

# The potential to integrate Forest therapy and Forest bathing (Shinrin-Yoku) with Nature-based mindfulness into public health programs

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## ABSTRACT:

The term ‘Forest therapy’ covers both preventive and therapeutic interventions in the forest. It is increasingly used for health promotive activities that are also referred to in the literature as “Forest bathing” (jap. “Shinrin-Yoku”), forest walks, and forest healing as well as for therapeutic purposes like nature therapy. It involves consciously engaging in slow, multi-sensory, immersive experiences in forests and other natural and semi-natural environments to achieve mental and physical health and well-being. There is a growing body of evidence-based research demonstrating the physiological and psychological effects of forests on health. Physiological effects can be seen in improvements in blood pressure, heart rate, cortisol levels, pain relief, stress reduction, respiratory function, and general well-being. It has been confirmed to have psychological effects on symptoms of depression, and anxiety, improving quality of life, mood, emotional and physical burnout, self-perception and acceptance, concentration, and improving cognitive function. Shinrin-Yoku leads to a deepening of the relationship between man and nature, and to the ‘invisible’ world. Mindfulness in and with nature, on the other hand, is a new setting that involves the ability to observe both one’s perceptions and those of nature in an open and non-judgmental experience. Research has shown that mindfulness indoors reduces symptoms of depression and anxiety, significantly reduces overall stress, and improves quality of life. This type of intervention has been shown to help improve chronic physical conditions, including cardiovascular and malignant diseases. The European Society of Hypertension has recognized the benefits of mindfulness and included it as a supportive, i.e., non-pharmacological therapy in the treatment guidelines for arterial hypertension in 2023. In this paper, the researchers argue using both methods in a combined outdoor setting as a comprehensive approach to lay the foundations for social prescribing to support usual healthcare, to improve health outcomes.

**KEYWORDS:** Forest Therapy; Shinrin-Yoku; Nature-Based Mindfulness; Public Health Programs

**SAŽETAK:**

POTENCIJAL ZA INTEGRACIJU TERAPIJE ŠUMAMA I KUPANJA ŠUMA (SHINRIN-YOKU) S PRIRODOM UTEMELJENOM MISAONOŠĆU U PROGRAME JAVNOG ZDRAVSTVA

Pojam „šumska terapija” obuhvaća i preventivne i terapijske intervencije u šumi. Sve se više koristi za aktivnosti promicanja zdravlja koje se u literaturi nazivaju i „Forest bathing” (JAP. „Shinrin-Yoku”), šumske šetnje i cijeljenje šuma, kao i u terapijske svrhe poput terapije prirodom. Uključuje svjesno bavljenje sporim, višesjetilnim, imerzivnim iskustvima u šumama i drugim prirodnim i poluprirodnim okruženjima kako bi se postiglo mentalno i fizičko zdravlje i dobrobit. Postoji sve veći skup istraživanja utemeljenih na dokazima koja pokazuju fiziološke i psihološke učinke šuma na zdravlje. Fiziološki učinci mogu se vidjeti u poboljšanjima krvnog tlaka, srčane frekvencije, razina kortizola, ublažavanja boli, smanjenja stresa, respiratorne funkcije i opće dobrobiti. Potvrđeno je da psihološki djeluje na simptome depresije i tjeskobe, poboljšavajući kvalitetu života, raspoloženje, emocionalno i fizičko izgaranje, samopercepciju i prihvaćanje, koncentraciju i poboljšavajući kognitivnu funkciju. Shinrin-Yoku vodi produbljivanju odnosa čovjeka i prirode te ‘nevidljivom’ svijetu. Svjesnost u prirodi i s prirodom, s druge strane, novo je okruženje koje uključuje sposobnost promatranja i vlastite percepcije i percepcije prirode u otvorenom i neprosuđujućem iskustvu. Istraživanja su pokazala da osviještenost u zatvorenom prostoru smanjuje simptome depresije i tjeskobe, značajno smanjuje ukupni stres i poboljšava kvalitetu života. Pokazalo se da ova vrsta intervencije pomaže u poboljšanju kroničnih fizičkih stanja, uključujući kardiovaskularne i maligne bolesti. Europsko društvo hipertenzije prepoznalo je koristi obzirnosti i uvrstilo ga kao potpurnu, tj. nefarmakološku terapiju u smjernice za liječenje arterijske hipertenzije 2023. godine. U ovom radu istraživači raspravljaju o uporabi obiju metoda u kombiniranom okruženju na otvorenom kao sveobuhvatnom pristupu postavljanju temelja za socijalno propisivanje kako bi se podržala uobičajena zdravstvena skrb, poboljšali ishodi zdravlja.

**KLJUČNE RIJEČI:** Šumska terapija; Shinrin-Yoku; Svjesnost temeljena na prirodi; Programi javnog zdravstva

**INTRODUCTION**

The burden of stress and its impact on physical and mental health is a serious threat to public health and one of the most important national issues in various countries around the world, particularly in Japan (1). Nowadays, technostress is an increasing stress factor, which was coined back in 1984 to describe unhealthy behaviour in connection with new technologies. Technostress can arise from everyday activities such as constantly checking your phone, obsessively sharing updates, and feeling the need to be constantly connected. Symptoms can take the form of anxiety, headaches, depression, mental fatigue, eye and neck strain, insomnia, frustration, irritability, and loss of control over emotions (2). On the other side, chronic high levels of stress can cause almost all non-communicable diseases such as cancer, high blood pressure, depression, cardiovascular disease, stroke, stomach ulcers, obesity, alcoholism, panic disorders, and eating disorders (3). Under the pressure of high costs and the serious negative consequences of stress, especially for the urban population stressed by everyday life in the city, the Japanese health system has been researching measures to reduce stress for decades, and the search for relaxation in the natural environment has proven to be an effective strategy. For more than 25 years, the forest environment has been researched for its peaceful atmosphere, beautiful

scenery, calming climate, clean, fresh air, and particularly pleasant odour. Empirically, forest environments can reduce stress and have a relaxing effect. Therefore, walks in forest parks can have a positive effect on human health.

Forest therapy is gaining popularity as a potentially clinically effective intervention for stress management (4). While in the West, complementary and alternative therapy approaches are dominated by a focus on balneotherapy, climatotherapy, Kneipp therapy, dietetics, phytotherapy, as well as on interventions based on mindfulness, exercise and yoga in everyday life, in most Asian countries, especially in countries where Shintoism is widespread, preventive measures that focus on spending time in the forest represent much more than just spending time in a relaxing atmosphere and pleasant and fresh air (5-8). Based on the tradition of ritual going out into nature, public health interventions have focused on the implementation of health interventions in the forest, also known as immersion in the forest atmosphere in Japan. Shinrin-Yoku is a health-promotional program based on mindful immersion in the atmosphere of the forest with all the senses, to improve the health and well-being of the individual and to reduce the undesirable and harmful effects of stress on the mental and physical health of the body (9,10).

