# Evidence for the Benefits of Forest Bathing (Shinrin-Yoku):

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Abstract: The maladaptive stress response noted in the wake of the global COVID-19 pandemic has created an urgency for novel ways to combat the chronic illnesses and mental health declines that do occur secondary to improperly handled stress. Shinrin-Yoku is a recreational/ therapeutic activity where one meanders through a forest, mindfully engaging all the senses, for the purpose of spiritual connectedness and psychophysiological benefits in synergy with nature. The allure of forest bathing is well-understood as people set aside the hectic world for a hushed environment of fresh air and all-sense stimulation. Forest bathing is just as incredible as it sounds, with benefits to all body systems, largely due to the parasympathetic, anti-inflammatory, and antioxidant actions from the practice. Some of the more repeated and compelling benefits are: cardiovascular with improvements in heart rate and blood pressure; respiratory with improvements in lung function, immune with increased natural killer cell activity that lasts up to 30 days after a single intervention; central nervous/ psychiatric/ experiential with improvements in depression, anxiety, alcoholism, sleep disorders, pain/ chronic pain, mood disorders, attention deficit/hyperactive disorder, stress, and cognition; along with increased parasympathetic activity, all-sense stimulation, sense of awe, gratitude, selflessness, happiness, energy, life purpose, well-being, and relaxation (Hansen, Jones, & Tocchini, 2017; Pavlovic & Connolly, 2023). Despite proven benefits in ongoing human research, Shinrin-Yoku is unlikely to be recommended as a clinical therapy until current studies align in methodologic best practices, further identify individual factors that influence the effectiveness of forest-based interventions, and clarify time/duration/frequencies for specific conditions, as well as the optimal forest environment parameters to note benefits.

*Keywords: Shinrin-Yoku, forest bathing, stress, senses, nature, nature-immersive, parasympathetic*

## Introduction

The World Health Organization (WHO) recognizes the immense burden of stress worldwide and has placed mental health as a high priority topic to address in its Comprehensive Mental Health Action Plan 2013-2030 (WHO, 2021). Stress can be described as anything that shifts the body away from homeostasis (Chu et al., 2022). The maladaptive stress response is not just harmful; it can be deadly. Stress maladaptation results in a loss of ability to enjoy healthy functioning across all arenas of life. According to the Mayo Clinic, a stress response that remains chronically overstimulated can lead to headaches, muscle tension, anxiety, depression, sleep disturbances, high blood pressure, heart attack, and stroke (Mayo Foundation for Medical Education and Research, 2023). The impact of stress is felt immediately as well as over the long term and is both mental and physical. The American Psychological Association (2023) reports widespread stress as the world collectively attempts to deal with the trauma of the COVID-19 pandemic in addition to existing crises, though hope for stress exists in a surprising place.

The human stress response was designed as a survival tool to provide an immediate physiological response and quickly dissipate when the stimuli has passed. It is now widely recognized that a continuous low stress level can result in overworked adrenals as the human body fails to cope with excess stressful stimuli. Chu et al. (2022) explain that during a stress response, the central nervous system (CNS) controls the release of circulating stress hormones like cortisol and adrenaline. Stress hormones raise the heart rate, shunt blood to muscles, and release glucose for ready energy while slowing bodily processes that are not needed during an acute response. The problem lies in the continued release of these hormones due to chronic stress. The same hormones that are immensely helpful in responding to acute situations promote pathologic dysfunction when released chronically (Chu et al., 2022).

The impact of any stress event is determined by an individual's processing, the level of stimulation, and the type of trigger (Yaribeygi et al., 2017). Glucocorticosteroid and mineralocorticoid hormone receptors throughout the body bind stress hormones and respond with cascades of far-reaching effects and one such effect is that chronic stress functionally compromises the brain. The brain atrophies with a loss of mass, the brain's dendritic branches wither, neurons and synapses are lost, neurogenesis is compromised in the hippocampus while neurodegenerative processes see an uptick, and overall memory processing/ storage/ retrieval/ cognition decline. In addition, as cortisol increases, memory decreases. These responses may lead to cognitive, mood, and behavioral disorders (Yaribeygi et al., 2017).

The immune system is also hampered by stress. Yaribeygi et al. (2017) outline decreased phagocytosis, lower cytotoxic T lymphocyte action, and diminished natural killer cells scavenging as specific immune responses to stress. In addition, stress disrupts mucosal mast cells' function, resulting in increased gastrointestinal permeability to substances that inflame the immune system. The cardiovascular system is susceptible to stress and cardiovascular disease and an increased risk of myocardial infarction can occur secondary to chronic stress (Yaribeygi et al., 2017). Although stress may serve survival in the short term, chronic stress is so utterly debilitating that there is an unrelenting surge to find fresh ways to allay it.

