRS) are presented in Table 3.

2.4. Statistical analyses

Data analyses were performed in RStudio using R 4.0.4. Differences in demographic variables between the treatment group and the control group were tested with $\chi 2$-tests for the categorical variables and *t*-test for age. Two control group participants were not included in these tests as all background information was missing from them. The main analysis was conducted by linear mixed-effects modelling using the nlme library in R. The participants that did not complete the intervention were not included in the analysis (n = 11). Models were constructed with depression (BDI), psychological symptoms (CORE-10), restorative experiences (ROS), and work/study ability measures as dependent variables, with group type (treatment, control), time (pre, post, follow-up) and medication (use of antidepressants; yes/no) as predictors. Medication was included because it had significant correlations with the dependent measures. The significance of the interaction between group and time was tested with an *F*-test, as well as the significance of time separately for each group. The effect of medication was tested for significance in each group at each measurement time. Between-group difference was also estimated and tested for significance at each measurement time. Effect sizes were estimated using Cohen's *d* statistic, calculated by dividing the difference in means by the pooled standard deviation. At post and follow-up, the effect sizes were corrected by adjusting for the difference at pre. A between-group effect size of 0.2 was considered small, 0.5 medium, and 0.8 large.

Reliable Change Index (RCI) of the BDI scores was used to examine the effectiveness of the intervention (Jacobson & Truax, 1991). The RCI scores were computed by dividing the change in BDI by the pre-treatment standard error adjusted to the reliability of the measurement 0.92. The mean of the BDI at pre-measurement in the data (clinical population) was 24.12 and standard deviation 9.80. For the normative population, mean 7.22 and standard deviation 6.33 were used (Seggar et al., 2002). A BDI cutoff point 13.85 between normative and clinical populations was computed. RCI classifies participants into four categories based on the change in symptoms during the intervention period: recovered, improved, unchanged, and deteriorated. Participants with an RCI below −1.96 that passed through the cutoff were classified as *recovered*. If the RCI was below −1.96 but the participant's BDI did not pass through the cutoff, the participant was classified as *improved*. If the RCI was between −1.96 and 1.96, the participant was classified as *unchanged*. Participants with an RCI over 1.96 were classified as *deteriorated*. Due to small class sizes, the participants were further classified into two categories to test for the difference in demographic background variables between recovered/improved participants and unchanged/-deteriorated participants.

Mediation analysis was performed using Andrew Hayes' Process macro for R (Hayes, 2017) to find variables that mediate the change in BDI. At this stage, the analysis included the participants of the original

treatment group as well as the participants from the original control group that received the treatment later. The participants who quit the intervention or for whom no BDI data existed were not included, leaving a total sample size of $n = 79$. The considered mediators were the sums of the ROS and GSRS from all 12 sessions, as well as the sum of changes in the CORE-5 scores during treatment sessions as measured before and after each session. In cases where a participant did not attend all sessions, the sums were computed from those sessions that the participant did attend.

In the mediation analyses, the independent variable (BDI) was measured at baseline (TI), mediator variables (ROS and CORE-5) during the intervention, and a dependent variable at the end of the intervention (T2) and after the three-month follow-up (T3). Thus, mediator variables were measured temporally, separately from independent and dependent variables, providing optimal conditions for causal interpretations (Hayes, 2017). By bootstrapping the sampling distribution of the indirect effects (e.g., BDI_{T1} on BDI_{T3}), resamples of the original sample were taken 5000 times repeatedly. Bias-corrected 95% confidence intervals for the indirect effects were derived (when the interval does not include the value of zero, the test statistic is significantly different from zero) (Hayes, 2017).

Prior to the start of the research, we calculated that we needed 64 participants in both the intervention and control group (128 participants in total) to reach 0.25 effect size with one-way analysis of variance (ANOVA) (alpha = .05; power = 0.80; Faul et al., 2007). In repeated measures ANOVA, in which interaction effects are investigated between two groups and changes in depression with three measurement points, we would get the same effect size if 14 participants would participate in both the intervention and control group (alpha = .05; power = 0.80) and the correlation between the measurements would be 0.50.