Walking and immersion in the forest atmosphere was first developed in Japan in 1982 by the Japanese Ministry of Agriculture, Forestry and Fisheries, based on the intuitive belief that spending time in a natural environment could have positive effects on health to overcome the effects of stress and not just technical stress. Indeed, the habitats of modern humans, which have undergone rapid urbanization, have evolved dramatically from near-natural environments to artificial environments where, despite modern urban development and technological advances providing convenience and comfort, complex and fragmented urban environments can cause increased stress and exacerbate various chronic health problems. Shinrin-Yoku also stands for a relaxing visit to a forest area, which has a similar effect to hiking or walking or natural aromatherapy, to relax and inhale volatile substances from coniferous trees, known as phytoncides, such as alpha-pinene and limonene (11). Exposure to the natural stimuli provided by the plants and water in a forest is an effective strategy for promoting health and relaxation, lowering blood pressure and heart rate, reducing stress, and strengthening the immune system, which favours faster recovery from various diseases (12,13). The core of the forest-based health programs consists of using the five senses (sight, smell, hearing, touch, and taste). In addition, activities such as meditation, walking, and hiking, are used to experience the forest in its entirety (14).

There has also been a growing interest outside Japan in health forest health programs, collectively known as “Shinrin-Yoku”, which promote the improvement of emotional and mental health using the natural forest environment. The presence and application of Shinrin-Yoku from the Asian countries, especially South Korea has spread to the USA, Canada, Germany, Austria, and some countries of the former Yugoslavia, especially Slovenia, through the activities of the Association of Nature and Forest Therapy (ANFT) based in the USA, whose training courses since 2015 have been completed by more than 2000 Forest therapy guides worldwide, creating a network of licensed Forest therapy guides.

The term Forest medicine is increasingly being used to describe the effects of the forest environment on human health and represents a new interdisciplinary field of science that belongs to the categories of alternative medicine, environmental medicine, and preventive medicine. Forest medicine has developed from the practice of Shinrin-Yoku and Forest therapy and represents proven evidence of the psychological effect with the aim of prevention. Forest bathing / Shinrin-Yoku according to International Society of Nature and Forest Medicine (INFOM) is a part of Forest therapy and is based on the practice of treatment through immersion in the forest environment to promote mental and physical health and improve disease prevention while enjoying and respecting the forest. In South Korea, for example, spending time in the forest using the Shinrin-Yoku method is considered an activity that improves the immune system and people's

health by utilizing various elements from nature. The Korean government started to create dozens of forest oases for healing and expanded the project on a national level (15). In Europe, Germany has also developed certification standards and introduced recreational and therapeutic forests to improve mental and physical health (16)

On the other hand, mindfulness used as mindfulness-based stress reduction (MBSR) is gaining increasing attention in public health research, demonstrating the increasing effectiveness of interventions for mental and physical health. Mindfulness is based on traditional Buddhist practices and was introduced to Western medicine and psychology in the late 20<sup>th</sup> century by Dr Jon Kabat-Zinn and has been widely used in various therapeutic interventions (17). Although there is no clear definition, mindfulness is a state, i.e. the ability to observe one's own experience in an open and non-judgmental way, whether it is a simple sensory experience, such as mindfully eating a single raisin or a more complex process of dealing with emotions. It is also described as a state of awareness and intention in the present moment, without thinking about the past and the future and without judgment about thoughts, feelings, bodily sensations, and the environment. The individual is open to new experiences and focuses all their attention on their thoughts and feelings, which affects the neuroplasticity of the brain, i.e. on the ability of the nervous system to change its activity by reorganizing its structure, functions, or neuronal connections in response to internal or external stimuli, and to improve cognitive functions (18,19). Stemming from the Buddhist tradition, the foundation of mindfulness emphasizes the centrality of awareness and understanding of the nature of reality, which is consistent with cognitive psychology and the cognitive processes involved in determining behaviour. In the context of cognitive psychology, mindfulness enables the understanding and management of cognitive processes, including thoughts, feelings, and behaviours, and encourages individuals to recognize and disengage from habitual, automatic responses, thus promoting the ability to respond consciously to a given situation. The therapeutic benefits of mindfulness practice lie in the ability to detach from automatic cognitive processes, ingrained habits, and unhealthy behavioural patterns. Practicing mindfulness promotes the development of a balanced and accepting attitude towards one's own life experiences. This change in mindset contributes to mental calm, resilience, and a generally improved sense of well-being (20). Shinrin-Yoku applies the approach of mindfulness practice to nature to immerse yourself in the atmosphere of the forest with all your senses and awaken your awareness of the interconnectedness of all beings.

#### AIM

This paper aims to analyse and descriptively present the selected results of previous research on the influence of the practice of the Shinrin-Yoku method as a nature-based mindfulness immer-

sion into the forest on people's physical and mental health. In addition, an attempt will be made to explain the mechanism of action and to link the findings to date with possible theoretical assumptions, as well as to point out the shortcomings and limitations of previous research and to make suggestions for the design of future research to overcome the current methodological limitations and the resulting impossibility of generalizing the results obtained.

## RESULTS

Shinrin-Yoku stands for a series of activities aimed at improving human health or well-being in a forest environment. The key element is the perception of the forest environment with the five senses, which can be combined with meditation, walks in the forest, and various activities like art therapy, sensomotoric training, etc. In recent years, Shinrin-Yoku and its valued preventive effects have attracted more and more attention. Many previous studies have reported its positive effects on physiological and psychological health. The effects of Forest bathing on health and well-being have been studied in various contexts, particularly through its effectiveness in reducing stress and the resulting physiological changes that can be measured in the body. In the first Shinrin-Yoku study, 12 healthy male participants aged between 37 and 55 were selected from three large companies in Tokyo. A questionnaire was used to collect information about the participants, including their age and lifestyle. None of the participants had any signs or symptoms of infectious diseases, were not taking any medication that could interfere with immunological analysis and were not taking any medication during the study. The study was conducted in a forest area in Iiyama, Nagano Prefecture, in the Chubu region of Japan, over three days and two nights in early September 2005. During the above-mentioned period, the test subjects were exposed to walks, and blood samples were taken on their return to Tokyo. The blood samples were used to measure white blood cell counts, natural killer (NK) cell activity, T-cell counts, and the number of lymphocytes expressing granulysin (GRN), perforin, and granzymes A and B (GrA/B). The same measurements were carried out before traveling, on a normal working day, as a control. The concentrations of phytoncides in the forest air were also measured. The stay in the forest significantly increased the activity and number of NK cells (21). Subsequent studies in Japan might confirm the results of this first study, even this study might be considered also not strong enough and without proven evidence (22,23).