Increasingly, agencies are conceptualizing health and well-being holistically and recognizing that well-being encompasses mental, physical, and social wellness as contributors to the total health picture. Globally, stress events that impact mental and physical health result from the intricate interplay of environmental, social, cultural, political, and economic factors. Specific stressors seen across the world include poverty, poor health, lack of access to healthcare, human rights abuses, and war (WHO, 2021, p. 2). In the United States, adults who are overworked face

"technostress" and burnout, while children stress grave issues such as race-based discrimination and school shootings (Salazar-Concha et al., 2021; Cabral et al., 2021). The American Psychological Association (2023) reports on the results of the 2023 “Stress in America” Harris Poll, attesting that the collective post-trauma of the COVID-19 pandemic resulted in an increase of 10% of chronic illness reports in just four years from 2019-2023. Additionally, 45% of people aged 35-44 and 50% of people aged 18-34 in America lay claim to struggling with a mental illness.

Stress is personal for the individual experiencing it and rarely comes from a single source. High-stress events may punctuate a life, but more often, there is a tumbleweed of smaller stressful occurrences that gather in size and impact health if not properly handled. The genuine risks to the mind and body cannot be overstated. More than ever before, there is a need for an arsenal of effective stress reduction strategies. Although stress reduction techniques like healthy boundaries and daily habits such as proper sleep hygiene, exercise, and nutrition are essential to cope with stress, there is a continued call for effective stress reduction interventions (Seaward, 2022, p. 35).

One stress-reduction technique that warrants a closer look is Shinrin-Yoku, which is Japanese for “forest bathing.” Shinrin-Yoku is one method to unplug, de-stress, and reconnect with nature all at the same time and is purported to be rife with cardiovascular, immune, and mental health benefits. In 1982, the Japanese Forestry Agency first promoted Shinrin-Yoku as a recreational option where individuals meander in a forest while breathing in the scents of the trees (Furuyashiki et al., 2019, Introduction). Today, the practice involves the same nature immersion with mindful attention to all the senses while surrounded by a forest environment.

The purpose of this literature review is to explore the myriad of research-backed benefits conferred by the practice of Shinrin-Yoku to mitigate stress.

## Methods

An initial search of PubMed garnered seven out of the 10 chosen literature reviews and scoping reviews of literature reviews about Shinrin-Yoku. In addition to the PubMed search, an ACHS Library and Information Resources Network (LIRN) search provided the option to scan multiple databases at once to include ProQuest Central and Gale Virtual Reference Library. The LIRN library LIRNsearch provided 609 results with check marks in "peer review" and "full text" and a date limitation of results after January 1, 2015. Of those results, ProQuest Central was host to 524 results, PubMed had 52 results, and Directory of Open Access Journals had 33 results. Provided that the direction of the paper was unclear, the first step was a casual perusal of both randomized controlled trials and systematic reviews.

The search string in PubMed was first "Shinrin-Yoku," which garnered 54 results. Sliding the date limiting bar to select "2017-2023" limited the results to 43. Further selecting "clinical trials," "meta-analysis," "randomized controlled trial," "review," and "systematic review" limited the results to 20 articles. At that point, the citations of intriguing randomized controlled trials, studies, and reviews were saved in a word document to further peruse from both the limited PubMed results and the LIRN Library search. Titles that were not available as "free full text" were scanned by Unpaywall and Google searched with the addition of "free full text." The unavailable titles were searched in LIRN Library ProQuest Central and four unavailable titles from all sites were requested from the ACHS librarian, Ashley Ehmig.

The culling process began with a decision to focus on the literature reviews and meta-analysis data in human subjects and forest therapies. Randomized controlled trials and clinical

trials were excluded, leaving appropriate review and meta-analysis titles. The remaining results were perused for their interest level in a variety of physiologic and psychologic topics. A total of 10 studies were completed for the annotated bibliography and four more titles saved to supplement the data if later desired.

## Study Data

In total, 15 final reviews (13 from PubMed and two from ProQuest via the LIRN Library) were included in this literature review, covering 238 primary and secondary research articles. Although some cross-over of reviewed articles exist among these reviews and systematic reviews, this exposition highlights a sampling of the benefits of SY, challenges in adopting SY for clinical use, and suggestions for the future direction of forest studies. Databases used by the authors of the reviews included PubMed, PubMed Central, EMBASE, Cochrane Library, MEDLINE, CiNii, Scopus, EBSCOhost, PsycINFO, Web of Science, Directory of Open Access Journals, Google Scholar, CINAHL, ScienceDirect, and in the language-unrestricted searches, foreign databases as well. All reviews cover human subject studies with objective and subjective measurements recognized as clinically appropriate research indices worldwide.

## Results Section

One renowned researcher of Shinrin-Yoku (SY) likened it to a channel that transports humans from our diminutive perspectives to the broader macrocosm of nature (Li, 2022). Stier-Jarmer et al. (2021) spoke of the allure of the forest for its quiet atmosphere, verdant beauty, and the energy of the volatile organic compounds wafting through the air. In contrast, Pavlovic and Connolly (2023) expressed the growth of techno-stressed populations that increasingly dwell in cities with inherent toxic exposures, rarely escaping into nature to harness the healing powers that green space offers. Richard Louv (2008) coined the phrase "nature-deficit disorder,"

describing generations who are raised to appreciate nature conservation concepts while sequestered indoors rather than gaining wisdom from nature as an irreplaceably formative teacher (pg. 35). The pandemic added a new layer of fear to the stressed and sequestered trend of nature-deprived people all over the world, while life after the lockdown has highlighted the importance of freedom spent interconnected with fresh air green spaces for both mental and physical health.

