



A Structured Forest Therapy Intervention Enhancing the Nature Connection, Mood States, and Satisfaction with Life of U.S. Veterans with PTSD: A Pilot Study

RESEARCH

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ABSTRACT

Forest therapy has gained increasing attention as an outdoor therapeutic intervention for individuals with various health challenges. However, its impact on nature connection, mood states, and life satisfaction among veterans with posttraumatic stress disorder (PTSD) remains underexplored. This pilot study investigated the outcomes of a structured forest therapy intervention for U.S. veterans with PTSD using a one-group pretest-posttest design. A total of thirty-five participants ($N = 35$) were recruited over multiple years through a convenience sampling approach during the one-day nature camp programs for smaller groups of veterans ($n = 5$, on average per group). Each group engaged in a guided one-hour forest therapy walk which incorporated a standard sequence of mindfulness-based invitations on a quarter-mile long natural dirt trail in a midwestern U.S. region forest. The intervention outcomes were measured using a questionnaire that included the Connectedness to Nature Scale, Profile of Mood States, and Satisfaction with Life Scale, before and after the intervention. A Wilcoxon signed-rank test was used to compare differences in the outcomes of the intervention. The results revealed that participants reported a stronger sense of nature connection. Negative mood states, including anxiety, depression, anger, fatigue, and confusion, decreased significantly, while the positive mood state of vigor showed a notable increase. Life satisfaction was significantly enhanced following the intervention. These findings underscore several substantial benefits of structured forest therapy for improving psychological nature connection, mood, and life satisfaction in veterans with PTSD. The study provides evidence-based support for implementing structured nature immersion interventions for similar populations.

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Posttraumatic stress disorder (PTSD) is a mental health disorder occurring after directly or indirectly experiencing a traumatic event(s), such as experiencing a life-threatening situation, witnessing death, and/or losing comrades (American Psychiatric Association [APA], 2013). Major PTSD symptoms include re-experiencing symptoms (e.g., intrusive thoughts—distressing and unwanted memories of a traumatic event leading to emotional distress or flashbacks—feeling like a traumatic event occurs again), avoidance symptoms (e.g., avoiding thoughts, feelings, people, situations), negative cognitions and mood symptoms (e.g., overly negative thoughts about oneself, feeling hopeless or detached, feeling unhappy, losing interest in activities), and negative arousal and reactivity symptoms (e.g., feeling tense, on edge, not relaxed, anxious, easily frustrated or angry, lack of concentration on a task, showing self-destructive behavioral issues [i.e., substance abuse], APA, 2013). PTSD is one of the most prevalent psychiatric disorders affecting veterans in the United States (U.S.), with nearly one in three veterans developing PTSD (U.S. Department of Veterans Affairs, 2021). Veterans with PTSD are at an increased risk of experiencing comorbid mental health conditions, including major depressive disorder, generalized anxiety disorder, substance use disorders, physical impairments, and disruptive behavior disorders (Rytwinski et al., 2013). Despite the adverse effects of PTSD, research indicates that over 44% of veterans hold negative perceptions of mental health treatment and do not seek professional help (Hoge et al., 2014). As a result, veterans with PTSD tend to underutilize therapeutic programs and interventions, potentially further exacerbating their mental health challenges.

One promising non-pharmacological intervention to improve mental health in veterans with PTSD is forest therapy. Forest therapy is a mindful nature connection walk within a forest or natural environment that has a purpose-driven potential to provide more restorative and calming experiences (e.g., reducing stress and improving mood) for veterans (Davis, 2024; Marchand et al., 2019). This approach originated in Japan, where it is known as *shinrin-yoku*, which translates to forest bathing (Li, 2018). It involves spending a slow, mindful time immersing oneself in natural environments to (re)connect with the natural world, using multiple senses, which is a personal experience of deep nature connection. The practice follows the general principle that it is beneficial to absorb the atmosphere of the natural environment, which intends to enhance positive health outcomes (Clifford, 2018a; Li, 2018). Structured forest therapy interventions (i.e., a standard sequence of nature connection invitations) include guided or self-guided experiences with intentionally pre-determined themes (invitations) and prompts to encourage shared

experiences. These invitations involve progressive nature immersion activities, starting with gentle mindfulness exercises (e.g., breathing techniques and sensory awareness), advancing to immersive nature activities (e.g., walking barefoot, drawing nature scenes, conversing with a tree), and concluding with calming sensory activities, such as medicinal plant-based tea ceremonies (Clifford, 2018a; 2018b). These progressive and concluding invitations, intentionally and potentially allow a sensory connection with nature and are repeated in a specific order every time the structured forest therapy is implemented.