The results of most published studies, conducted mainly in Japan and China, indicate that a single exposure to a forest atmosphere leads to a reduction in blood pressure, pulse, and heart rate compared to subjects exposed to an urban environment (24-29). The results of certain published Asian studies have shown that practicing Shinrin-Yoku as an integral part of Forest therapy can reduce blood pressure, reduce pulse, increase heart rate variability

(HRV) of participants, and improve cardiovascular and metabolic function, cardiopulmonary function and inhibit inflammation in middle-aged and older people with prehypertension or hypertension (30-36).

Forest therapy like Shinrin-Yoku lowers blood pressure by reducing the activity of the sympathetic nervous system and increasing the activity of the parasympathetic nervous system. Sympathetic nervous system activity can be determined by measuring urinary adrenaline and/or noradrenaline levels, and there are significant correlations between blood pressure and urinary adrenaline and noradrenaline levels. In addition, many studies have reported that forest visits and forest walks significantly decrease sympathetic nervous system activity and increase parasympathetic nervous system activity compared to the same activities in an urban environment. Shinrin-Yoku lowers blood pressure by inhibiting the renin-angiotensin system (37).

Research has also shown that practising Shinrin-Yoku increases the adiponectin level in the serum. Adiponectin is a protein hormone in serum that is specifically produced by adipose tissue. Studies have shown that low levels of adiponectin in the blood are associated with various metabolic disorders such as obesity, type 2 diabetes, cardiovascular disease, and metabolic syndrome. Recent research suggests that adiponectin has antitumor activity in various cancers such as prostate, breast, endometrial, brain, and colon cancer. It has also been shown that Shinrin-Yoku effectively lowers blood sugar levels in patients with type 2 diabetes and has a preventive effect on type 2 diabetes (38).

The Shinrin-Yoku method seems to provide a positive effect on stress reduction, which is confirmed by the reduction in cortisol levels and the steroid hormone DHEA (dehydroepiandrosterone) in the participants' saliva and serum, as well as the reduction in stress hormones in the serum and urine (39).

Numerous previous studies have shown that the practice of forest therapy can improve the symptoms of depression and anxiety. According to the results of several studies, spending time in a forest environment practising outdoor mindfulness could lead to a reduction in symptoms of anxiety, depression, anger, fatigue, and confusion in male and female subjects, as well as an increase in vitality according to the POMS test (40). Studies on depression and anxiety disorders treated with Forest therapy showed that the mood-lifting effect of spending time in the forest is stronger the greater the mental strain on the individual (41).

Several studies have also studied the effect of forest therapy on sleep disorders. It has been observed that Shinrin-Yoku walks significantly increases sleep duration in middle-aged male workers, which has been confirmed in Japanese studies, but also studies conducted in the West. During the intervention, sleep duration after a forest walk improved, as did fatigue and stress, while self-rated health scores increased (42,43). On the other hand, an actual Japanese study with over 2000 participants demonstrated, that frequent forest walks were associated with a low percentage

of insomnia symptoms (Insomnia Severity Index  $\geq 10$ ) in women, but not in men (44) which suggested that increasing the frequency of forest walks through Shinrin-Yoku may be effective in preventing insomnia in women. Earlier studies recommended a forest visit in the afternoon due to better sleep improvements vs. forest walks in the morning (45). In addition, many studies have shown that natural environments such as forests have a positive effect on mood. Western authors also report that the mood and self-confidence of participants improved significantly after physical activity in the forest (35, 46).

There are studies available that demonstrate a positive health effect from exposure to the environmental microbiome (46, 47). *Mycobacterium vaccae*, for example, is found in soil and can stimulate the production of serotonin, which makes you relaxed and happier. Studies have been carried out on cancer patients who reported a better quality of life and less stress during chemotherapy, indicating a better coping strategy (47). The soil bacterium appears to be a natural antidepressant with no adverse health effects, increasing serotonin levels and reducing depression, anxiety, obsessive-compulsive disorder, and bipolar disorder. This bacterium is also present in the forest and may also be responsible for the anxiolytic properties of a visit to the forest. Despite the positive and measurable changes in the psychophysical state of the participants who practiced Shinrin-Yoku walks, there is no consensus among scientists on the assumption of a single theory that would explain the observed effects. One group of scientists tends to look for explanations within the framework of ecological psychology, which includes Kaplan's "Attention Restoration Theory" (ART) and Ulrich's "Stress Reduction Theory" (SRT), which are among the most influential explanations for the effects of Shinrin-Yoku. According to Kaplan's "Theory of Attention Restoration" (ART), spending time in nature, e.g. in forests, can reduce mental fatigue or psychological stress and refocus attention on a more positive emotional and psychological response. The brain's ability to focus on a particular stimulus or task is limited, leading to "focused attention fatigue". The ART approach assumes that exposure to the natural environment stimulates the brain to work more easily, thereby restoring the ability to focus attention. A few studies support this theory and show that exposure to the natural environment has a positive effect on recovery from attention fatigue. The Stress Reduction Theory (SRT) focuses on psychophysiological stress and assumes that the natural environment influences the emotional state by promoting recovery from stress, triggering positive emotions, and blocking negative ones. This theory emphasizes the connection between the natural environment and the reduction of physiological and emotional stress. It also states that the natural environment, including forests, has a calming effect on the human body. Spending time in nature can reduce the activity of the sympathetic nervous system, which is responsible for the "fight-or-flight" response, and increase the activity of the parasympa-

thetic nervous system, which is responsible for relaxation and calmness (48, 49)

Besides the theoretical concepts, there are already proven benefits to human health based on bioclimatological effects (50). The forest climate itself ensures high air purity with high humidity, a reduction in anthropogenic noise pollution, and reduced air temperature values, which leads to a reduction in thermal stress. In addition, the forest microclimate protects high levels of solar radiation, wind, and rain. The natural tranquillity in the forest is described as particularly beneficial to health by those seeking relaxation.

There is a growing body of research publications highlighting the benefits of mindfulness practice that seek to examine the effectiveness of mindfulness-based stress reduction (MBSR) programs in different populations such as students, health professionals, pregnant women, the general population, etc. who did not have specific diseases or health conditions. Research has shown that mindfulness, as a fundamental component of the MBSR program, has an impact on reducing symptoms of depression, anxiety, and stress, with a significant reduction in overall stress and an improvement in quality of life (51). In addition, this type of intervention has been shown to contribute to the improvement of chronic physical conditions, including cardiovascular and malignant diseases (52). In older people, mindfulness practice has been associated with improved cognitive function, better mental health, and higher quality of life (53,54). In Shinrin-Yoku/Forest bathing walks as well as in a therapy intervention, MBSR elements are adapted to the natural environment. In addition, the mindfulness exercises are extended into the natural environment to not only become aware of oneself but also to direct attention to the surroundings and observe one's bodily reactions.