3. Results

3.1. Levels and changes in symptoms, restoration experiences and work/study ability across the measurements times

Over the three measurement times, we observed a significant decrease in depression (BDI-I) in the treatment and control groups, as seen in Table 2. The magnitude of the change from pre-measurement to the follow-up measurement was larger in the treatment group (5.36 points) than in the control group (2.30 points). However, H1 was not supported since the interaction effect between *group* and *time* was non-significant overall and at each measurement point. Interestingly, among participants in the treatment group, medication showed an interaction effect: the participants taking antidepressant medication had significantly higher depression at post and follow-up (5.85 points and 4.99 points higher, respectively) than the participants who were not on antidepressant medication.

In addition, psychological distress (CORE-10) reduced, and restorative experiences (ROS) and work/study ability increased during the measurement period among the participants in the treatment group, whereas the measurement time showed no significant main effect for these outcome measures among the participants in the control group. The overall reduction of distress and increase in restorative experiences were stronger in the treatment group than in the control group. However, the pairwise differences in change in distress and restorative

Table 2
Means and Standard Deviations of Outcome Measures in the Treatment and Control Groups: F-values, Including Estimates and Corrected Between-Group Effect Sizes. Treatment group n = 59, control group n = 77, overall N = 136.

Measurement	Pre	Post	Follow-up	*F*-Test Time	*F*-Test Group*Time
BDI[a]					2.62, ns
1. Treatment group	24.56 (10.66)	20.89 (11.13)	19.20 (12.04)	14.27***	
Medication effect	3.30, ns	5.85**	4.99*		
2. Control group	23.78 (9.13)	21.86 (10.13)	21.48 (10.33)	4.23*	
Medication effect	0.18, ns	1.32, ns	1.53, ns		
Group*Time effect	−0.67, ns	−2.16[e], ns	−0.62[f], ns		
Between-group ES	.08	.16[e]	.28[g]		
CORE-10[b]					3.93*
1. Treatment group	19.41 (6.77)	15.98 (7.31)	15.16 (7.16)	11.07***	
Medication effect	1.20, ns	2.46, ns	2.39, ns		
2. Control group	18.56 (6.71)	18.10 (6.90)	17.32 (7.67)	1.27, ns	
Medication effect	−2.31, ns	−2.58, ns	−0.73, ns		
Group*Time effect	−1.71, ns	−3.59[e], ns	1.52[f], ns		
Between-group ES	0.13	0.42[e]	0.40[g]		
ROS[c]					7.06**
1. Treatment group	3.30 (1.00)	4.01 (1.12)	4.13 (1.27)	19.08***	
Medication effect	−0.47, ns	−0.54, ns	−0.40, ns		
2. Control group	3.24 (1.02)	3.52 (1.00)	3.56 (1.04)	0.77, ns	
Medication effect	0.22, ns	−0.29, ns	−0.49*		
Group*Time effect	0.31, ns	0.31[e], ns	−0.14[f], ns		
Between-group ES	0.07	0.40[e]	0.43[g]		
Work/study ability[d]					2.45, ns
1. Treatment group	5.20 (2.53)	5.76 (2.45)	5.92 (2.76)	4.58*	
Medication effect	−0.01, ns	−1.01, ns	−0.67, ns		
2. Control group	5.41 (2.75)	5.33 (2.74)	5.63 (2.66)	0.78, ns	
Medication effect	0.34, ns	0.68, ns	0.36, ns		
Group*Time effect	0.06, ns	1.63*[e]	−0.70[f], ns		
Between-group ES	0.08	0.25[e]	0.18[g]		

Note.
*$p < .05$; **$p < .01$; ***$p < .001$.
[a] A lower score on BDI indicates fewer depression symptoms.
[b] A lower score on CORE-10 indicates less psychological distress.
[c] A higher score on ROS indicates higher restoration.
[d] A higher score on work/study ability indicates better self-rated ability to work or study.
[e] The difference in change from pre to post.
[f] The difference in change from post to follow-up.
[g] The difference in change from pre to follow-up.

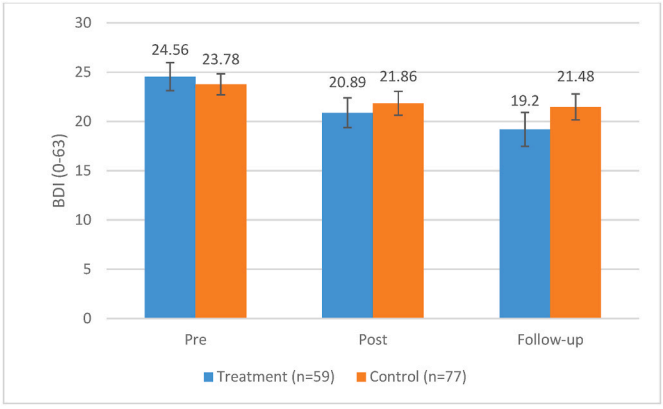

Fig. 2. Means and Error Bars in BDI-I in the Treatment and Control Groups between Pre- and Follow-up Measurements.

