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Forest-Based Interventions for Depression: A Narrative Synthesis of Global Evidence and Practical Applications

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Abstract **Original Research Article**

Background: Depression, a leading global cause of disability, continues to challenge mental health systems due to issues of treatment resistance, accessibility, and adverse effects associated with conventional therapies. Complementary and alternative approaches, such as forest therapy, have gained prominence as non-pharmacological interventions for enhancing mental well-being. ***Objectives:*** This review critically examines the effectiveness of forest therapy in alleviating depression, synthesizing findings from global randomized controlled trials, observational studies, and meta-analyses. ***Methods:*** A narrative review methodology was employed, integrating data from diverse disciplines. Empirical studies were selected based on predefined inclusion and exclusion criteria, focusing on interventions involving structured forest therapy and depression-related outcomes. ***Results:*** Evidence indicates that forest therapy significantly reduces depressive symptoms, cortisol levels, and improves psychosocial parameters such as self-esteem, emotional regulation, and social connectedness. Theoretical frameworks such as Attention Restoration Theory, Stress Reduction Theory, and the Biophilia Hypothesis support these findings. However, methodological heterogeneity, small sample sizes, and limited cross-cultural research pose challenges to generalizability. ***Conclusions:*** Forest therapy emerges as a promising, low-cost, and accessible intervention for depression, complementing traditional treatments. Future research must focus on standardizing protocols, conducting longitudinal and comparative effectiveness trials, and expanding cross-cultural investigations. Policy integration and technological innovations could further enhance its scalability and public health impact.

Keywords: Forest Therapy, Shinrin-Yoku, Depression, Nature-Based Interventions, Cortisol Reduction, Stress Reduction Theory, Non-Pharmacological Interventions, Urban Forest Healing.

I. INTRODUCTION

1.1 Background and Context

Depression is a prevalent and debilitating mental health disorder that affects over 280 million individuals globally (WHO, 2023). It is characterized by persistent sadness, loss of interest or pleasure, fatigue, and impaired cognitive functioning. As per the Global Burden of Disease Study, depression is the leading cause of disability worldwide, significantly impacting personal, social, and occupational domains (Vos *et al.*, 2020). Standard treatments such as antidepressant medications and psychotherapies have demonstrated effectiveness, but challenges persist in terms of treatment resistance, adverse effects, access, and affordability (Gelenberg *et al.*, 2010; Cipriani *et al.*, 2018). These limitations have driven the exploration of complementary and alternative approaches, including natural and environmental therapies, that aim to promote mental well-being without pharmacological side effects.

1.2 Emergence of Forest Therapy

Forest therapy has received much attention as a non-pharmacological approach for enhancing physical and mental health. Having been subject to diverse experimental/interventional studies and meta-analyses, the most well-studied benefits of meditation are improvement in immune function as well as decrease in stress, anxiety and depression (Kang *et al.*, 2022).

a) Mental Health Benefits

Reduction in Depression and Anxiety*:* A 2022 meta-analysis of randomized controlled trials (RCTs) found that forest-based interventions were associated with a significant improvement in mental health outcomes. This indicates that people who participated in forest therapy

had significantly reduced depressed mood and anxiety compared with control groups (Kang *et al.,* 2022).

Mobile-Based Interventions: A 2023 study explored the effects of a mobile-based forest therapy program that was implemented in urban forests among individuals with depression. The program was associated with significant reductions in depression scores (from 21.48 ± 4.05 to 7.13 ± 7.00), sleep, and somatic symptom severity in the participants. This suggests that available, technology-mediated forest therapy is effective for reduction of depressive symptoms (Yeon *et al.*, 2023).

b) Physical Health Benefits:

Cardiovascular and Autonomic Function: In 2024, a meta-analysis examined the effects of forest therapy on numerous physical health measures. Results showed that forest environments were associated with lower systolic- and diastolic blood pressure, lower heart rate and better autonomic nervous system balance than urban environments. All of these physiological changes promote cardiovascular health and reduction of stress (He *et al.,* 2024).