Chronic stress is based on two constructs: perceived helplessness and perceived self-efficacy. Perceived helplessness is a psychological concept that refers to a person's perception of having no control or influence over the outcome of a particular situation or event and is often associated with feelings of stress, anxiety, and depression. Previous randomized controlled trials have shown that mindfulness helps to activate cognitive and behavioural processes that promote individual resilience, develop the ability to control various life situations, and increase determination in solving challenges and therefore lower helplessness levels (55). On the other hand, mindfulness promotes the development of perceived self-efficacy towards positive outcomes, with self-efficacy becoming a mediator between mindfulness of the present moment and increased resilience to stressful situations (56). Higher levels of self-efficacy are associated with lower levels of anxiety, a higher likelihood of changing a particular behavioural pattern and more effective coping with stressful situations due to increased resilience (57).

Depression and anxiety are two of the most common mental health conditions in primary care. Therefore, it is extremely

important to identify the mechanisms by which mindfulness has an impact on reducing symptoms of depression and anxiety. Current evidence suggests that stress causes dysfunction at the neurological level and thus hurts the corticolimbic system, which plays a key role in the process of emotion regulation and the integration of bodily sensations with emotional responses. In one part of this system, the amygdala is hyperactive and reduced functionality of the prefrontal cortex (58,59). In addition, it is known that even relatively brief exposure to stressful situations can induce changes in the neuroendocrine hypothalamic-pituitary-adrenal axis, leading to a reduced effect of cortisol and a reduced sensitivity of immune cells to anti-inflammatory processes due to resistance to glucocorticoids (60). In these situations, the stress response system stimulates the secretion of many cytokines, i.e. signalling molecules that cause inflammation (61). In addition, previous research has shown a link between inflammatory processes and the occurrence of depressive symptoms and consequently reduced neurogenesis in the hippocampus, limiting learning processes related to psychological recovery (62,63). Therefore, the practice of mindfulness influences strengthening the stress response system, as program participants face stress with openness and acceptance without trying to think hard about it or avoid it, thereby reducing the further development of depression and related symptoms (64,65).

A review article by O'Reilly et al. (2014) showed that interventions based on mindfulness can be helpful as a technique or method for controlling body weight and preventing emotional overeating (66). Research in the field of behaviour change has uncovered neurobiological models that can help to understand the adoption of healthy lifestyles as a means of successfully managing non-communicable chronic diseases. Interventions that can contribute to this should be based on neurobiological mechanisms that influence behaviour as a whole and act on the individual's reflection on their thoughts, feelings, actions, and behaviour. In addition, it is necessary to act on the recognition of impulsive processes as one of the most important predictors of changes in health behaviour, i.e. reckless decisions without predicting their consequences (67). One of the models that explain the above is the dual system model of health behaviour. The model refers to the fact that behaviour change is based on the interaction between reflexive and inhibitory processes that affect health behaviour, i.e. regulatory and cognitive processes (future orientation and self-regulated behaviour) and habits (present orientation and impulsivity). Regulatory activities and self-control that contribute to the adoption of certain healthy behaviours, such as physical activity or healthy eating, can interact with automatic or impulsive processes. For example, for a person to adopt a healthy behavioural pattern such as physical activity or a healthy diet, their goal and intention is to be physically active (regulatory and cognitive processes) and should "override" the "pleasant" neurological impulse to remain seated, which does not happen often (68).

## DISCUSSION

A review of the literature to date has shown that the results of the research conducted on the physiological and psychological effects of the "Health Interventions in the Forest" method, particularly the Shinrin-Yoku method, are still under scrutiny by the medical public, as only a small number of studies have been conducted strictly according to research protocols in line with generally recognized evidence-based medicine (EBM). Some of these studies have not fully confirmed the effects described in the predominantly Asian studies (69).

As far as scientific accuracy is concerned, it should be noted that the Asian research conducted to date has numerous limitations, especially when analysed from the perspective of EBM. Most of the studies have been conducted on very small samples, the method of selecting participants is unclear, and they are mainly convenient samples consisting of young healthy men.

In addition, there is a lack of existence and monitoring of control groups, physical data on the environmental conditions under which the research was conducted, data on the research protocol, and a description of the interventions to which the subjects were exposed so that they could be replicated, data on the qualifications of the guides who conducted the intervention, there is no prospective monitoring of the durability of the recorded changes, there is no description of the population included in the sample, in particular, there is no data on the health status of the subjects, the drug therapy received by the subjects suffering from cardiovascular disease and arterial hypertension and there is a lack of data on adherence to the therapy applied. For example, some authors claim that the increased activity of natural killer (NK) cells and the presence of anti-cancer proteins lasted longer than 7 days and even 30 days after staying in the forest, but these results should be verified by conducting similar studies with a robust study design with the control of all confounding variables (70-72). Regarding mental health, research on the effects of Shinrin-Yoku provides a lot of useful information, but like all research, it has its drawbacks. In addition to the general limitations already mentioned, most of the data on the effects of Shinrin-Yoku on mental health are collected through the subjective assessment of the participants, which can lead to bias. Subjective assessments of emotional state or general well-being can be difficult to quantify. Different studies include different groups of participants with different characteristics such as age, gender, nationality, health status, and previous experiences with nature. This can make it difficult to generalize the results to the wider population. Most Shinrin-Yoku research focuses on short-term effects, and the lack of long-term studies limits understanding of the lasting effects of regular time spent in nature on mental health. Researchers studying Shinrin-Yoku may believe in the positive effects of nature on mental health, which may influence the way data is collected and interpreted. This may limit the overall applicability of the results. The natural environment includes many variables

that can influence mental health (e.g. weather conditions, time of year, environmental microbiome). Controlling all these variables can be challenging. It is also worth pointing out that there is a lack of consideration of the influence of the cultural context, which in terms of the understanding and attitude towards nature and the forest in Asian cultures and religions differs significantly from the Western understanding of nature and the forest (73-76). Considering all this, the number of studies included in the analyses in systematic literature reviews or meta-analyses is very small, usually less than 0.5-1% (77,78).

Although the practice of mindfulness is effective, it also has certain limitations and negative consequences. In some cases, the practice of mindfulness can trigger the emergence of previously suppressed or inadequately processed emotions or trauma, which can lead to discomfort or anxiety. For this reason, guided nature-based mindfulness exercises should be carried out by trained professionals (79,80). Although many studies have shown the benefits of mindfulness, there is still a need for better-designed and sophisticated research to consider as many aspects related to this skill as possible and to demonstrate its effectiveness in general health (81). Despite these limitations and possible negative consequences, the positive effects of practicing mindfulness and its potential for widespread application in public health are more than significant. This is particularly true for older people, as mindfulness-based interventions can serve as an accessible, cost-effective, and non-pharmacological approach to improve mental health, self-efficacy, and quality of life (82-84). It should also be noted that classic formal mindfulness exercises need to be adapted to nature. Nature-based mindfulness practice requires a qualified therapist who carefully guides the client/patient in their connection to nature.