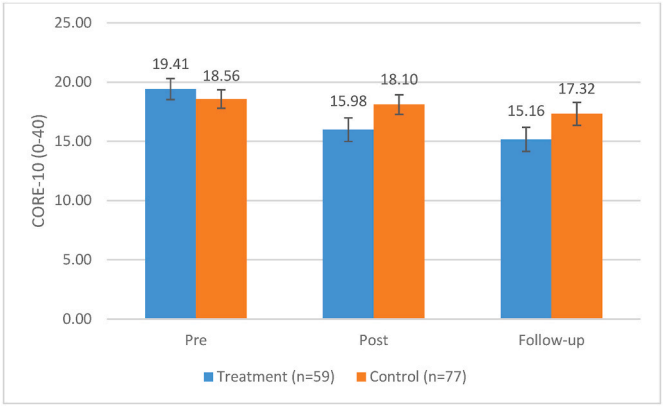

Fig. 3. Means and Error Bars in CORE-10 in the Treatment and Control Groups between Pre- and Follow-up Measurements.

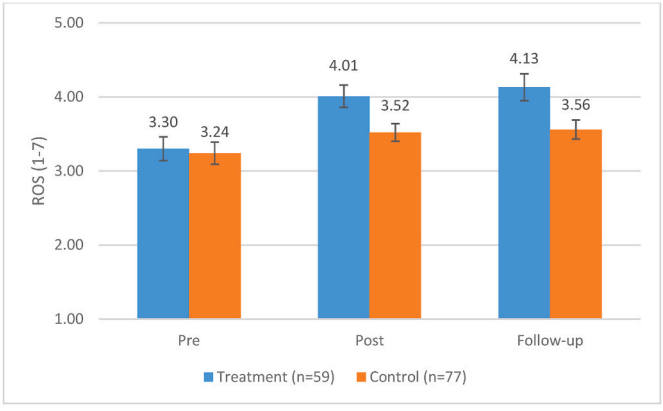

Fig. 4. Means and Error Bars in ROS in the Treatment and Control Groups between Pre- and Follow-up Measurements.

experiences from pre to post and from post to follow-up were not significant. For work/study ability, the overall interaction was non-significant, but a significant pairwise *group* and *time* interaction effect was observed at post, showing that work/study ability was better in the treatment group than in the control group. The means and error bars of each outcome measure in the treatment and control groups are presented in Figs. 2–5. The confidence intervals of the effects of the outcome measures in the treatment and control groups are presented in supplementary material (Table S1).

The RCI classification was first analyzed for the participants in the treatment group, whose BDI scores were above the cutoff point at pre

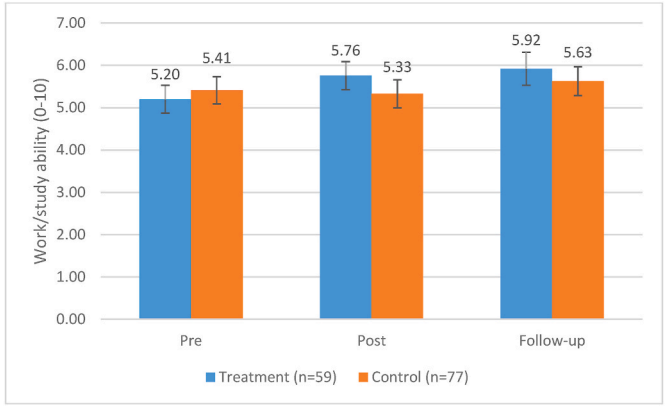

Fig. 5. Means and Error Bars in the Ability to Work or Study in the Treatment and Control Groups between Pre- and Follow-up Measurements.

Table 3
Bootstrap Results for Direct and Indirect Effects of Restorative, Distress and Group mediators (ROS, CORE-5, GSRS) on Depression at the Post (n = 79) and Follow-Up (n = 77). (Significant effects are in bold type).