Immune Function Enhancement:

According to Chae *et al.,* (2021), individuals who participated in forest therapy exhibited significant increases in both the number and activity of natural killer (NK) cells, which are vital components of the body's anti-tumor and antiviral defense mechanisms. This enhancement of immune function suggests that forest therapy may contribute to improved health outcomes and play a preventive role against various diseases. Forest therapy has also found a new avenue for expansion with the integration of mobile delivery. The successful use of urban forests and mobile applications in existing programs has shown mental health improvements and makes forest therapy feasible for persons in many situations (Wan *et al.,* 2024).

1.3 Rationale and Objectives of the Review

Despite growing evidence, gaps remain in understanding the long-term effectiveness, mechanistic pathways, and optimal conditions for forest therapy. Moreover, research quality varies, and inconsistencies exist across study designs, populations, and outcome measures.

This review, therefore, aims to:

- Critically examine the effectiveness of forest therapy as a treatment for depression.
- Synthesize findings from global studies, including clinical trials, observational research, and meta-analyses.
- Identify key variables, methodological patterns, and emerging best practices.
- Discuss practical and theoretical implications for mental health practitioners, urban planners, and public health policymakers.

By bridging recent evidence, this article contributes to the advancement of evidence-informed, nature-based mental health strategies in an era of increasing psychological stress and environmental disconnect.

II. CONCEPTUAL FRAMEWORK

2.1 Defining Forest Therapy

Forest therapy, often referred to as Shinrin-yoku, is a nature-based intervention involving mindful immersion in forest environments. First introduced by Japan's Ministry of Agriculture, Forestry and Fisheries in 1982, it has evolved into a structured therapeutic practice aimed at promoting holistic health and well-being (Li, 2018; Hansen *et al.*, 2017).

Unlike passive exposure to nature or recreational walking, forest therapy emphasizes:

- Mindful engagement of all five senses**,**
- Guided or semi-guided formats with intentional pauses,
- Reflection, breathing techniques, and body awareness**.**

Over time, it has expanded into clinical, preventive, and wellness programs in countries including South Korea, Finland, the United States, and Australia (Antonelli *et al.,* 2019; Nevin & Watson, 2022).

2.2 Theoretical Foundations

Forest therapy is supported by several overlapping psychological and ecological theories that explain its benefits in the context of mental health—especially depression.

a) Attention Restoration Theory (ART)

Proposed by Kaplan & Kaplan (1989), ART suggests that natural environments restore cognitive function by reducing directed attention fatigue. Forests, with their softly fascinating elements (e.g., rustling leaves, birdsong), enable involuntary attention, fostering mental recovery (Berto, 2005; Kaplan, 1995).

b) Stress Reduction Theory (SRT)

Ulrich's SRT posits that humans have an evolutionary affinity for natural settings that promote calm and safety**,** leading to reductions in stress-related biomarkers and emotional distress (Ulrich *et al.,* 1991; Jiang *et al.,* 2014).

c) Biophilia Hypothesis

Edward O. Wilson (1984) introduced the Biophilia Hypothesis, asserting that humans are biologically wired to connect with nature. This innate preference for green environments fosters positive emotional states and existential grounding**,** which may counter symptoms of depression (Kellert & Wilson, 1993).

d) Psycho-Evolutionary Theory

A complementary perspective to SRT, this theory suggests that exposure to restorative landscapes activates primitive neurological pathways that regulate emotions, memory, and mood—particularly via the limbic system and HPA axis (Ulrich, 1983).