Future research on the preventive effects of Shinrin-Yoku and nature-based mindfulness interventions on mental and physical health can be improved by applying different approaches and carefully considering previous limitations, which would include developing standardized protocols for conducting these two methods sessions to promote consistency in research. A clearer definition of procedures may facilitate the comparison of results between different studies. In addition, the inclusion of placebo control groups should be done, and conducting double-blind studies may help to identify their specific effects. It is useful to try to increase the sample size and ensure that participants are representative. In addition, the inclusion of long-term follow-up allows a better understanding of the lasting effects of Shinrin-Yoku on mental health as well as combining subjective assessment with objective measurements, such as biological indicators (e.g. cortisol, heart rate), provides a deeper insight into the actual physiological changes. Organizing a multidisciplinary research team could provide a deeper insight into the mechanisms by which Shinrin-Yoku affects mental health, including neurological, hormonal, and psychological processes. Finally, it is impor-

tant to strive for transparency in research procedures. Active community participation can improve the quality of research and contribute to the creation of useful guidelines for the application of Shinrin-Yoku in practice.

Considering all this, the Republic of Croatia has great potential for the implementation of Forest therapy as well as the Shinrin-Yoku approach as a method in the process of self-management of physical and mental health. Compared to other countries, Croatia has several advantages for its application, which can attract researchers, tourists, and local communities. Croatia is known for its animal diversity and natural beauty, including mountains, forests, lakes, rivers, and the coast of the Adriatic Sea. This diversity provides a rich spectrum of natural environments suitable for Shinrin-Yoku practice. Croatia has large areas of untouched and preserved forests that provide an ideal environment for people seeking an authentic *Forest bathing/Forest therapy* experience.

The mild Mediterranean climate that characterizes most of the Croatian coast allows the practice of Shinrin-Yoku during most of the year, which enables a continuous experience of connection with nature. In addition, the population density in Croatia is relatively low, which allows for a higher level of privacy and tranquillity during your stay in nature. Croatia has a good infrastructure that connects the cities with the rural areas. This makes the natural oases easily accessible from the urban centres. Croatia is increasingly emphasizing sustainable tourism. The integration of Shinrin-Yoku into these initiatives can additionally support an environmentally friendly approach to tourism, which creates a unique experience that combines the therapeutic effects of nature with a rich cultural heritage. In addition to emphasizing tourism, the possibility of involving the local population and thus creating communities that value the connection to nature should not be excluded. All these advantages make Croatia a promising destination for the application of Forest therapy and Shinrin-Yoku and offer the opportunity to develop sustainable programs aimed at improving health and well-being through contact with nature. Currently, thanks to its creative and visionary leadership, the municipality of Radoboj has recognized the possibilities of integrating Forest therapy into the destination's existing offer. Thanks to Mountain Strahinjščica's good research, the entire above-mentioned area has been included in the largest coordinated nature conservation network in the world NATURA 2000, where the first two certified therapeutic trails have been created, which are a solid foundation for the development of the Forest therapy offer as well as for profiling the place as a training centre for future *Forest bathing* guides and Forest therapists.

Regardless of all this, it is necessary to engage certified experts to carry out the Shinrin-Yoku method, who would be the only ones to organize the implementation of structured forest therapy. In collaboration with higher education institutions in the field of biomedicine and healthcare, education and training for certified professionals in Forest medicine needs to be organized to raise

awareness of this approach and give people the opportunity to acquire the skills needed to practice Shinrin-Yoku on their own, especially among adolescents and younger population knowing that this population is not so keen on-going Forest bathing. But we also need to encourage them to recognize the stress-reducing effect of forest visits. Collaboration with health facilities, wellness centres, or therapists as well as the local community can also lead to the organization of programs that incorporate the preventive *forest bathing* program as a support for recovery and mental health self-management.

Investment in research and development of *Forest bathing* and Forest therapy can lead to innovative approaches, tailored programs, and improved participant experiences, and collaboration between academia, health professionals, forest owners, nature conservation and the tourism sector can drive progress in this area.

## CONCLUSION

Introducing the practice of Shinrin-Yoku or Forest Therapy and nature-based mindfulness into daily life has proven to be a potentially powerful factor in improving physical and mental health. Research conducted in recent years has provided important insights into the positive effects of spending time in nature, especially in forest habitats. The Forest therapy method is an effective way of reducing the risk of several physical illnesses. Research suggests that regular time spent in the forest can help

lower blood pressure, improve the immune system, reduce the risk of cardiovascular disease, reduce cortisol levels, the stress hormone, and increase the activity of the parasympathetic nervous system. In addition, the physical activity that often accompanies Forest bathing helps maintain physical condition and prevent obesity. The mechanisms behind these changes in physical and mental health are partly related to the forest bioclimate, the presence of phytoncides in the air (substances produced by trees and plants that are associated with enhanced immune responses) as well as the environmental microbiome. However, despite these promising results, certain challenges need to be addressed in future research. Standardization of methods and protocols as well as a larger number of participants could contribute to a better reliability of the results. All in all, Shinrin-Yoku as well as Forest therapy has proven to be a promising practice that can contribute significantly to improving the physical and mental health of individuals and nature through a proactive nature protection.