The structured forest therapy developed by Clifford (2018a; 2018b) has been recently incorporated into research. For example, Lim et al. (2020) guided a set of structured forest therapy interventions in outdoor natural settings for university students and residents in Singapore. Lim et al. (2020) found significant improvements in nature connection and mood after the structured intervention. A substantial increase in positive affect (e.g., attention, interest, excitement) and a significant decline in negative affect (e.g., distress, hostility, anger) were observed, as measured with the Positive and Negative Affect Scale (PANAS, Watson et al., 1988). More recently, Kil et al. (2023) facilitated a set of similar structured forest therapy interventions twice during a two-day interval (e.g., Monday, Wednesday) in a city-level forest park in the U.S. for children and adolescents with mental and co-occurring behavioral health issues (e.g., anxiety, stress, trauma, attention-deficit/hyperactivity disorder). Kil et al. (2023) found that mindfulness, nature connection, and mood states (e.g., reductions in tension-anxiety, depression, anger-hostility, fatigue-stress, confusion, increase in vigor), as measured with the Profile of Mood States Scale (Grove & Prapavessis, 1992), were significantly improved after the interventions.

Prior research has demonstrated that forest therapy can reduce negative psychological symptoms, improve immune function, and enhance heart health (Kotte et al., 2019; Stier-Jarmer et al., 2021; Wen et al., 2019). The therapeutic benefits of forest therapy have been explored across diverse populations, including middle-aged women (Ochiai et al., 2015), individuals with chronic alcoholism (Shin et al., 2012), female workers (Jung et al., 2015), and hypertensive older adults (Sung et al., 2012). In an international context, studies have shown that Japanese college students exposed to forest environments experienced reduced blood pressure and pulse rates, as well as improved concentration and positive affect, compared to those in urban settings (Lee et al., 2009; Tsunetsugu et al., 2007).

Research on nature-based programs, including forest therapy, has shown positive effects on the co-occurring mental health conditions of veterans with PTSD, such as major depressive disorder, generalized anxiety disorder,

and alcohol and substance use (Duvall & Kaplan, 2014; Marchand et al., 2019; Poulsen et al., 2018). However, nature connection interventions may trigger re-experiences of traumatic situations (e.g., certain smells or sounds, being isolated in nature) among veterans with flashbacks. For example, such beneficial programs included a week-long group-based nature recreation event that significantly improved psychological well-being, social connection, and life outlook of U.S. veterans (Duvall & Kaplan, 2014). A 10-week nature-based therapy process helped Danish veterans take nature in, feel nature as a part of their life and as a more safe place, and experience relaxation and restoration (Poulsen et al., 2016). A mindfulness training and nature exposure intervention (i.e., sailing) was significantly beneficial for U.S. veterans to experience reduced anxiety and improved mindfulness (Marchand et al., 2019). Forest therapy, characterized by slow and mindful nature connection walks, has gained international recognition for its healing and preventative benefits (Kotte et al., 2019). Forest therapy shows potential to concurrently complement psychotherapies (e.g., Prolonged Exposure [PE], Cognitive Processing Therapy [CPT], Eye Movement Desensitization and Reprocessing – [EMDR]) and medications (e.g., selective serotonin reuptake inhibitors [SSRIs], serotonin-norepinephrine reuptake inhibitors [SNRIs]) in treating veterans with PTSD (Farkic et al., 2021; U.S. Department of Veterans Affairs, 2024).