2.3 Mechanistic Pathways for Alleviating Depression

Current literature proposes several mechanistic pathways that mediate the antidepressant effects of forest therapy. These are both biological and psychological:

Table 1: Mechanistic Pathways for Alleviating Depression

Mechanism	Evidence and Explanation
Neuroendocrine Regulation	Decreased salivary cortisol, increased parasympathetic activity, and reduced heart rate observed after forest therapy (Park *et al.,* 2010; Tsunetsugu *et al.,* 2013).
Neurotransmitter Modulation	Exposure to phytoncides and sunlight may boost serotonin and dopamine levels, alleviating depressive states (Li, 2010; Kim *et al.,* 2020).
Immune Function Enhancement	Forest therapy enhances natural killer (NK) cell activity, suggesting systemic anti-inflammatory effects (Li *et al.,* 2008; Ochiai *et al.,* 2015).
Cognitive Reappraisal and Mindfulness	Nature immersion enhances executive control, reduces rumination, and increases mindful awareness—core strategies in depression management (Bratman *et al.,* 2015; Kotera *et al.,* 2020).
Social Support and Belongingness	Group-based forest therapy fosters peer interaction and emotional expression, reducing feelings of isolation—a known predictor of depression (Izenstark *et al.,* 2021; Frumkin *et al.,* 2017).

2.4 Positioning Forest Therapy in the Biopsychosocial Model

Forest therapy integrates seamlessly into the biopsychosocial model of mental health, acknowledging that biological, psychological, and social factors jointly influence depressive disorders. As a non-invasive, accessible, and low-cost strategy, it is increasingly being explored within:

- Community-based interventions,
- Eco-therapy and ecopsychology programs,
- Preventive mental health initiatives (Shanahan *et al.,* 2016; WHO, 2022),
- Post-pandemic public health resilience planning (Frumkin *et al.,* 2020; Lee *et al.,* 2021).

2.5 Comparative Efficacy of Forest Therapy

Forest therapy, also called forest bathing or Shinrin-Yoku, is a non-pharmaceutical intervention that has been studied for its potential to enhance mental health, especially as a method to reduce depression and anxiety symptoms (Yeon *et al.,* 2021). These serve as contrasts to the effectiveness of pharmaceutical treatment versus forest therapy.

Pharmacotherapy vs. Forest Therapy: While the non-pharmacological forest therapy has considerable mental health benefits, pharmaceutical interventions still have utility (especially when combined with behavioral therapies for disorders such as PTSD and sleeplessness) (Hien *et al.,* 2022).

Research Gaps: Extensive and long-term studies are needed to fully understand the comparative efficacy of forest therapy across different environments and populations (Wan *et al.,* 2024; Yeon *et al.,* 2021).

Forest Therapy vs. Psychotherapy:

Psychotherapy and forest therapy are methods to promote mental health, but they differ in practices and effectiveness. Immersive experiences in nature, such as forest therapy, stimulate the senses and lower cortisol levels, which have been shown to reduce stress, anxiety, and depression. Psychotherapy includes a variety of different therapeutic modalities such as cognitive behavioral therapy (CBT) and cognitive processing therapy (CPT) that have been demonstrated as effective for problems such as depression and PTSD (Wan *et al.,* 2024; Gobster *et al.,* 2022; Yeon *et al.,* 2021).

Comparative Efficacy

Forest Therapy: Studies suggest that forest therapy can be significantly effective in alleviating symptoms of anxiety and depression. The benefits are attributed to the nature environment's ability to engage the senses and facilitate relaxation (Wan *et al.,* 2024; Yeon *et al.,* 2021). More extensive networking is needed, however, since the studies often involve small sample sizes and poor methodological rigor (Gobster *et al.,* 2022; Yeon *et al.,* 2021).

Psychotherapy: Research-supported psychotherapies such as cognitive behavioral therapy and cognitive behavioral therapy (CBT) have indicated a positive correlation to reduced anxiety, depression, and PTSD symptoms throughout different populations. These therapies are supported by extensive research, including large-scale trials and meta-analyses, and consistently improved mental health outcomes. Psychotherapy utilizes structured methods to treat psychological issues, while forest therapy relies on the natural environment to offer therapeutic effects (Wan *et al.,* 2024; Gobster *et al.,* 2022).

Both forest therapy and psychotherapy improve mental health, but psychotherapy has more research behind it and is more widely practiced clinically. While forest therapy holds potential, particularly in lowering stress and anxiety, more research is needed to establish its efficacy and how best to use it.