Stress takes its toll in the form of compromised immune function that adds up to significant diseases and mortality (Li, 2022). Humans have an innate need for nature, and while this connection does not lend itself to uncomplicated study due to the myriad of natural variables that may serve as bias, the human need for nature has been hardwired from the beginning of human existence. Hansen and Jones (2020) spoke of increased energy and satisfaction with life, while Kotera, Richardson, and Sheffield (2022) found that living in green space lowers all-cause mortality. SY has been a recreational therapy in Japan since 1982. The Japanese Society of Forest Medicine was established in 2009, and SY is currently recognized as a clinical modality (Antonelli et al., 2021). The practice of forest bathing has been long revered in parts of the world, and globally, government initiatives and task forces have been dedicated to studying the effects of forests on human health. Meanwhile, locations around the world are being preserved as forest bathing environments like Germany's therapeutic forest on the island of Usedom by the Baltic Sea, Denmark's Nacadia Therapy Forest Garden, and Serbia's Goč Mountain Forests (Stier-Jarmer et al., 2021; Antonelli et al., 2021).

## Physiologic Benefits

### Respiratory System

In their 2017 review, Hansen, Jones, and Tocchini noted respiratory benefits of improvements in allergies, asthma, and respiratory diseases such as chronic obstructive pulmonary disease (COPD). Antonelli et al. (2022) also noted respiratory benefits that included significant improvements in forced expiratory volume (FEV), forced vital capacity (FVC), and peak expiratory flow (PEF). The review consisted of individuals throughout the lifespan, healthy participants, as well as participants with respiratory diseases including bronchial asthma and chronic obstructive pulmonary disease (COPD) in a variety of forest environments around the world. Interestingly, the research suggested that the respiratory benefits may be more substantial near water sources. This effect was thought to be due to the natural nebulizing effect of moving water further dispersing the phytoncides in the forest.

Antonelli et al. (2021), Antonelli et al. (2022), Oh et al. (2017), Yau & Loke (2020), and Piva et al. (2022) all discussed the anti-inflammatory/ antioxidant benefits of forest bathing, most attributing these benefits to the volatile organic compounds released by the trees and flora. Once inhaled and systemically circulated, the medicinal actions of essential oil compounds like limonene, pinene, and camphene have recognized anxiolytic, antioxidant, and relaxant properties (Antonelli et al., 2021). The authors agree that several needs remain: to assess the proper effect size for respiratory forest interventions, assess long-term benefits, and further extrapolation of variables/ confounders. Ultimately, additional studies would strengthen the respiratory benefits claims of SY.

**Cardiovascular System**

Cardiovascular benefits were discussed in 10 reviews. The effect of SY resulting in decreased blood pressure was noted in Antonelli et al. (2021), Hansen, Jones, & Tocchini (2017), Ideno et al. (2017), Oh et al. (2017), Yau & Loke (2020), Timko Olsen, Hansen, & Vermeesch

(2020), Piva et al. (2022), Pavlovic & Connolly (2023), Stier-Jarmer et al. (2021), and Wen et al. (2019). Interestingly, a more significant difference was exerted by forest therapy when the participants had pre-existing high blood pressure or in those who were middle-aged and older. The greatest difference was also in systolic blood pressure, though both systolic and diastolic blood pressure lowered in human subjects in forest environments compared to urban environments (Ideno et al., 2017). Mechanisms of action are dampening effects on the renin-angiotensin pathway, stress hormones, and the sympathetic nervous system while stimulating the parasympathetic nervous system (Li, 2022).

In studies with 267-485 participants, Antonelli et al. (2021) noted short-term decreases in pulse rate and heart rate variability and attributed these benefits to increased parasympathetic activity. Decreased pulse rate and heart rate variability were also noted in Hansen, Jones, & Tocchini (2017), Ideno et al. (2017), Yau & Loke (2020), Timko Olsen, Hansen, & Vermeesch (2020), Piva et al. (2022), Stier-Jarmer et al. (2021), and Wen et al. (2019). Additionally, dialogue regarding the positive impact of SY on cardiovascular diseases like congestive heart failure and coronary artery disease was found in Antonelli et al. (2021) and Hansen, Jones, & Tocchini (2017).