Studies have also indicated that forest therapy is significantly associated with a reduction in stress, lowering blood pressure, and improved heart health and immune functions among adults with severe depression, hypertension, and chronic obstructive pulmonary disease (COPD; Stier-Jarmer et al., 2021; Wen et al., 2019). Indeed, Lee et al. (2009) found that spending time in forest environments was associated with decreased cortisol levels, blood pressure, and pulse rate, accompanied by feelings of comfort, relaxation, and rejuvenation. These findings indicate that forest therapy contributes to multidimensional health benefits, resulting in holistic improvements in overall quality of life.

Substantial evidence supports the mental health benefits of group-based outdoor recreation activities for veterans with PTSD (Duvall & Kaplan, 2014; Marchand et al., 2019; Poulsen et al., 2016). Health benefits of the structured forest therapy approach developed by Clifford (2018a, 2018b) have been reported only among children and adolescents with at-risk health conditions (Kil et al., 2023) and young adults (Lim et al., 2020). However, there is limited research on the specific effects of structured forest therapy on health outcomes on those populations, particularly individuals with PTSD. Thus, the present study seeks to determine whether a one-hour structured forest therapy intervention improves nature connection, mood

states, and life satisfaction among U.S. veterans with PTSD. The interventions were implemented for the veterans during a one-day full nature program in an outdoor natural area with a quarter-mile long dirt trail, which is safe and wheelchair accessible with abundant wildlife and trees (e.g., young and mature white pine trees) for mindfulness-based invitations in nature, including sensory connection (e.g., touch, sight, sound, smell). This pilot study aims to provide initial evidence of structured forest therapy's potential to enhance mental health and life satisfaction, serving as a basis for future research.

METHODOLOGY

DESIGN AND SUBJECTS

Ethical approval was obtained from the Human Research Ethics committee at the University of Wisconsin-La Crosse (IRB number: 19-NK-572) in a midwestern U.S. region for the one-group pretest-posttest design with a convenience sample. The inclusion criteria for the characteristics of the target population were self-reported PTSD with/out co-occurring health issues, ages 18 years old or older, all sexes, genders, and races. The pilot study did not obtain the participants' more personal medical information about a formal PTSD diagnosis from a licensed health professional, duration of a symptom(s), and when a symptom(s) was (were) developed (i.e., before or during their military service). Participants ($N = 35$) were invited to one-day outdoor nature connection camp programs for veterans, provided by a nonprofit health care organization (Easter Seals Wisconsin Camp, Wisconsin Dells, WI) in a midwestern U.S. region. Participants were informed about the study's purpose and completed a consent form. Participants were recruited through various nature connection activity options provided at the forest camp, including forest therapy, nature-related coloring, tie dye, duck tour, and board games. To control the effects of other one-day nature-based outdoor camp programs on nature connection, mood states, and life satisfaction, participants did not participate in any other nature connection activity before the forest therapy sessions. No incentives were provided.

Of the 35 veteran participants, more than half were male (66%), the average age ($M = 54.5$) ($SD = 13.81$), and majority identified as white (83%). All participants reported that they had self-reported PTSD, which is consistent with the information provided for the session preparation prior to the camp, as the hosting agency noted that all veterans in its camp programs had self-reported PTSD, which meet the inclusion criteria. Also, veterans had other self-reported mental (26%) and physical (37%) health impairments (Table 1).

CHARACTERISTICS	VETERANS WITH PTSD	
	<i>n</i>	%
Sex/Gender		
Female	12	34
Male	23	66
Age in years, <i>M</i> (<i>SD</i>)	54.46	(13.81)
Race/ethnicity: Whites ²	29	83
Military service years, <i>M</i> (<i>SD</i>)	7.59	(6.39)
Military service branches ¹		
Army	25	71
Navy	6	17
Air Force	2	6
Marine Corps	4	11
Health conditions ²		
Mental health impairments: PTSD	35	100
Other mental health impairments ³	9	26
Physical health impairments ⁴	13	37

Table 1 Characteristics of Forest Therapy Participants.

Note. *N* = 35. ¹Row totals for the participant groups are reported.

²Only the percentage of respondents who were in a subcategory is reported. ³Depression, anxiety, panic disorder, or ADHD. ⁴Back injury, arthritis, knee, or cancer.