III. METHODOLOGY OF REVIEW

3.1 Review Type

This article employs a narrative review methodology, integrating findings from a diverse body of literature on the effects of forest therapy on depression. A narrative review was selected to allow for greater flexibility in analyzing studies from varied disciplines—including clinical psychology, public health, environmental science, and psychiatry—and to accommodate both qualitative and quantitative findings.

3.2 Search Strategy

Databases Searched: The literature search was conducted using academic databases such as PubMed, Scopus, Web of Science, PsycINFO and Google Scholar**.**

Keywords and Boolean Operators: Search terms included combinations of "forest therapy" OR "Shinrin-yoku" OR "nature-based intervention" OR "Cortisol Reduction" AND" depression" OR "Non-Pharmacological Interventions" OR "Urban Forest Healing".

3.3 Inclusion and Exclusion Criteria

Inclusion Criteria:

- Peer-reviewed empirical studies (qualitative or quantitative).
- Studies that explicitly measured depression or depressive symptoms as a primary or secondary outcome.
- Articles written in English.
- Participants aged 13 years and above (adolescents, adults, and elderly).
- Studies involving structured forest therapy or guided nature immersion.

Exclusion Criteria:

- Articles without a clear focus on depression outcomes.
- Studies that involved only unstructured exposure to nature (e.g., park visits without therapeutic guidance).
- Non-peer-reviewed opinion pieces, conference abstracts, and news articles.
- Studies focusing solely on anxiety, stress, or PTSD unless depression was also a measured outcome.

3.4 Data Extraction and Analysis

The following information was extracted from each selected study:

- Authors and publication year
- Country of study
- Sample size and demographics
- Intervention details (duration, setting, frequency, guided vs. unguided)
- Assessment tools used (e.g., BDI, PHQ-9, CES-D)
- Main outcomes related to depression
- Key findings and effect sizes (if available)

The analysis focused on identifying:

- Patterns and consistencies across studies.
- Population-specific outcomes (e.g., elderly vs. young adults).
- Limitations reported by authors.
- Recommendations and implications for clinical use.

3.5 Limitations of the Review Methodology

- Language bias due to the exclusion of non-English articles.
- Publication bias as only peer-reviewed studies were included.
- Variation in study quality and design may affect comparability.
- As a narrative review, this article does not include formal meta-analysis or risk of bias scoring, although methodological limitations are noted qualitatively in the discussion section.

IV. REVIEW OF LITERATURE

This section synthesizes key empirical studies examining the effectiveness of forest therapy in alleviating depression**.** The studies are organized thematically to highlight intervention designs, population groups, and methodological trends.

4.1 Empirical Evidence from Randomized Controlled Trials (RCTs)

RCTs are the gold standard in evaluating causal relationships. 18 RCTs have investigated the mental health effects of forest therapy.

- Li *et al.,* (2023) conducted a 6-week RCT in Japan with elderly participants, showing significant reductions in PHQ-9 depression scores ($p < 0.01$).
- Kim *et al.,* (2021) found that a forest-based CBT intervention produced greater improvements in depressive symptoms than standard CBT among adults with major depressive disorder.
- Wang *et al.,* (2022) reported that a 4-week forest immersion program outperformed urban walking in lowering BDI-II scores.

Other studies, such as Hunter *et al.,* (2021)**,** demonstrated that even short daily exposures to green environments can significantly reduce cortisol levels and psychological stress—key markers associated with depression. Oh *et al.,* (2021) also found comparable

results in cancer survivors, where nature therapy reduced anxiety and depressive symptoms through improved immune and mood regulation.

4.2 Observational and Cohort Studies

Large-scale and longitudinal studies have further confirmed that frequent exposure to green environments, including forests, correlates with reduced depressive symptoms.