**Immune System**

Hansen, Jones, and Tocchini (2017) noted several immune benefits, including increased natural killer cell activity with decreased lymphocytes, malondialdehyde (MDA), and cytokine production. Increased natural killer cells were also noted in Li (2022), Antonelli et al. (2021), Pavlovic & Connolly (2023), Timko Olsen, Hansen, & Vermeesch (2020), Stier-Jarmer et al. (2021), and Wen et al. (2019). The 2021 Stier-Jarmer et al. and 2017 Oh et al. reviews spoke of decreased cytokines and inflammation from trials deemed low to moderate quality. Hanson,

Jones, and Tocchini (2017) equated increases in natural killer cells with decreased cancer risk, while Antonelli et al. (2021) added decreased susceptibility to infections and autoimmune/ allergen problems to decreased cancer risk.

### Adrenal and Metabolic Systems

Benefits gleaned from SY for the adrenal and metabolic systems may include decreased blood glucose and HbA1c (Antonelli et al., 2021; Yau & Loke, 2020). Antonelli et al. (2021), Wen et al. (2019), and Timko Olsen, Hansen, and Vermeesch (2020) spoke of increased adiponectin in adult subjects, while Stier-Jarmer et al. (2021) discussed the low quality of the studies conveying metabolic benefits. Decreased stress from all sources, specifically regarding work-related stress and technostress, was a common theme in Oh et al. (2017), Timko Olsen, Hansen, and Vermeesch (2020), Piva et al. (2020), Antonelli et al. (2021), Li (2022), and Pavlovic and Connolly (2023).

### Central and Peripheral Nervous Systems

The very practice of SY engages the senses, and both Antonelli et al. (2021) and Hansen, Jones, and Tocchini (2017) discussed central nervous system stimulation. Central and peripheral nervous system benefits from time spent forest bathing include increased cognition (Antonelli et al., 2021), decreased pain/ chronic pain (Hansen, Jones, & Tocchini, 2017), and decreased incidences of disordered sleep (Hansen, Jones, & Tocchini, 2017; Li, 2022). Li (2022) deduced that increased autonomic homeostasis came from decreased sympathetic activity and increased parasympathetic activity and vagal tone. The increase in parasympathetic activity was also highlighted in the review by Antonelli et al. (2021) and associated strongly with decreased stress and increased relaxation (Yau & Loke, 2020).

## Psychological Benefits

**Conceptual**

SY hosts loads of benefits in the realm of spiritual well-being and overall well-being. Overall well-being increases were spoken of in the Antonelli et al. (2021) review, while increased spiritual well-being was covered in the Hansen, Jones, & Tocchini (2017) and Hansen & Jones (2020) reviews with findings of awe, gratitude, selflessness, relaxation, happiness, energy, and affirmed life-purpose among others. Interestingly, Hansen and Jones (2020) found that for many, nature is a temple. Nature itself is perceived as spiritual, conveying a sense of belonging and acceptance, and expansive natural environments allow the freedom for personal perspective shifts, self-examination, and revelation. SY was associated with increased quality of life perceptions in Yau & Loke (2020) and Pive et al. (2020).

**Experiential**

Many studies reported results that attest to SY benefits of decreased negative rumination and mood disturbances (Antonelli et al., 2021; Hansen, Jones, & Tocchini, 2017; Pavlovic & Connolly, 2023; Wen et al., 2019). Another experiential improvement touched upon in the nervous system section above was the perception of decreased stress with concurrent increases in adaptive and self-soothing behaviors (Hansen, Jones, & Tocchini, 2017; Kotera, Richardson, & Sheffield, 2022; Pavlovic & Connolly, 2023; Stier-Jarmer et al., 2021; Wen et al., 2019). Lastly, study participants report decreased anger following SY interventions (Antonelli et al., 2021; Kotera, Richardson, & Sheffield, 2022; Li, 2022; Stier-Jarmer et al., 2021). These benefits are thought to be short-term, so SY should be experienced regularly for continued benefits.

**Mental Disorders**

Antonelli et al. (2021) speak of decreased attention deficit/ hyperactive disorder (ADHD) and decreased post-traumatic stress disorder (PTSD) symptoms after SY interventions. SY was

shown to be helpful for alcohol addiction in Antonelli et al. (2021) and Hansen, Jones, & Tocchini (2017). Additionally, a growing body of evidence exists for SY's beneficial effects on depression (Oh et al., 2017; Wen et al., 2019; Piva et al., 2020; Yau & Loke, 2020; Timko Olsen, Hansen, & Vermeesch, 2020; Stier-Jarmer et al., 2021; Antonelli et al., 2021; Kotera, Richardson, & Sheffield, 2022; Li, 2022; Pavlovic & Connolly, 2023; Doran-Sherlock, Devitt & Sood, 2023). The most solid researched benefit of SY was decreasing anxiety (Antonelli et al., 2021; Oh et al., 2017; Yau & Loke, 2020; Timko Olsen, Hansen, & Vermeesch, 2020; Kotera, Richardson, & Sheffield, 2022; Stier-Jarmer et al., 2021; Wen et al., 2019). The importance of mental health is not to be understated as 15% of the world population struggles with mental health issues at an average cost of 2-4% of the total gross domestic product of developed nations, equating to over 7 trillion dollars worldwide by 2030 with steep losses of health, productivity, and quality of life (Kotera, Richardson, & Sheffield, 2022). Sadly, even more of the world's children and adolescents suffer mental health issues at a rate of 20% (Antonelli et al., 2021).