FOREST THERAPY TRAIL AND DAY SELECTION

We chose a natural dirt trail in a midwestern U.S. region forest (Medicine Trail within the Easter Seals Wisconsin Camp, Wisconsin Dells, WI). The trail had several elements of an optimal forest therapy trail, including desirable infrastructure, a high level of accessibility, natural features, biodiversity, support from management, and a sufficient level of safety. For example, the quarter-mile long trail was easily wheelchair accessible from adjoining forest facilities (e.g., equipped with staff, shelter, restrooms), with abundant wildlife species, a natural soundscape, and safe, gentle terrains. The forest was full of young and mature white pine trees that provided participants with an opportunity to engage in different sensory connection activities (e.g., sight, smell, touch, sound) during the forest therapy session, which can be facilitative of beneficial health outcomes, including emotional and physiological health (Li et al., 2009). Benefits can also be absorbed through drinking tea made from the white pine needles gathered by the guide for use during the forest therapy session. Overall, the forest and this specific trail were appropriate for supporting forest therapy opportunities.

A one-group pretest-posttest design with a convenience sample was utilized during the one-day nature camp program for veterans on one Saturday during September and April between 2019 and 2023—except for the active pandemic year of 2020. Over the years, each program had an average small group of veterans (*n* = 5), resulting in a total of 35 participants (*N* = 35) for the pilot study. Each group checked in at the agency on a late Friday afternoon for the one-day program the next day, followed by their checkout on Sunday morning. Each group participated in a one-hour morning session, delivered only once by a forest therapy guide, at the beginning of the one-day nature-based camp program.

FOREST THERAPY PROCEDURE

Participants engaged in a forest therapy walk that included a standard sequence of invitations as a structured forest therapy intervention, which is a methodology employed by Certified Nature and Forest Therapy Guides, trained by the Association of Nature and Forest Therapy Guides and Programs (Clifford, 2018b). The standard sequence involves a series of structured invitations that support slow, mindful, sensory connection with deep immersion in natural environments (Clifford, 2018a, 2018b). The standard sequence was implemented on a quarter-mile long trail for about 60 minutes by a forest therapy guide certified by the Association of Nature and Forest Therapy Guides and Program, which is a U.S.-based agency that certifies guides throughout the world. The standard sequence consisted of the following five phases:

1. A general 10-minute introduction orienting the participants to the forest therapy location.
2. A 15-minute sensory engagement that invites participants to explore their five primary senses (e.g., touch, sound, smell, taste, sight) one at a time.
3. A slow and solitary 10-minute meander that attempts to slow the participant to the rhythm of the natural world, and out of a fast-paced, cognitive function, into a more embodied experience of being in the present moment.
4. A 15-minute saunter or sit spot that allows participants to continue using this expanded sensory awareness to build a relationship(s) with individual beings in the natural world.
5. A 10-minute tea ceremony that allows participants to integrate with the land by drinking a tea prepared from plants harvested from that area while experiencing a mindful and sensory taste of tea and a snack. After each of the structured steps, 2–5, participants have an opportunity to share their experiences with one another.

MEASURES OF PSYCHOLOGICAL OUTCOMES

The study instrument included nature connection, mood states, and satisfaction with life items to assess psychological outcomes for the forest therapy participants. In addition, demographic questions, such as gender, age, and health conditions, were included. An on-site questionnaire was delivered in pen-and-paper format for participants to complete before and after the forest therapy intervention.

Nature Connection

The 14-item Connectedness to Nature Scale (CNS) was utilized as a unidimensional ordinal scale (i.e., one-factor structure) to measure the level of an individual's affective connection with nature (Mayer & Frantz, 2004). Each item (i.e., I feel connected with nature) was measured on a five-point Likert scale ranging from 1 = Strongly disagree to 5 = Strongly agree. Higher summated mean scores, which were closer to 5 after the observed scores for each statement were summed and averaged, represented a greater overall connection with nature. The overall latent nature connection scale had Cronbach's alpha (α) values of .97 and .97 for the pre- and post-intervention measures, respectively, which showed good internal consistencies.