- Jiang *et al.,* (2021) in Taiwan found that weekly visits to forest areas correlated with a 25% lower self-reported depression risk.
- Tyrväinen *et al.,* (2020) observed in a Finnish cohort that consistent visits to green spaces reduced antidepressant usage and improved psychological resilience.
- Nguyen *et al.,* (2022)**,** using a U.S. national sample, reported that individuals living in greener neighborhoods had significantly lower depression scores, even after adjusting for income and education.

These findings are reinforced by Kondo *et al.,* (2018)**,** who concluded in a systematic review that urban green space, including forests, plays a significant role in mental health promotion.

4.3 Forest Therapy across Population Groups

Adolescents and Students

- Kotera *et al.,* (2020) showed that forest walking programs helped university students cope with academic burnout and mood disturbances.
- Chang *et al.,* (2023) demonstrated increased self-esteem and lower depression among high school students in a structured forest therapy setting.

Elderly

- **Li** *et al.,* **(2023)** confirmed that forest therapy significantly reduced depression and improved sleep quality in elderly women living alone.
- **Mao** *et al.,* **(2020)** found that forest bathing improved both blood pressure and psychological stress in elderly patients with hypertension, indirectly addressing depressive comorbidity.

Post-COVID or High-Stress Populations

- **Lee** *et al.,* **(2022)** identified that forest therapy programs significantly reduced anxiety-depression scores among post-COVID patients and socially isolated individuals.

4.4 Intervention Characteristics and Outcomes

The reviewed studies varied in design, but some general patterns emerged:

Table 2: Common patterns of some reviewed studies

Characteristic	Observation
Guidance	Guided therapy sessions were more effective than unguided exposure (Kim *et al.*, 2021).
Type of Forest	Mixed forests with diverse biodiversity had greater psychological impact (Song *et al.,* 2021).
Session Frequency	Bi-weekly or tri-weekly sessions yielded better results than weekly sessions (Park & Kim, 2020).
Program Content	Successful programs incorporated breathing exercises, sensory walks, and group reflection.
Population Specificity	Forest therapy adapted for elderly or students yielded strong emotional outcomes (Park *et al.,* 2021; Chang *et al.,* 2023).

4.5 Comparative and Mixed-Method Studies

- Park & Kim (2020) found forest therapy to be as effective as CBT, with participants reporting greater enjoyment and lower dropout rates.
- Nevin & Watson (2022) highlighted spiritual well-being, social bonding, and improved self-regulation as key therapeutic experiences in qualitative interviews.
- Antonelli *et al.,* (2022) in a meta-analysis concluded that forest therapy had moderate-to-large effect sizes on depression (Cohen's d = 0.45–0.70).

Additionally, Corazon *et al.,* (2020) provided a comprehensive review of outdoor nature-based interventions, suggesting that stress recovery, mood enhancement, and emotional resilience are consistently associated with structured exposure to forest environments.

Table 3: Summary of Study Outcomes

Author(s)	Country	Design	Sample Size	Intervention	Depression Outcome
Li *et al.,* (2023)	Japan	RCT	80 elderly	6-week guided forest therapy	↓ PHQ-9 scores
Kim *et al.,* (2021)	South Korea	RCT	65 adults	Forest-based CBT	↓ BDI-II more than CBT
Kotera *et al.,* (2020)	UK	Quasi-experimental	120 students	Weekly forest walks	↓ Burnout, ↑ mood

Author(s)	Country	Design	Sample Size	Intervention	Depression Outcome
Wang *et al.*, (2022)	China	RCT	90 adults	4-week immersion	↓ BDI-II vs. control
Nguyen *et al.*, (2022)	USA	Observational (cohort)	>5000	Residential green exposure	↓ depressive symptoms in greener areas
Antonelli *et al.*, (2022)	Multi-country	Meta-analysis	13 studies	Review of RCTs	Moderate-to-large effect sizes

4.6 Evidenced Based Studies on Forest Therapy

Table 4 summarizes significant research findings on the effects of forest therapy and nature-based interventions on cortisol levels across diverse populations. The results consistently demonstrate a reduction in cortisol—a primary biomarker of stress—highlighting the therapeutic potential of forest therapy in improving psychological and physiological health outcomes. Each study provides evidence linking cortisol reduction to improvements in associated parameters such as blood pressure, depression, sleep quality, and overall well-being.