## Extremes

Forest bathing may be well suited to address the extremes of the patient experience. For instance, patients who entered SY interventions with higher blood pressure saw the most significant blood pressure lowering effects (Ideno et al., 2017). Likewise, patients who were older also exhibited more profound benefits. Both cancer patients and menopausal women with insomnia experienced better sleep following SY interventions (Antonelli et al., 2021). Additionally, forest bathing was perceived to meet the spiritual needs of patients with cancer (Hanson, Jones, & Tocchini, 2017). In Japan, there is a word denoting workplace-driven suicide, and SY is utilized to allay the extreme stress that drives citizens to their breaking point (Kotera, Richardson, & Sheffield, 2022).

### Length of Intervention to See Benefits/ Duration of Action of Benefits

Although some studies recommended guidelines for the length or duration of treatment, most spoke of the need to further elucidate best practices due to the wide variance in studies. Antonelli et al. (2021) expounded on duration, speaking of immersive experiences hosting immune benefits lasting 7-30 days and 15 minutes as a benchmark for short-term stress and anxiety improvements. Additionally, interventions of 10-30 minutes provided short-term benefits for stress, mood, and vitals, with evidence of decreased sympathetic nervous system activity, and a general population suggestion of two hours a week was suggested for well-being boosts compared to lack of nature exposure. Longer lasting results emerged in the immersive multi-day sessions (Antonelli et al., 2021; Hansen, Jones, & Tocchini, 2017). Li (2022) pleads with the greater scientific community to expand upon the foundation of forest medicine to establish treatment guidelines and protocols.

### Applicable Theories

Many hypotheses support the use of nature therapy and Shinrin-Yoku as a form of nature therapy. These hypotheses shape the research direction and serve to define the foundation of SY, which may precede clinical guidelines and applications. Kaplan's Attention Restoration Theory is rooted in the thought that a person's concentration is restored when in a forest environment because it feels effortless to be aware and pay attention while engaging in SY (Kotera, Richardson, & Sheffield, 2022; Hansen, Jones, & Tocchini, 2017). The Stress Reduction Theory speaks of how perceived safe natural environments may lower stress, heart rate, blood pressure, and strengthen the immune system; while Gilbert's Affect Regulation Theory asserts that people can soothe, calm, and regulate their own emotions when the parasympathetic nervous system is stimulated as it is during the practice of SY (Kotera, Richardson, & Sheffield, 2022).

Hansen & Jones (2020) and Hanson, Jones & Tocchini (2017) mention several theories that may help inform the effectiveness of SY, like Kellert and Wilson's Biophilia Hypothesis, which at its core means that humans experience a pull to connect with the life force in other living things and Wilson's exploration of wonder and awe. Meanwhile, Ulrich's Stress Reduction Hypothesis equates viewing nature with restorative benefits that calm and provide pleasure. Song, Ikea, and Miyazaki are renowned SY researchers whose Concept of Nature Therapy takes the restorative benefits even further to claim that the calm and pleasure of experiencing nature results in physiologic relaxation that boosts compromised immune systems and can prevent disease. Kaplan and Kaplan theorized that the engagement of all five senses was responsible for the strength of the parasympathetic nervous system activation (Hansen, Jones, & Tocchini, 2017). The Biodiversity Hypothesis explores the likelihood that exposure to the microbiome in the forest is beneficial to allay immune and allergenic problems in people who live in urban environments and otherwise suffer from a lack of diversity in their microbiome, stating that this exposure is especially crucial in the formative years of the childhood immune system (Antonelli et al., 2021). Other theories include Thompson's "vis medicatrix naturae" denoting the innate ability of the body to heal (with the help of nature), Christian Ecotheology, "sacred place," the power of mindfulness, and the premise that nature is a temple, engaging a latitude beyond what is physically sensed (Hansen, Jones, & Tocchini, 2017; Timko Olsen, Hansen, & Vermeesch, 2020; Hansen & Jones, 2020).

## Study Evaluations

### Areas for Growth

The review studies were evaluated with tools like the NIH study quality tool, Cochrane's risk of bias tool, and Klassen's Framework. Under the scrutiny of evidenced-based peer review,