Mood States

The 34-item Profile of Mood States (POMS) measures six different mood states as a multidimensional ordinal scale (i.e., more than one-factor structure) developed by Grove and Prapavessis (1992). The six mood state dimensions (i.e., factors) include tension-anxiety, depression, anger-hostility, vigor, fatigue-stress, and confusion. The scale consists of four to six items for each emotion state. Each item (e.g., tense for anxiety) measured the extent to which participants currently feel each emotion state on a five-point Likert scale ranging from 1 = Not at all to 5 = Extremely. Higher summated mean scores for each latent mood state, which were closer to 5 after the observed scores for each statement per mood state were summed and averaged, represented a more severe mood state (e.g., higher levels of anxiety, depression, anger, fatigue, confusion) or a more positive mood state (e.g., higher levels of vigor). The mood states scale had Cronbach's alpha (α) values ranging from .79 (confusion) to .97 (vigor) for the pre-intervention measures and ranging from .78 (confusion) to .97 (vigor) for post-intervention measures, indicating good internal consistencies (i.e., each item measured per mood state representing its respective mood state).

Satisfaction with Life

The five-item Satisfaction with Life Scale (SWLS, Diener et al., 1985) was used as a unidimensional ordinal scale

to measure an individual's global cognitive judgments of satisfaction with her or his life. Each item (e.g., 'The conditions of my life are excellent') was rated on a five-point Likert scale ranging from 1 = Strongly disagree to 5 = Strongly agree. Higher summated mean scores, which were closer to 5 after the observed scores for each statement were summed and averaged for overall satisfaction with life, indicated greater life satisfaction. The satisfaction with life scale had Cronbach's alpha (α) values of .90 and .89 for the pre-and post-intervention measures, respectively, which indicated good internal consistencies.

DATA ANALYSIS

Data analyses were conducted with IBM SPSS Statistics 29 for Windows (IBM Corp). Before examining the study purpose, normality in the data was checked with acceptable threshold values of skewness (-2 to +2) and kurtosis (-3 to +3) (Westfall & Henning, 2013) for the individual observed items and their latent dimensions of nature connection, mood states, and satisfaction with life. Some researchers may use skewness values ranging from -7 to +7 as acceptable threshold values, as suggested by Hair et al. (2010). However, the kurtosis threshold values were chosen because we sought a more symmetrical distribution in parametric analyses. For additional normality checks, Kolmogorov-Smirnov and Shapiro-Wilk tests were used, and most of the data were not normally distributed. For example, depression and anger factors measured after the forest therapy intervention had skewness values of 4.27 and 5.00, each. The anxiety factor measured after the intervention showed a kurtosis value of 10.84. Additional results indicated that several latent scale data were not normal (e.g., $D = .22$, $p < .001$ based on Kolmogorov-Smirnov test, $W = .86$, $p < .001$ based on Shapiro-Wilk tests for overall nature connection). Hence, a Wilcoxon signed-rank test was used as a non-parametric analysis in this study to compare any significant differences in nature connection, mood states, and life satisfaction of the participants between before and after the forest therapy intervention.

RESULTS

NATURE CONNECTION

Wilcoxon signed-rank test results (Table 2) indicated a statistically significant difference in nature connection between pre-and post-forest therapy ($Z = -4.35$, $p < .001$), meaning that the level of nature connection reported by participants was higher after the intervention ($M = 4.29$, $SD = .72$) than before the intervention ($M = 3.65$, $SD = 1.00$).

VARIABLE	PRE-FOREST THERAPY			POST-FOREST THERAPY			WILCOXON SIGNED-RANK TEST	
	<i>M</i>	<i>SD</i>	α	<i>M</i>	<i>SD</i>	α	<i>Z</i>	<i>p</i>
Nature connection	3.65	1.00	.97	4.29	.72	.97	-4.35	< .001

Table 2 Results of Wilcoxon Signed-Rank Test Comparing Nature Connection of Forest Therapy Participants.

Note. Measured using a five-point Likert scale format (1 = Strongly disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly agree).