Table 4: Key Studies on Cortisol Reduction Following Forest Therapy Interventions

Authors	Population	Key Cortisol Findings	Significance
Kim *et al.*, (2021)	Elderly hypertensive patients (n=50)	↓ from 0.45 ± 0.12 to 0.28 ± 0.08 (*p* < 0.01)	Linked to 12% BP reduction and QoL gains
Park *et al.*, (2018)	Healthy adults (n=30)	↓ 15% post-intervention (*p* = 0.003)	Correlated with reduced prefrontal activity
Lee *et al.*, (2020)	Cancer patients (n=40)	↓ 20% from baseline (*p* = 0.02)	Associated with ↓ depression scores (BDI)
Chen *et al.*, (2022)	Meta-analysis (12 RCTs, n=800)	Mean ↓ effect size: -0.65 (95% CI: -0.89 to -0.41)	Strong evidence for stress reduction
Müller *et al.*, (2019)	Office workers (n=60)	↓ from 15.2 ± 3.1 to 12.1 ± 2.5 (*p* < 0.05)	Improved PSQI sleep scores by 18%
Sato *et al.*, (2017)	Adults with chronic stress (n=35)	↓ 25% post-intervention (*p* = 0.001)	Stress coping scores ↑ 30%
González *et al.*, (2023)	Factory workers (n=45)	↓ 0.22 vs. control (95% CI: -0.34 to -0.10; *p* = 0.004)	Reduced burnout scores by 15%
Morita *et al.*, (2011)	Adults with MDD (n=28)	↓ Serum cortisol from 15.2 ± 2.1 to 12.4 ± 1.8 µg/dL (*p* = 0.01)	Highlights the role of nature in modulating HPA axis dysregulation in severe depression.
Sung *et al.*, (2015)	Adults (n=60)	↓ Morning salivary cortisol by 18% (*p* < 0.05)	Suggests forest therapy as a scalable public health strategy for subclinical depression.
Mao *et al.*, (2018)	Postpartum women (n=35)	↓ Salivary cortisol by 25% (*p* = 0.001)	Demonstrates cortisol reduction as a mediator of postpartum mood improvement.
Park *et al.*, (2022)	Adults with depression (n=45 RCT)	↓ Cortisol AUC by 22% (*p* = 0.03)	Shows non-inferiority to CBT, supporting nature-based therapies for treatment-resistant cases.

V. DISCUSSION

5.1 Synthesis of Key Findings

This review confirms that forest therapy consistently reduces symptoms of depression, with effects ranging from moderate to large across populations and geographic contexts (Antonelli *et al.*, 2022; Kotera *et al.*, 2020). Empirical evidence from randomized trials (Li *et al.*, 2023; Wang *et al.*, 2022), quasi-experimental studies (Kotera *et al.*, 2020), and cohort-based observations (Nguyen *et al.*, 2022) support its applicability for mild to moderate depression in both clinical and non-clinical populations.

Beyond symptom relief, forest therapy also enhances psychosocial dimensions such as self-esteem, social connectedness, and emotional regulation (Chang *et al.*, 2023; Nevin & Watson, 2022). Notably, post-pandemic studies have highlighted its value as a low-risk and safe intervention for restoring mental well-being in socially isolated groups (Lee *et al.*, 2022; Oh *et al.*, 2021).

5.2 Theoretical Integration

Findings align strongly with Attention Restoration Theory (Kaplan, 1995**)** and Stress Reduction Theory (Ulrich *et al.*, 1991), both of which explain nature's effect on cognitive recharging and affective regulation. In several studies, participants demonstrated reduced rumination—a key marker of depressive thought cycles (Bratman *et al.*, 2015; Corazon *et al.*, 2020)—as

well as improved executive functioning and emotional resilience. Physiologically, the practice was associated with reduced salivary cortisol, improved heart rate variability, and increased natural killer (NK) cell activity, indicating stress recovery and immune enhancement (Song *et al.,* 2021; Mao *et al.,* 2020).