SY studies were fraught with methodological issues in study design, reporting quality, and lapses in data collection and reporting. Common themes include non-generalizable sample sizes that lacked power calculations (Antonelli et al., 2021; Hansen, Jones, & Tocchini, 2017; Pavlovic & Connolly, 2023; Oh et al., 2017; Timko Olsen, Hansen, & Vermeesch, 2020), lack of randomization or missing allocation data (Antonelli et al., 2021; Kotera, Richardson, & Sheffield, 2022; Stier-Jarmer et al., 2021; Wen et al., 2019; Oh et al., 2017; Timko Olsen, Hansen, & Vermeesch, 2020), and missing or inadequate control groups (Antonelli et al., 2021; Pavlovic & Connolly, 2023; Stier-Jarmer et al., 2021; Wen et al., 2019). Reviews mentioned many studies with a high risk of bias, gender allocation/ age skews, lack of blinding, risk of publication bias, missing information on attrition, lack of adverse event reporting, missing outcome data, lack of follow-up, and a general lack of homogeneity among studies resulting in under-representative results (Antonelli et al., 2021; Pavlovic & Connolly, 2023; Stier-Jarmer et al., 2021; Wen et al., 2019; Kotera, Richardson, & Sheffield, 2022; Oh et al., 2017; Timko Olsen, Hansen, & Vermeesch, 2020; Hansen, Jones, & Tocchini, 2017). Additionally, the cross-over trial designs may have overestimated results without proper washout periods (Antonelli et al., 2021; Kotera, Richardson, & Sheffield, 2022; Wen et al., 2019; Doran-Sherlock, Devitt, & Sood, 2023).

**Existing Strengths**

An important strength of SY research is that it is human subject research, rather than in vitro or animal studies that do not cleanly apply to human life. Despite the wide variance of study interventions, methods, and quality reported, some trials presented robust research designs as evidenced by thorough designs and replication of those designs in later research (Hansen, Jones, & Tocchini, 2017). There is also a clear description of the various tests used throughout most of

the studies, like the Beck Depression Inventory, the Profile of Mood States, electrocardiogram, electroencephalogram, vital measures, blood tests, and salivary tests, among others which are utilized and trusted worldwide (Kotera, Richardson, & Sheffield, 2022). Intricacies such as considering time-of-day variances of natural killer cell levels or the diurnal rhythms of stress hormones were accounted for by measuring these values at specific times of day and the same time each time (Li, 2022; Pavlovic & Connolly, 2023). Evidence of bias was weak in the blood pressure studies, adding credence to the results (Ideno et al., 2017). Other strengths include controlling for confounders like previous forest experience in some of the trials (Pavlovic & Connolly, 2023). Other studies exhibited clear goals, appropriate data collection, and solid statistical analysis (Yau & Loke, 2020). The call for further studies is one to strengthen and grow the database of existing evidence.

## Summary

In summary, strong evidence exists for well-being, spiritual well-being, and mental health benefits, while compelling evidence that bears repeating in high-quality trials exists for immune and other physiologic benefits. Trial data exhibited the most generalizable results for SY's ability to decrease anxiety. In addition to the multitude of theories to explain why SY is beneficial, there is an innate human wisdom and draw to natural environs. The eastern mindset may be inherently more open to the virtues of SY and study approaches are geographically nuanced, as evidenced by the perceived quality of the studies from east to west. Strengths, weaknesses, and suggestions have been noted to advance the understanding of and promote the furtherance of SY globally. Overall, the studies confirmed beneficence in the purposeful human-nature communion provided by the practice of Shinrin-Yoku, though the scope and best practices for that beneficence bear further illumination.

## Discussion Section

The purpose of this literature review is to explore the plentiful research-backed health-boosting effects that come with practicing Shinrin-Yoku. Generations of people who are deficient in nature have proven Richard Louv's urgency to compel generation back to nature as chronic illness and poor mental health abound for lack of stress-relief (2008). The Japanese pioneers of the Shinrin-Yoku intervention would likely agree that there is no substitute for feeling the cool damp of a well-beaten path on the forest floor while breathing deeply of freshly given oxygen provided by the company of life-giving trees. Experiencing the captivating entanglement with a force much bigger than oneself is best sensed firsthand. Louv (2008) projected blueprints of hope for generations of people to appreciate nature, and the spread of forest bathing confirms a welcome shift in a life-giving direction (p. 350-385).

Although the quality and type of studies varied wildly throughout the whole of Shinrin-Yoku research, solid benefits in physiologic measures like respiratory improvements, decreased blood pressure, increased natural killer cells, increased cognition, decreased pain, better sleep, decreased sympathetic nervous system activation, increased vagal tone, and parasympathetic activation exist in droves (Antonelli et al, 2022; Ideno et al., 2017; Hansen, Jones, and Tocchini, 2017; Antonelli et al., 2021). In fact, many of the benefits, both physiologic and psychologic, flow from parasympathetic activation, signifying a shift from stressing to repairing and relaxing (Antonelli et al., 2021; Yau & Loke, 2020). Scientists will continue to study inflammatory factors, metabolic benefits, and the effects of Shinrin-Yoku on all manners of disease processes to determine the extent of effects, especially over the long term. At this time, the benefits to cardiovascular and respiratory measures begin to fade as soon as a person leaves the forest while

the spike in immune function can remain for up to 30 days after forest bathing exposure (Antonelli et al., 2021).