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## REFERENCES

1. Kasuga, N. (1992). Study on Technostress Syndrome (Report 1). *Japanese Journal of Psychosomatic Medicine*, 1992 32(5), 383-390.
2. Anderson A. Technostress: Another Japanese discovery. *Nature*. 1985 Sep 1;317(6032):6. Available from: <https://www.nature.com/articles/317006b0>
3. Li Q, Kawada T. Possibility of clinical applications of forest medicine. *Nihon Eiseigaku Zasshi*. 2014 Jan 1;69(2):117–21. Available from: <https://pubmed.ncbi.nlm.nih.gov/24858507/>
4. Oh B, Lee KJ, Zaslowski C, Yeung A, Rosenthal D, Larkey L, et al. Health and well-being benefits of spending time in forests: systematic review. *Environ Health Prev Med*. 2017 Oct 18;22(1). Available from: <https://doi.org/10.1186/s12199-017-0677-9>
5. Cuijpers P, Berking M, Andersson G, Quigley L, Kleiboer A, Dobson KS. A Meta-Analysis of Cognitive-Behavioural Therapy for Adult Depression, Alone and in Comparison with other Treatments. *Can J Psychiatry*. 2013 Jul 1;58(7):376–85. Available from: <https://pubmed.ncbi.nlm.nih.gov/23870719/>
6. Kvam S, Kleppe CL, Nordhus IH, Hovland A. Exercise as a treatment for depression: A meta-analysis. *J Affect Disord*. 2016 Sep 1;202:67–86. Available from: <https://pubmed.ncbi.nlm.nih.gov/27253219/>
7. Cramer H, Anheyer D, Lauche R, Dobos G. A systematic review of yoga for major depressive disorder. *J Affect Disord*. 2017 Apr 15;213:70-77. doi: 10.1016/j.jad.2017.02.006. Epub 2017 Feb 7. PMID: 28192737.
8. Fumero A, Peñate W, Oyanadel C, Porter B. The Effectiveness of Mindfulness-Based Interventions on Anxiety Disorders. A Systematic Meta-Review. *Eur J Invest Health Psychol Educ*. 2020 Jul 14;10(3):704-719. doi: 10.3390/ejihpe10030052. PMID: 34542506; PMCID: PMC8314302.
9. Association of Nature & Forest Therapy. What is forest therapy. [Internet]. ANFT.Earth LLC. Available from: <https://www.anft.earth/>. Accessed 20 March 2024.
10. Ideno Y, Hayashi K, Abe Y, Ueda K, Iso H, Noda M, Lee JS, Suzuki S. Blood pressure-lowering effect of Shinrin-yoku (Forest bathing): a systematic review and meta-analysis. *BMC Complement Altern Med*. 2017 Aug 16;17(1):409. doi: 10.1186/s12906-017-1912-z. PMID: 28814305; PMCID: PMC5559777.
11. Li Q, Kobayashi M, Wakayama Y, Inagaki H, Katsumata M, Hirata Y, et al. Effect of Phytoncide from Trees on Human Natural Killer Cell Function. *Int J Immunopathol Pharmacol*. 2009 Oct 1;22(4):951–9. Available from: <https://doi.org/10.1177/039463200902200410>
12. Lee I, Choi H, Bang KS, Kim S, Song M, Lee B. Effects of Forest Therapy on Depressive Symptoms among Adults: A Systematic Review. *Int J Environ Res Public Health*. 2017 Mar 20;14(3):321. doi: 10.3390/ijerph14030321. PMID: 28335541; PMCID: PMC5369157.
13. Li Q. The secret power of the forest: From a feeling to a science. In: Miles E, editor. *NATURE IS A HUMAN RIGHT*. Dorling Kindersley Ltd, UK; 2022. p. 36–48.
14. Kotte D, Li Q, Shin WS, Michalsen A. *International Handbook of Forest Therapy*. Cambridge Scholars Publishing; Cambridge, UK: 2019
15. Forestry culture and recreation act. [Internet]. Available from: <https://faolex.fao.org/docs/pdf/kor108380.pdf>. Accessed 10 April 2024.
16. Immich G, Robl E. Development of Structural Criteria for the Certification and Designation of Recreational and Therapeutic Forests in Bavaria, Germany. *Forests*. 2023; 14(6):1273. <https://doi.org/10.3390/f14061273>
17. Kabat-Zinn J. Mindfulness-based interventions in context: Past, present, and future. *Clin Psychol* 2003;10(2):144-56. <https://doi.org/10.1093/clipsy.bpg016>.
18. Bishop S, Lau MA, Shapiro SL, Carlson LE, Anderson N, Carmody J, et al. Mindfulness: A proposed operational definition. *Clinical Psychology*. 2004 Jan 1;11(3):230–41. Available from: <https://doi.org/10.1093/clipsy.bph077>
19. Lardone A, Liparoti M, Sorrentino P, Rucco R, Jacini F, Polverino A, et al. Mindfulness Meditation Is Related to Long-Lasting Changes in Hippocampal Functional Topology during Resting State: A Magnetoencephalography Study. *Neural Plast*. 2018 Dec 18;2018:1–9. Available from: <https://pubmed.ncbi.nlm.nih.gov/30662457/>
20. Shapiro SL, Carlson LE, Astin JA, Freedman B. Mechanisms of mindfulness. *J Clin Psychol*. 2005 Dec 29;62(3):373–86. Available from: <https://pubmed.ncbi.nlm.nih.gov/16385481/>
21. Li Q, Morimoto K, Nakadai A, Inagaki H, Katsumata M, Shimizu T, et al. Forest bathing enhances human natural killer activity and expression of Anti-Cancer proteins. *Int J of Immunopathol Pharmacol*. 2007 Apr 1;20(2\_suppl):3–8. Available from: <https://pubmed.ncbi.nlm.nih.gov/17903349/>
22. Han JW, Choi H, Jeon YH, Yoon CH, Woo JM, Kim W. The Effects of Forest Therapy on Coping with Chronic Widespread Pain: Physiological and Psychological Differences between Participants in a Forest Therapy Program and a Control Group. *Int J Environ Res Public Health*. 2016 Feb 24;13(3):255. doi: 10.3390/ijerph13030255. PMID: 26927141; PMCID: PMC4808918
23. Tsao TM, Tsai MJ, Hwang JS, Cheng WF, Wu CF, Chou CK, et al. Health effects of a forest environment on natural