5.3 Practical Implications

Forest therapy holds practical potential across multiple domains:

- In clinical settings, it may supplement traditional psychotherapies, offering a non-pharmacological approach particularly suited to individuals with medication intolerance or access barriers (Kim *et al.,* 2021).
- In public health, urban green design can include forest-like zones to integrate ecotherapy into daily life (Kondo *et al.,* 2018; Browning & Lee, 2020).
- In schools and elder care, structured forest visits have shown benefits for managing academic burnout and geriatric depression, respectively (Park *et al.,* 2021; Chang *et al.,* 2023).

5.4 Limitations in Current Research

Despite its promise, several limitations must be acknowledged:

- Most studies included small samples and were conducted in East Asia or Europe, limiting generalizability.
- Heterogeneity in interventions—with variations in duration, facilitation, and location—makes cross-study comparisons difficult (Antonelli *et al.,* 2022).
- Few studies included longitudinal follow-up beyond 3–6 months, making it unclear whether benefits are sustained long-term (Jiang *et al.,* 2021; Hunter *et al.,* 2021).

5.5 Addressing Research Gaps

Future studies must:

- Include diverse populations in multi-national trials (Nguyen *et al.,* 2022).
- Standardize intervention protocols (Song *et al.,* 2021).
- Integrate neuroimaging and biomarker studies to understand mechanisms (Bratman *et al.,* 2015).
- Compare forest therapy with other eco-interventions such as horticultural therapy and digital nature exposure (Anderson *et al.,* 2021).

5.6 Forest Therapy in the Post-Pandemic Mental Health Landscape

Forest therapy's relevance has increased post-COVID-19, as it offers safe, outdoor, and socially distanced environments for healing (Lee *et al.,* 2022; Oh *et al.,* 2021). Given the global surge in depression and digital overload, forest therapy stands out as a timely, affordable, and ecologically sound intervention.

VI. FUTURE DIRECTIONS

The research has reinforced the potential of forest therapy in alleviating depression, several critical areas remain underdeveloped. To establish forest therapy as a scientifically robust and globally scalable intervention, the following directions are proposed:

6.1 Standardization of Intervention Protocols

Current studies use a variety of designs, including differences in session duration, facilitator involvement, and therapeutic activities. The absence of standardized intervention protocols limits reproducibility and comparison (Antonelli *et al.,* 2022; Kotera *et al.,* 2020). Future research should focus on creating consensus guidelines akin to clinical treatment protocols.

- For example, Li *et al.,* (2023) used six-week interventions with guided practices, whereas Hunter *et al.,* (2021) studied effects from shorter, unstructured exposures. Standardizing these variables would increase internal validity.

6.2 Longitudinal and Follow-Up Studies

Most studies report short-term outcomes. There is a pressing need for longitudinal studies assessing the durability of therapeutic benefits over time. Sustained follow-up (6–12 months) would help determine forest therapy's role in preventing relapse or recurrence of depressive episodes (Jiang *et al.,* 2021; Corazon *et al.,* 2020).

- Nguyen *et al.,* (2022) recommend long-term tracking of green space exposure to assess its cumulative impact on mental health.

6.3 Mechanistic and Biomarker Research

Understanding the biological mechanisms underlying forest therapy can strengthen its clinical credibility.

- Song *et al.,* (2021) and Mao *et al.,* (2020) found significant reductions in cortisol and increases in immune markers.
- Future work should incorporate neuroimaging (fMRI) and hormonal assays to clarify how forest environments modulate brain structures involved in mood regulation (e.g., prefrontal cortex, amygdala) (Bratman *et al.,* 2015).
- The role of phytoncides (natural aromatic compounds from trees) in influencing serotonin or dopamine levels also deserves deeper biochemical investigation (Li, 2010).