VARIABLE	PRE-FOREST THERAPY			POST-FOREST THERAPY			WILCOXON SIGNED-RANK TEST	
	<i>M</i>	<i>SD</i>	α	<i>M</i>	<i>SD</i>	α	<i>Z</i>	<i>p</i>
Tension-anxiety	2.13	.87	.88	1.14	.32	.84	-4.71	< .001
Depression	1.55	.65	.91	1.09	.29	.89	-3.75	< .001
Anger-hostility	1.56	.61	.83	1.06	.27	.85	-3.77	< .001
Vigor	2.51	.86	.93	3.04	1.17	.97	-2.69	.007
Fatigue-stress	2.35	1.01	.93	1.22	.44	.92	-4.75	< .001
Confusion	2.15	.78	.79	1.22	.40	.78	-4.72	< .001

Table 3 Results of Wilcoxon Signed-Rank Test Comparing Mood States of Forest Therapy Participants.

Note. Measured using a five-point Likert scale format (1 = Not at all, 2 = A little, 3 = Moderately, 4 = Quite a bit, 5 = Extremely).

VARIABLE	PRE-FOREST THERAPY			POST-FOREST THERAPY			WILCOXON SIGNED-RANK TEST	
	<i>M</i>	<i>SD</i>	α	<i>M</i>	<i>SD</i>	α	<i>Z</i>	<i>p</i>
Satisfaction with life	3.24	.89	.90	3.90	.73	.89	-4.07	< .001

Table 4 Results of Wilcoxon Signed-Rank Test Comparing Satisfaction with Life of Forest Therapy Participants.

Note. Measured using a five-point Likert scale format (1 = Strongly disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly agree).

MOOD STATES

Wilcoxon signed-rank test results (Table 3) showed statistically significant differences in mood states between pre-and post-forest therapy. The level of tension-anxiety ($Z = -4.71$, $p < .001$), depression ($Z = -3.75$, $p < .001$), anger-hostility ($Z = -3.77$, $p < .001$), fatigue-stress ($Z = -4.75$, $p < .001$), and confusion ($Z = -4.72$, $p < .001$), respectively, decreased significantly after the forest therapy. For example, the level of tension-anxiety reported by participants was lower after the intervention ($M = 1.14$, $SD = .32$) than before the intervention ($M = 2.13$, $SD = .87$). The fatigue-stress level was lower after the intervention ($M = 1.22$, $SD = .44$) than before the intervention ($M = 2.35$, $SD = 1.01$). In addition, a statistically significant difference in vigor ($Z = -2.69$, $p < .01$) indicated that the vigor level ($M = 3.04$, $SD = 1.17$) was higher after the intervention than before the intervention ($M = 2.51$, $SD = .86$).

SATISFACTION WITH LIFE

Wilcoxon signed-rank test results (Table 4) revealed a statistically significant difference in satisfaction with life

($Z = -4.07$, $p < .001$) between pre-forest therapy walk ($M = 3.24$, $SD = .89$) and post-forest therapy walk ($M = 3.90$, $SD = .73$) measures, indicating that the level of satisfaction with life was significantly improved.

DISCUSSION

This study sought to obtain evidence on the psychological outcomes of a structured forest therapy intervention for veterans with PTSD. Specifically, it evaluated the intervention's impact on nature connection, mood states, and life satisfaction among U.S. veterans. The findings revealed significant improvements in participants' nature connection, emotional well-being, and life satisfaction after the intervention. These results provide strong evidence that forest therapy improves the psychological health of veterans with PTSD and also offer a compelling rationale for incorporating forest therapy into strategies aimed at promoting mental well-being among veterans and similar populations.

The findings suggest that the structured forest therapy program significantly enhanced nature connection among veterans with PTSD. This result aligns with prior studies demonstrating increased nature connection following forest exposure among college students and community residents in Singapore (Lim et al., 2020) and school-aged children in Germany participating in environmental education programs (Liefänder et al., 2013). Nature connection encompasses cognitive, emotional, and experiential characteristics reflecting the symbiotic relationship between individuals and the natural world (Zylstra et al., 2014). Greater nature connection has been linked to positive emotions, increased energy, higher life satisfaction, and overall well-being (Capaldi et al., 2015; Pritchard et al., 2019). Thus, structured forest therapy programs that enhance slow mindful sensory connection with outdoor natural environments can significantly benefit veterans by fostering nature connection and promoting psychological health.