- killer cells in humans: an observational pilot study. *Oncotarget*. 2018 Mar 27;9(23):16501-16511. doi: 10.18632/oncotarget.24741. PMID: 29662662; PMCID: PMC5893257
24. Wang X, Gong XF, Xiong KX, Guo DS, Liu LJ, Lin CM, et al. Mapping of Research in the Field of Forest Therapy-Related Issues: A Bibliometric Analysis for 2007-2021. *Front Psychol*. 2022 Jul 11;13:930713. doi: 10.3389/fpsyg.2022.930713. PMID: 35898977; PMCID: PMC9309728.
  25. Hackenmiller MB. *The Outdoor Adventurer's Guide to Forest Bathing: Using „Shinrin - Yoku“ to Hike, Bike, Paddle, and Climb Your Way to Health and Happiness*. Rowman & Littlefield; 2019.
  26. Horiuchi M, Endo J, Akatsuka S, Hasegawa T, Yamamoto E, Uno T, et al. An effective strategy to reduce blood pressure after forest walking in middle-aged and aged people. *J Phys Ther Sci*. 2015 Dec;27(12):3711-6. doi: 10.1589/jpts.27.3711. Epub 2015 Dec 28. PMID: 26834337; PMCID: PMC4713776.
  27. Lee JY, Lee DC. Cardiac and pulmonary benefits of forest walking versus city walking in elderly women: a randomised, controlled, open-label trial. *Eur J Integr Med*. 2014;6(1):5–11.
  28. Li Q, Kobayashi M, Kumeda S, Ochiai T, Miura T, Kagawa T, et al. Effects of Forest Bathing on Cardiovascular and Metabolic Parameters in Middle-Aged Males. *Evid Based Complement Alternat Med*. 2016;2016:2587381. doi: 10.1155/2016/2587381. Epub 2016 Jul 14. PMID: 27493670; PMCID: PMC4963577.
  29. Song C, Ikei H, Kobayashi M, Miura T, Li Q, Kagawa T, et al. Effects of viewing forest landscape on middle-aged hypertensive men. *Urban For Urban Green*. 2017;21:247–52.
  30. Mao GX, Cao YB, Lan XG, He ZH, Chen ZM, Wang YZ, et al. Therapeutic effect of forest bathing on human hypertension in the elderly. *J Cardiol*. 2012 Dec;60(6):495-502. doi: 10.1016/j.jjcc.2012.08.003. Epub 2012 Sep 1. PMID: 22948092.
  31. Lee JY, Lee DC. Cardiac and pulmonary benefits of forest walking versus city walking in elderly women: a randomised, controlled, open-label trial. *Eur J Integr Med*. 2014;6(1):5–11.
  32. Ochiai H, Ikei H, Song C, Kobayashi M, Takamatsu A, Miura T, et al. Physiological and psychological effects of forest therapy on middle-aged males with high-normal blood pressure. *Int J Environ Res Public Health*. 2015 Feb 25;12(3):2532-42. doi: 10.3390/ijerph120302532. PMID: 25809507; PMCID: PMC4377916.
  33. Song C, Ikei H, Miyazaki Y. Sustained effects of a forest therapy program on the blood pressure of office workers. *Urban For Urban Green*. 2017 Oct 1;27:246–52. Available from: <https://www.sciencedirect.com/science/article/pii/S1618866717302017>
  34. Sung J, Woo JM, Kim W, Lim SK, Chung EJ. The effect of cognitive behavior therapy-based “forest therapy” program on blood pressure, salivary cortisol level, and quality of life in elderly hypertensive patients. *Clin Exp Hypertens*. 2012;34(1):1-7. doi: 10.3109/10641963.2011.618195. Epub 2011 Oct 18. PMID: 22007608
  35. Yu CP, Lin CM, Tsai MJ, Tsai YC, Chen CY. Effects of Short Forest Bathing Program on Autonomic Nervous System Activity and Mood States in Middle-Aged and Elderly Individuals. *Int J Environ Res Public Health*. 2017 Aug 9;14(8):897. doi: 10.3390/ijerph14080897. PMID: 28792445; PMCID: PMC5579495.
  36. Yau KK, Loke AY. Effects of forest bathing on pre-hypertensive and hypertensive adults: a review of the literature. *Environ Health Prev Med*. 2020 Jun 22;25(1):23. doi: 10.1186/s12199-020-00856-7. PMID: 32571202; PMCID: PMC7310560
  37. Tsunetsugu Y, Park BJ, Miyazaki Y. Trends in research related to “Shinrin-yoku” (taking in the forest atmosphere or forest bathing) in Japan. *Environ Health Prev Med*. 2010;15:27–37
  38. Ohtsuka Y, Yabunaka N, Takayama S. „Shinrin - yoku“ (forest-air bathing and walking) effectively decreases blood glucose levels in diabetic patients. *Int J Biometeorol*. 1998;41(3):125–7
  39. Park B, Tsunetsugu Y, Kasetani T, Hirano H, Kagawa T, Sato M, et al. Physiological effects of „Shinrin - yoku“ (taking in the atmosphere of the forest)—Using salivary cortisol and cerebral activity as indicators. *J. Physiol. Anthropol*. 2007; 26, 123–128.
  40. Park CH, Kang J, An M, Park S. Effects of forest therapy program on stress levels and mood state in fire fighters. *Fire Sci Eng*. 2019;33(6):132-141.
  41. Morita E, Fukuda S, Nagano J, Hamajima N, Yamamoto H, Iwai Y, Nakashima T, Ohira H, Shirakawa T. Psychological effects of forest environments on healthy adults: Shinrin-yoku (forest-air bathing, walking) as a possible method of stress reduction. *Public Health*. 2007 Jan;121(1):54-63. doi: 10.1016/j.puhe.2006.05.024.
  42. Li Q. „Shinrin - yoku“. *The Art and Science of Forest Bathing*. Penguin Random House UK, London, UK, 2018.4, pp. 1–320.
  43. Choi JH, Kim HJ, Shin CS, Yeon PS, Lee JS. The Effect of 12-Week Forest Walking on Functional Fitness, Self-Efficacy, and Stress in the Middle-Aged Women. *J. Korean Inst. For. Recreat*. 2016; 20, 27–38.
  44. Morita E, Kadotani H, Yamada N, Sasakabe T, Kawai S, Naito M, Tamura T, Wakai K. The Inverse Association between the Frequency of Forest Walking (Shinrin-yoku) and the Prevalence of Insomnia Symptoms in the General