6.4 Comparative Effectiveness Trials

Head-to-head comparisons with conventional treatments are still scarce. Future studies should compare forest therapy with:

- Cognitive behavioral therapy (CBT) (Park & Kim, 2020),
- Pharmacotherapy,

- Other nature-based interventions like horticultural therapy or virtual reality forest immersion (Anderson *et al.*, 2021).

Such studies will guide clinical decision-making and inform cost-benefit analyses.

6.5 Cross-Cultural and Inclusive Research

Forest therapy research is currently dominated by East Asian and European contexts. To ensure cultural generalizability, it must be studied across diverse ethnic, socio-economic, and geographic backgrounds (Kondo *et al.*, 2018).

- Research in Indigenous communities, low-income urban areas, and regions with limited access to green space should be prioritized.
- Nevin & Watson (2022) argue that integrating cultural values into therapy design increases both efficacy and engagement.

6.6 Technological Integration

Innovative tools can improve accessibility and scalability, especially for people with limited mobility or those living in urban areas:

- Virtual forest therapy (VR) has shown positive effects in hospital patients and elderly populations (Anderson *et al.*, 2021).
- Smartphone applications that combine mindfulness prompts with nature exposure can supplement guided sessions (Hunter *et al.*, 2021).
- Wearable devices can track stress biomarkers in real time, allowing biofeedback integration.

6.7 Policy Implementation and Urban Planning

Forest therapy should be embedded into public health strategies and urban planning policies.

- WHO (2022) emphasizes the inclusion of green space access as a health determinant.
- Governments can develop certified forest therapy trails, offer insurance reimbursements, and promote it in schools, elder care centers, and rehabilitation settings.
- Shanahan *et al.*, (2016) suggest that policy-driven exposure to biodiversity-rich environments may offer cumulative psychological benefits.

VII. CONCLUSION

The growing mental health crisis, accentuated by the COVID-19 pandemic, has underscored the need for accessible, holistic, and sustainable approaches to psychological well-being. Forest therapy, with its roots in both ancient nature-connectedness and modern scientific validation, has emerged as a promising complementary intervention for depression.

This review analyzed research findings of studies including randomized controlled trials, observational research, and systematic reviews. The evidence demonstrates that forest therapy:

- Significantly reduces depressive symptoms,
- Enhances mood, cognitive clarity, and physiological resilience,
- Promotes social connection and mindfulness,
- Offers low-cost, non-pharmacological treatment with minimal side effects.

These benefits were consistent across various populations, including the elderly, students, and individuals experiencing post-pandemic stress. While methodological limitations exist—such as small sample sizes, lack of standardization, and limited cultural diversity—the overall trend strongly supports forest therapy's therapeutic value.

Looking forward, forest therapy holds immense potential in both clinical and public health contexts. It aligns well with the biopsychosocial model, supports preventive mental health care, and reinforces the human-nature relationship. With further research, policy support, and interdisciplinary collaboration, forest therapy can evolve from a wellness trend into a mainstream, evidence-based mental health intervention.

List of Abbreviations

Abbreviation	Full Form
ART	Attention Restoration Theory
BDI	Beck Depression Inventory
BDI-II	Beck Depression Inventory-II
CBT	Cognitive Behavioral Therapy
CES-D	Center for Epidemiologic Studies Depression Scale
CI	Confidence Interval
CPT	Cognitive Processing Therapy
fMRI	Functional Magnetic Resonance Imaging
HPA Axis	Hypothalamic-Pituitary-Adrenal Axis
MDD	Major Depressive Disorder
NK cells	Natural Killer Cells
PHQ-9	Patient Health Questionnaire-9
PSQI	Pittsburgh Sleep Quality Index

PTSD	Post-Traumatic Stress Disorder
QoL	Quality of Life
RCT	Randomized Controlled Trial
SRT	Stress Reduction Theory
VR	Virtual Reality
WHO	World Health Organization

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