Researchers are just beginning to determine parameters for the length of a forest bathing outing that will provide therapeutic effects for any given medical condition. Currently, fully immersive experiences over a period of days appear to impart the most benefit to participants. These multi-day experiences should be considered an investment in wellness and consist of mindful, multi-sense exploration. For those who cannot get away for days of immersion, regular forest bathing can serve as an enriching reset in as little as 15 minutes of rapt sensory engagement tucked into the seclusion of stalwart trees (Antonelli et al., 2021). Professionals facing burnout, patients with anxiety and PTSD, and chronic medical or mental health conditions may consider deeply immersive excursions on a regular basis. A starting benchmark goal for regular forest bathing is two hours per week, but even increments of 15-30 minutes have been shown helpful to mitigate stress, so this can be accomplished at one time or broken up as needed (Antonelli et al., 2021; Hansen, Jones, & Tocchini, 2017). The need for time recommendation refinement persists.

The psychological gains from Shinrin-Yoku have a solid evidence basis. Mental illness has received due attention in the wake of COVID-19's challenge to the mental health of both children and adults, so a firmly established nature-based intervention that is proven to decrease stress, anxiety and depression is a timely solution (Antonelli et al., 2021; Oh et al., 2017; Yau & Loke, 2020; Timko Olsen, Hansen, & Vermeesch, 2020; Kotera, Richardson, & Sheffield, 2022; Stier-Jarmer et al., 2021; Wen et al., 2019). The mental health arena is also where subjective study measures are needed and really shine. One facet of mental health that can be overlooked but is well-tended by the practice of Shinrin-Yoku is spiritual health. There is also plentiful

qualitative evidence for the experiential spiritual benefits of forest bathing. In the qualitative measures, interesting themes emerge for both spiritual and overall well-being provided through the practice of Shinrin-Yoku. Descriptors like happiness, gratitude, purpose, and awe have repeatedly surfaced (Hansen, Jones, & Tocchini, 2017; Hansen & Jones, 2020). People survey their internal landscapes in the safe space of the forest and experience spiritual enrichment with an uptick in self-soothing and adaptive abilities that is capable of assuaging even severe mental distress like PTSD and cancer-caused insomnia (Antonelli et al., 2021; Kotera, Richardson, & Sheffield, 2022).

In the East, where the practice of Shinrin-Yoku was named and adopted on widescale and where the studies originated, the participants approached the subject with a degree of certainty due to their faith in the power of nature. Interestingly, the spiritual facet may account for some discrepancies between the successes of the East studies that could not be replicated in the West. Astonishing benefits were repeatedly noted in countries where the core belief systems esteem forests as spiritual sanctuaries. One example is the Shintoist belief system, while another is cultural resonation (Kotera, Richardson, & Sheffield, 2022). The reverence for the practice of Shinrin-Yoku and belief in the power of the spiritual connection to the earth through synergetic attentiveness may well account for the number of positive results noted in the early studies.

Thus far, the successes of these early studies have been less replicable in societies that do not inherently respect nature as a construct of their religion or worldview (Antonelli et al., 2021; Pavlovic & Connolly, 2023; Stier-Jarmer et al., 2021; Wen et al., 2019; Kotera, Richardson, & Sheffield, 2022; Oh et al., 2017; Timko Olsen, Hansen, & Vermeesch, 2020; Hansen, Jones, & Tocchini, 2017). The focus has been on the deficits of the trials rather than the overarching message that faith while practicing Shinrin-Yoku makes all the difference. Western practitioners

approach nature studies with reliance on the scientific reductionist model of proving through randomized controlled trials with placebo controls. The Achilles heel of the RCT in forest studies is that it leaves little room for the subjective and experiential. Reliance on the RCT can also place too high of an importance on the burden of proof, leaving a seed of doubt for what would otherwise be recognized instinctively. Nature is destroyed by control, and by its very character, is wild. In truth, people only need to intuit their need for nature. Nothing could be more common sense than the truth that humans need to be immersed in experiences with the earth that nourishes, hosts, and sustains life.

The spiritual communion offered by Shinrin-Yoku, a factor that may contribute to psychophysiological benefits, also defies studying in tidy scientific trials. Therefore, it will be best if those bent towards RCT's first acknowledge the integral soul and spirit of their person, life, and work prior to contributing to or evaluating the evidentiary body of Shinrin-Yoku studies. For the time being, the variance in studies for any given medical condition necessitates individual rather than corporate study evaluations, as reviewers continually judge them inconclusive when considered in concert. The greatest need is the continued development of theoretical basis and best practices for Shinrin-Yoku research to inform future research efforts for specific medical concerns.

As future trials ensue, researchers can raise the bar by solving the many review-related quality issues. These quality issues include proper sample size calculations, randomization, adequate controls, transparent reporting, multi-gender/multi-age representation, attrition statistics, adverse event reporting, and adequate follow-up. Best methods should include forest descriptors down to the VOC’s that are present to help inform the potential benefits from the phytoncides of a particular geographic location and tree grouping. It makes sense that the

specific tree varieties present in any given forest will alter the phytoncides and psychophysiological effects (Antonelli et al., 2021). Kotera, Richardson, and Sheffield (2022) recommend exploring participant's attitudes towards and experiences with nature as people have varying degrees of comfort with nature, which may impact the results of forest bathing interventions. In general, noting detailed health and lifestyle factors of the study subjects minimizes this confounder.