This study also found significant reductions in negative mood states: tension-anxiety, depression, anger-hostility, fatigue-stress, and confusion, following the forest therapy intervention. These results are consistent with previous studies involving diverse populations, such as Korean firefighters (Park et al., 2019), psychiatric patients in Portland (Bielinis et al., 2020), and middle-aged Japanese women (Ochiai et al., 2015). The findings support the use of structured forest therapy programs as a cost-effective and accessible mental health intervention, particularly for veterans with PTSD who often face substantial medical expenses related to mental health care (MacDonald, 2019).

Additionally, the results revealed significant improvements in life satisfaction among participants. While previous studies have not specifically examined life satisfaction in veterans with PTSD undergoing structured forest therapy, similar findings have been reported in urban forest-based programs for adolescents with at-risk health conditions (Tesler et al., 2018). Given that veterans with PTSD are often associated with low levels of life satisfaction (Morgan et al., 2017; Tsai et al., 2012), the enhancement of life satisfaction observed in this study underscores the importance of exploring forest therapy as a viable intervention. Life satisfaction is a critical component of mental well-being, contributing to successful aging and reduced mortality risk (Meeks & Murrell, 2001; Hülür et al., 2017).

STUDY LIMITATIONS

This study has several limitations. First, the absence of a control group (e.g., participants engaging in unstructured

nature activities not intentionally promoting slow mindful sensory connection with nature) limits the ability to attribute psychological benefits solely to the structured forest therapy intervention. Second, participants' prior experiences in various nature connection activities (e.g., walking, hiking, structured forest therapy) and expectations about the ways to connect with nature may have influenced the results. For example, veterans who returned to our structured forest therapy intervention tended to take in the mindful nature connection invitations more easily than the first-time forest therapy participants.

Third, this study relied solely on self-reported PTSD and other mental health measures, which may introduce bias. More careful application of the results needs to be considered for veterans formally diagnosed with PTSD. Future scholarship of structured forest therapy could recruit veterans formally diagnosed with PTSD to measure the mental health measures, including the PANAS.

Future research should also incorporate objective physiological measures, such as cortisol levels, blood pressure, and heart rate variability, to provide a more comprehensive evaluation of forest therapy's effects. Fourth, the positive effects were measured in a short-time period after the therapy. Future studies should investigate whether the positive effects persist days later. Despite these limitations, the study provides valuable insights into the potential benefits of structured forest therapy with more systematic mindful nature connection invitations not explored in previous research for veterans with PTSD. Future studies should conduct structured forest therapy with other groups of people of all ages with various deployment experiences and health conditions, including people with(out) a formal PTSD diagnosis from a licensed health care professional.

CONCLUSION

This study demonstrated that a structured forest therapy intervention significantly enhances nature connection, reduces negative mood states, and improves life satisfaction among U.S. veterans with PTSD. These findings suggest that forest therapy is a promising, non-pharmacological approach to improving psychological health for veterans and other individuals experiencing mental health challenges. Given its potential to address chronic stress and enhance well-being, forest therapy should be considered a complementary or alternative intervention for the populations.

DATA ACCESSIBILITY STATEMENT

The data used for this study are available upon request from the corresponding author.

ETHICS AND CONSENT

Ethical approval for this study was obtained from the Human Research Ethics committee at the University of Wisconsin-La Crosse (IRB number: 19-NK-572). Informed consent was gained from our research participants.

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COMPETING INTERESTS

The authors have no competing interests to declare.

AUTHOR CONTRIBUTIONS

Namyoon Gil contributed to the introduction, research design, data collection, data analysis, writing results, and editing.

Junhyoung Kim and Jin Gun Kim contributed to the introduction and discussion.

Cora Vogt and Kate Bast assisted the primary author with data collection.

Tamberly Conway wrote and edited the forest therapy procedures.

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