	Bootstrap estimate		Bootstrap 95% confidence interval	
	Effect	SE	Lower	Upper
Post				
Direct effect of BDI_{T1} on BDI_{T2} (indirect effects are controlled for)	**.65**	.10	**.46**	**.85**
Indirect effect of ROS (α^a = 0.89)	**.20**	.07	**.07**	**.36**
Indirect effect of CORE-5 (α^a = 0.73)	.001	.01	−.02	.03
Indirect effect of GSRS (α^a = 0.90)	−.03	.04	−.11	.04
Follow-up				
Direct effect of BDI_{T1} on BDI_{T3}	**.74**	.09	**.56**	**.93**
Indirect effect of ROS	**.15**	.06	**.04**	**.28**
Indirect effect of CORE-5	.01	.02	−.04	.06
Indirect effect of GSRS	−.01	.02	−.04	.03

Note. BDI_{T1} = BDI at pre; BDI_{T2} = BDI at post; BDI_{T3} = BDI at follow-up.
[a] Mean of 12 post-session measurements.

and who had responded at the pre and follow-up measurement times (n = 47). Of these participants, 17 (36%) had either recovered (n = 8) or improved (n = 9). In addition, 30 (64%) participants were classified as unchanged and none had deteriorated. In the control group (n = 61), 12 (20%) participants had either recovered (n = 8) or improved (n = 4). In total, 47 (77%) participants in the control group remained unchanged and 2 (4%) participants deteriorated. There were no differences between treatment group participants with different RCI classifications regarding age, use of antidepressant medication, or previous depression episodes. There were no significant differences between classification of either recovered or improved among the participants in the treatment group when compared to the participants in the control group ($\chi^2 = 4.88$, df = 2, p = .09).

3.2. *The mediation effects of restorative experiences, psychological distress, and alliance on depression*

In accordance with H2, restorative experiences during nature sessions among intervention participants mediated the decrease in depression from the baseline to both post and follow-up measurements, the indirect effects being 0.20 and 0.15, respectively (Table 3). Other mediators of psychological distress (CORE-5) and group therapy alliance (GSRS) were non-significant. The statistically significant models with three mediators explained 61.1% of the post-measurements and 66.9% of the follow-up depression scores.

4. Discussion

The finding of our study shows that for participants with depression, attending nature-based treatment in addition to receiving treatment-as-usual (TAU) can reduce their psychological distress, and increase restorative experiences and self-reported work/study ability while also decreasing depression symptoms. The depression scores of participants in the control group also reduced, and against our expectations no differences were observed between the treatment and control groups regarding depression symptoms. However, the decrease in psychological distress ($p < .05$) and the increase in restorative experiences ($p < .01$) were stronger in the treatment group than in the control group. Moreover, work/study ability was reported to be higher among participants in treatment group than among the participants in the control group at the post-measurement time ($p < .05$). This supports the notion of the usefulness of the combination of TAU and nature-based intervention, especially for the feeling of comfort and having the sense of agency when it comes to working or studying. In other words, adding the nature-based group intervention to the usual treatment of depression benefited the participants as observed across three measurement points over six months. However, when measured at the end of the group intervention there was evidence of added benefit only with regard to self-reported work or study ability when compared to those having received their treatment-as-usual on its own. Furthermore, and in line with our hypotheses, the nature sessions produced restorative experiences that mediated the decrease in depression scores.

4.1. The clinical significance of the findings

As the treatment added benefit to participants' treatment-as-usual with regard to psychological distress, restoration, and work/study ability (measured post-intervention), this indicates that participants with depression who are motivated to address personal experiences through nature experiences and group sharing can benefit by joining such nature-based treatment. Our study highlights the importance of restorative experiences during the group meetings, and it was found that those participants who experienced more restoration also experienced a more positive change in their depressive symptoms by the end of the intervention. These effects also remained up to the end of the three-month follow-up. These findings are in line with an earlier study in Finland, in which restoration experiences mediated an increase in positive mental well-being (Korpela et al., 2016).

Nature-based treatment such as *Flow with Nature* treatment (Salonen et al., 2022) can be a safe and meaningful way of incorporating the positive health and well-being effects of nature as an integral part of psychological care in mental health services. This suggestion is also in line with the wider ecosystem service perspective underlining the value of nature experiences in population-level indicators of mental health (Bratman et al., 2019). For instance, accessible natural areas can play a key role in the primary prevention of mental health disorders occurring in the community. Our findings offer further support that nature-based treatment models can be safely integrated in the secondary and tertiary prevention of mental health disorders in health services and rehabilitation centers.