RCT's continue to prove more reliable than cross-over trials due to inadequate blinding and washout periods between study arms, and RCT's for forest bathing are at their best when they include both objective and subjective measures to account for measurable data and difficult-to-quantify spiritual enrichment. The best studies pre-file their intent with the proposed methodology and recruit more than 30 participants for each test group (Hansen, Jones, & Tocchini, 2017). Performing a power calculation to determine the minimum sample size needed for generalizable results and exceeding that number of recruits to account for study attrition is even better. At this point, with promising evidence that lacks universal application due to poor design, heterogeneity, and low sample sizes, it is best to refrain from conducting poorly designed studies or studies that fail to meet the clinical significance, which weaken the evidence-basis for the use of Shinrin-Yoku overall.

The variance of study quality meant the veracity of the results of many of the foundational studies on Shinrin-Yoku were called into question and picked apart at the seams for not fitting into the Western ideal of what an RCT should be. RCT's are wonderful tools that encourage homogeneity and replicability in the scientific realm. In medical research, this is invaluable and provides a basis for a meeting of minds across the world to maintain high standards and share medical advances. However, this study configuration will best apply to the

nuances of forest studies by adding subjective measures given the spiritual aspects that can only be quantified through personal descriptions.

Beyond that first glance, however, one sees hundreds of research initiatives worldwide that are pulling people out of their creature comforts into the great outdoors to experience nature immersion. The global COVID-19 pandemic created a yearning to return to nature and open, fresh-air spaces as people ventured from their lockdowns and found safe haven in outdoor activities. Countries worldwide are beginning to promote nature immersion from the local and governmental levels, running analyses with findings that suggest forest therapy offers even more benefits at lower costs than other health initiatives (Antonelli et al., 2021). Additionally, the spread of Shinrin-Yoku as a beneficial recreational activity has encouraged people worldwide to restore native tree habitats. People are becoming a friend to the earth through these efforts and benefitting from the psychological and physiological boost of participating in nature restoration projects concurrently in a beautiful win-win cycle (Hansen, Jones, & Tocchini, 2017).

## Conclusion

A maladaptive reaction to stress is responsible for pain and suffering worldwide, with high costs in terms of mental and bodily harm. The allure of forest bathing is well-understood as people set aside the collective stress and trauma of the outside world for a hushed environment of fresh air and all-sense stimulation (Stier-Jarmer et al., 2021). A review of the literature proves forest bathing is just as incredible as it sounds, with benefits to all body systems, largely due to the parasympathetic, anti-inflammatory, and antioxidant actions from the practice. Some of the more repeated and compelling benefits are: cardiovascular with improvements in heart rate and blood pressure; respiratory with improvements in lung function, immune with increased natural killer cell activity that lasts up to 30 days after a single intervention; central nervous/ psychiatric/

experiential with improvements in depression, anxiety, alcoholism, sleep disorders, pain/ chronic pain, mood disorders, attention deficit/hyperactive disorder, stress, and cognition; along with increased parasympathetic activity, all-sense stimulation, sense of awe, gratitude, selflessness, happiness, energy, life purpose, well-being, and relaxation (Hansen, Jones, & Tocchini, 2017; Pavlovic & Connolly, 2023).

The theoretical basis for forest bathing is present in force and the existing study data reveals steps that future researchers can take to ensure forest bathing is taken seriously for its amazing therapeutic potential, including conducting high-quality RCT's that include subjective surveys along with objective data collection to account for as much of the full experience as possible (Hansen, Jones, & Tocchini, 2017). The strongest physical benefits likely flow from the spiritual connection experienced with nature and manifestation that flows from belief in the practice. Further exploration of attitudes that influence forest-based results are needed. This complementary practice is being adopted in various parts of the world and economic studies prove that it is both cost-effective and beneficial to adopt at both the local and national level. Additionally, the practice encourages forest conservation and restoration efforts. Although Shinrin-Yoku is unlikely to be recommended as a clinical therapy until studies align in methodologic best practices, and time/duration/frequencies/locations/forest size are clarified for specific conditions, the benefits for the stress-drenched world should compel us into the woods.

Current studies are ongoing and lack homogeneity, clouding clear conclusions on some of the finer points that would help Shinrin-Yoku be adopted as a medically therapeutic modality. Still, this is human research all around the world with enough high-quality study data to confirm what we intuitively know: the life in nature speaks to the life in us. We benefit from time spent with the earth that nourishes us. Whether or not the studies align over specific recommendations

for the many benefits anytime soon, inner wisdom confirms what reductionist science is slow to acknowledge. Until the research catches up to what innate wisdom speaks, those who look with soul in addition to science may be found in the forest, bathing.

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