Positive nature experiences may be pivotal in strengthening participants' levels of restoration as well as their personal resources. Previous studies suggest that exposure to a natural environment decreases negative affect, such as anger, fatigue and sadness (Bowler et al., 2010). In addition, the shorter five-week version of this nature-based treatment was found to strengthen positive affect and decrease negative affect at each group session among employees who attended the nature-based intervention designed to promote occupational well-being (Salonen et al., 2020) when compared to a control group who continued life as normal. For an individual who is struggling with depression, safe and positive experiences of oneself and support for psychological processing in nature can be as meaningful as the reduction in symptoms; that is, the therapeutic work can support alternative perspectives concerning negative thoughts and feelings about oneself and one's surrounding. The therapeutic work in nature-based interventions can invite participants to shift attention from troubling inner experiences to the support that is available, and to feel more connected to other people (e.g., the group) and the natural environment. Returning to and reliving these meaningful nature experiences can also offer long-term relief after the intervention finishes.

It is possible that restorative experiences also support work- and study-related resources, such as self-reported work/study ability as measured in our study. In the treatment, the aim was to find a balance between demands (internal and external) and resources with the help of the natural environment and the social support of the group. The nature-based treatment in our research was based on an earlier intervention (Salonen et al., 2020) that focused on promoting occupational well-being, and that might also be the reason why work/study ability was higher among participants in the treatment group than in the control group at post.

The reduction in depression scores is in line with previous research that included a smaller number of participants with depression in Finland (Korpela et al., 2016) as well as in international studies (e.g., Gonzalez et al., 2010; Kim et al., 2009). In the Finnish study examining participants with depression, the depression scores decreased by six points on average, measured using the Beck Depression Inventory-II during the eight-week intervention program involving nature walks (Korpela et al., 2016). In our study, we observed a similar decrease in the average depression scores (five points) measured with the original, older version of the Beck Depression Inventory (BDI-I). Another study, a 12-week therapeutic horticulture program for participants with clinical depression, showed comparable mean changes in the BDI (4.5-point decrease in average scores; Gonzalez et al., 2010).

A change exceeding six points in the BDI has been suggested to be clinically significant (Bright et al., 1999). The decrease was clinically significant ($\geq$6 points) for 29% of the participants at the end of the intervention. The decrease was somewhat lower than in a previous study in Finland, wherein 54% of the participants reported a clinically significant change at the end of the intervention (Korpela et al., 2016). The clinical significance of the decrease was also assessed with the RCI classification (Jacobson & Truax, 1991), which takes into account the statistical and clinical significance of a scale. In the treatment group, 36% of participants were seen as having recovered or improved, representing a reliable and clinically significant change for the better. Comparatively, 20% of the participants in the control group were classified as recovered or improved. The corrected between-group effect sizes between the treatment group and control group were small at the end of the three-month follow-up period ($d = 0.28$) for depression, as well as for the other outcome variables at the post and/or follow-up measurement times ($d = 0.25$–0.43), in favor of the intervention group. Note that the largest effect sizes ($d = 0.40$–0.43, at post and follow-up) pertained to the increase in restorative experiences and the decrease in psychological distress.

Antidepressant medication appeared to have played a role in the degree of the decrease in depressive symptoms: the participants in the treatment group who were not taking antidepressant medication benefited from the treatment group more than those participants who were on medication. The participants in the treatment group on medication reported slightly higher depressive symptoms at baseline, but this difference was not significantly higher than that of the participants in the treatment group who did not take antidepressant medication. This difference in depression scores between those participants in the treatment group on versus not on medication was found to be significant at post (5.85 points, $p < .01$) and follow-up (4.99 points, $p < .05$). It is possible that participants on antidepressant medication had a more complex symptomology and the medication had balanced their mood. If this were the case, it could be assumed that the smaller changes may have been due to the more complex type of depression and comorbidity.

The participants in this study experienced the key elements of the treatment, social support and natural environment mainly positively (Salonen et al., 2022) and reported beneficial effects particularly with regard to distress and restoration as highlighted in these findings. Therefore, it can be useful to pay special attention to integrating social support and positive nature experiences into group exercises when developing nature-based treatments. To facilitate restoration during group sessions, exercises focusing on concentration and mindfulness in restorative natural environments can be relevant (Lymeus et al., 2022). The intensity and length of the treatment, as well as group exercises, should also be adjusted to match the group members' symptomology. It would be worthwhile to develop this treatment further to meet the needs of patients with a more complex type of depression better, for instance, by offering a longer treatment with more mindfulness exercises in natural environments which are experienced as restorative, safe, and peaceful for therapeutic work.

4.2. Limitations, strengths, and future research

There are several study limitations, as well as strengths, that should be taken into account when making inferences on the basis of our findings. The participants who took part in the nature-based treatment were probably very motivated to engage in this type of therapy. Participants were also asked in the screening interview whether they felt able to commit to the 12 nature-based group sessions. These participants are also more likely to benefit from group-form treatment in natural environments. Therefore, it would be informative to compare the effectiveness of the nature-based treatment group with another widely used treatment group for depression, such as cognitive-behavioral therapy or psychoeducational groups, for instance (Finnish Current Care Guidelines, 2016[1]). This would shed further light on whether patients motivated to attend this type of nature-based treatment group can expect similar benefits to other widely researched group treatments for depression. More specifically, it is worthwhile gaining insight into what the therapeutic factors or mechanisms of change in nature-based treatments are (e.g., nature exposure, social support, common therapeutic factors). Further comparative studies are needed to clarify how, why, and when nature-based treatments lead to beneficial outcomes.

In our study, we included only self-reported measures. However, physiological changes take place in natural environments, and these could therefore be relevant when investigating the effectiveness of nature-based treatments. In addition, less than 17% of the participants in our study were male. It is advisable to use more gender-balanced data in future research. Nevertheless, the majority of patients with depression are female, thus information specific to the female participants' experience and recovery is relevant (WHO, 2020[3]). Group-form treatment in nature may also be relevant for women in terms of establishing a sense of safety, since women have been found to feel safer walking in urban nature with another person or at least with a dog (O'Brien, 2005).

Eleven participants who were randomized to the treatment group dropped out before and during the treatment. These participants were less likely to use antidepressant medication and had a slightly lower mean level of depression symptoms at the start of the study when compared to those participants who continued throughout the treatment phase. It is possible that they had less need for additional psychological support. However, participants with milder depression symptoms in particular might benefit from this type of short-term treatment group (Paakkolanvaara et al., 2022). Therefore, minor changes would be more likely among participants with moderate or severe depression symptoms, which might have affected the results in relation to the treatment group.

It should be noted that over 30% of all the participants who attended the treatment (including the participants in the control group who later received the same treatment) participated during the COVID-19 pandemic in 2020, and, accordingly, these treatment groups were facilitated partly online. During spring 2020 when there were COVID-19 restrictions in place, the participants in the treatment groups went to their own favorite places alone and met together in an online conference room. In autumn 2020, some group meetings were facilitated as hybrid meetings (e.g., some participants were online due to mild flu symptoms). This raises at least two further questions regarding the applicability of our findings. Further research would be needed to replicate this intervention study when there are no restrictions in place, since this may have affected participants' experience of participating a group. A further study comparing the experiences and changes in symptoms of participants in the nature-based treatment delivered in-person versus through hybrid/online meetings would be required to gain clarification concerning the effectiveness and applicability of these delivery methods.

5. Conclusions

Our research supports the observation that nature-based intervention can be a safe and beneficial form of short-term group treatment for depression in addition to TAU. The added benefit of nature-based treatment was observed in the reduction of psychological distress, the increase in restorative experiences, and improved self-reported work or study ability (only at the end of the group intervention) compared to TAU-only. The greatest improvement in depressive symptoms among the nature-based treatment participants was observed in those not taking antidepressant medication. However, participants on or not on antidepressant medication benefited from the nature-based intervention. Thus, more studies are recommended to further investigate the impact of medication in nature-based treatments. It may be useful to incorporate nature-based activities in other treatment groups or individual sessions in order to enhance restoration during sessions. It would be important for the patients and clinicians to be able to choose suitable interventions and treatment environments in a cost-efficient way, relying on natural environments nearby.

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Author statement

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Declaration of competing interest

We have no known conflict of interest to disclose. Materials and analysis code for this study are not available.

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[3] WHO, 2020. Gender and women's mental health: https://www.who.int/mental_health/prevention/genderwomen/en/.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jenvp.2022.101950.

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