- Japanese Population: A Japan Multi-Institutional Collaborative Cohort Daiko Study. *Int J Environ Res Public Health*. 2024 Mar 15;21(3):350. doi: 10.3390/ijerph21030350.
45. Morita E, Imai M, Okawa M, Miyaoura T, Miyazaki S. A before and after comparison of the effects of forest walking on the sleep of a community-based sample of people with sleep complaints. *Biopsychosoc Med*. 2011 Oct 14;5:13. doi: 10.1186/1751-0759-5-13.
  46. O'Brien, M. E.; Anderson, H.; Kaukel, E.; O'Byrne, K.; Pawlicki, M.; von Pawel, J.; Reck, M. (2004). "SRL172 (killed Mycobacterium vaccae) in addition to standard chemotherapy improves quality of life without affecting survival, in patients with advanced non-small-cell lung cancer: phase III results". *Annals of Oncology*. 15 (6): 906–14. doi:10.1093/annonc/mdh220.
  47. Mutius, E. The "Hygiene Hypothesis" and the Lessons Learnt From Farm Studies. *Frontiers in Immunology*. 2021 12. 635522. 10.3389/fimmu.2021.635522
  48. Ulrich RS, Simons RF. Stress recovery during exposure to nature. *J Environ Psychol*. 1991;11:201–230.
  49. Kaplan R, Kaplan S. *The Experience of Nature: A Psychological Perspective*. Cambridge, UK: CUP Archive; 1989.
  50. Schuh A, Immich G. *Forest Therapy – The Potential of the Forest for Your Health*. Springer Publishing, Berlin 2022.
  51. Khoury B, Sharma M, Rush SE, Fournier C. Mindfulness-Based Stress Reduction for Healthy Individuals: A Meta-Analysis. *J Psychosom Res* 2015;78(6):519-28. doi: 10.1016/j.jpsychores.2015.03.009.
  52. Marino F, Failla C, Carrozza C, Ciminiata M, Chila P, Minutoli R, et al. Mindfulness-Based Interventions for Physical and Psychological Wellbeing in Cardiovascular Diseases: A Systematic Review and Meta-Analysis. *Brain Sci* 2021;11(6):727. doi: 10.3390/brainsci11060727.
  53. Marciniak R, Šumec R, Vyhňálek M, Bendíčková K, Lázníčková P, Forte G, et al. The Effect of Mindfulness-Based Stress Reduction (MBSR) on Depression, Cognition, and Immunity in Mild Cognitive Impairment: A Pilot Feasibility Study. *Clin Interv Aging*. 2020 Aug 12;15:1365-1381. doi: 10.2147/CIA.S249196. PMID: 32848377; PMCID: PMC7429186.
  54. Grossman P, Niemann L, Schmidt S, Walach H. Mindfulness-Based Stress Reduction and Health Benefits. A Meta-Analysis. *J Psychosom Res* 2004;57(1):35-43. doi: 10.1016/S0022-3999(03)00573-7.
  55. Baer RA, Carmody J, Hunsinger M. Weekly Change in Mindfulness and Perceived Stress in a Mindfulness-Based Stress Reduction Program. *J Clin Psychol* 2012;68(7):755-65. doi: 10.1002/jclp.21865.
  56. Berdida DJE, Lopez V, Grande RAN. Nursing Students' Perceived Stress, Social Support, Self-Efficacy, Resilience, Mindfulness and Psychological Well-Being: A Structural Equation Model. *Int J Ment Health Nurs* 2023. doi: 10.1111/inm.13179.
  57. Zlomuzica A, Preusser F, Schneider S, Margraf J. Increased Perceived Self-Efficacy Facilitates the Extinction of Fear in Healthy Participants. *Front Behav Neurosci* 2015;9:270. doi: 10.3389/fnbeh.2015.00270.
  58. Siegle GJ, Thompson W, Carter CS, Steinhauer SR, Thase ME. Increased Amygdala and Decreased Dorsolateral Prefrontal BOLD Responses in Unipolar Depression: Related and Independent Features. *Biol Psychiatry* 2007;61(2):198-209. doi: 10.1016/j.biopsych.2006.05.048.
  59. Zunszain PA, Anacker C, Cattaneo A, Carvalho LA, Pariante CM. Glucocorticoids, Cytokines and Brain Abnormalities in Depression. *Prog Neuropsychopharmacol Biol Psychiatry* 2011;35(3):722-9. doi: 10.1016/j.pnpbp.2010.04.011.
  60. Dantzer R, O'Connor JC, Freund GG, Johnson RW, Kelley KW. From Inflammation to Sickness and Depression: When the Immune System Subjugates the Brain. *Nat Rev Neurosci* 2008;9(1):46-56. doi: 10.1038/nrn2297.
  61. Borsini A, Zunszain PA, Thuret S, Pariante CM. The Role of Inflammatory Cytokines as Key Modulators of Neurogenesis. *Trends Neurosci* 2015;38(3):145-57. doi: 10.1016/j.tins.2014.12.006.
  62. Anacker C, Luna VM, Stevens GS, Millette A, Shores R, Jimenez JC, et al. Hippocampal neurogenesis confers stress resilience by inhibiting the ventral dentate gyrus. *Nature*. 2018 Jul;559(7712):98-102. doi: 10.1038/s41586-018-0262-4. Epub 2018 Jun 27. PMID: 29950730; PMCID: PMC6118212.
  63. Creswell JD, Lindsay EK. How Does Mindfulness Training Affect Health? A Mindfulness Stress Buffering Account. *Curr Dir Psychol Sci* 2014;23(6):401-7. <https://doi.org/10.1177/0963721414547415>
  64. Lindsay EK, Creswell JD. Mechanisms of Mindfulness Training: Monitor and Acceptance Theory (MAT). *Clin Psychol Rev* 2017;51:48-59. doi: 10.1016/j.cpr.2016.10.011.
  65. Wright CJ, Schutte NS. The Relationship Between Greater Mindfulness and Less Subjective Experience of Chronic Pain: Mediating Functions of Pain Management Self-Efficacy and Emotional Intelligence. *Aust J Psychol* 2014;66(3):181-6. doi: 10.1111/ajpy.2014.66.issue-3.
  66. O'Reilly GA, Cook L, Spruijt-Metz D, Black DS. Mindfulness-Based Interventions for Obesity-Related Eating Behaviours: A Literature Review. *Obes Rev* 2014;15(6):453-61. doi: 10.1111/obr.12156.

67. Hofmann W, Friese M, Wiers RW. Impulsive Versus Reflective Influences on Health Behavior: A Theoretical Framework and Empirical Review. *Health Psychol Rev* 2008;2(2):111-137. doi: 10.1080/17437190802617668.
68. Mitchell AD, Martin LE, Baldwin AS, Levens SM. Mindfulness-Informed Guided Imagery to Target Physical Activity: A Mixed Method Feasibility and Acceptability Pilot Study. *Front Psychol* 2021;12:742989. doi: 10.3389/fpsyg.2021.742989.
69. Zhang, Z, Ye, B. (2022). Forest therapy in Germany, Japan, and China: Proposal, development status, and prospects. *Forests*, 2022;13(8), 1289.
70. Kim, J. G., Shin, W. S. Forest therapy alone or with a guide: is there a difference between self-guided forest therapy and guided forest therapy programs?. *International journal of environmental research and public health*, 2021; 18(13), 6957.
71. Li Q, Kobayashi M, Inagaki H, Hirata Y, Hirata K, Li YJ, et al. A day trip to a forest park increases human natural killer activity and the expression of anti-cancer proteins in male subjects. *J Biol Regul Homeost Agents*. 2010; 24:157–65
72. Li Q. Effect of forest bathing trips on human immune function. *Environ Health Prev Med*. 2010;15:9–17
73. Stier-Jarmer M, Throner V, Kirschnock M, Immich G, Frisch D, Schuh A. The psychological and physical effects of forests on human health: A systematic review of systematic reviews and meta-analyses. *International journal of environmental research and public health*, 2021; 18(4), 1770.
74. Kotera Y., Richardson, M., Sheffield, D. Effects of „Shinrin-yoku“ (forest bathing) and nature therapy on mental health: A systematic review and meta-analysis. *International journal of mental health and addiction*, 2020; 1-25.
75. Wen Y, Yan Q, Pan Y, Gu X, Liu, Y. Medical empirical research on forest bathing („Shinrin-yoku“): A systematic review. *Environmental health and preventive medicine*, 2019; 24(1), 1-21.
76. Kim E, Park S, Kim S, Choi Y, Cho J, Cho SI, et al. Can Different Forest Structures Lead to Different Levels of Therapeutic Effects? A Systematic Review and Meta-Analysis. *Healthcare (Basel)*. 2021 Oct 23;9(11):1427. doi: 10.3390/healthcare9111427. PMID: 34828474; PMCID: PMC8623963.
77. Rajoo K, Karam DS, Abdullah, MZ. The physiological and psychosocial effects of forest therapy: A systematic review. *Urban Forestry & Urban Greening*, 2020; 54, 126744.
78. Yeon PS, Jeon JY, Jung MS, Min G, Kim GY, Han KM, et al. Effect of forest therapy on depression and anxiety: A systematic review and meta-analysis. *Int J Environ Res Public Health*.2021; 18(23), 12685.
79. Geiger PJ, Boggero IA, Brake CA, Caldera CA, Combs HL, Peters JR, et al. Mindfulness-Based Interventions for Older Adults: A Review of the Effects on Physical and Emotional Well-being. *Mindfulness (NY)* 2016;7(2):296-307. doi: 10.1007/s12671-015-0444-1.
80. de Frias CM, Whyne E. Stress on Health-Related Quality of Life in Older Adults: The Protective Nature of Mindfulness. *Aging Ment Health* 2015;19(3):201-6. doi: 10.1080/13607863.2014.924090.
81. Farias M, Wikholm C. Has the Science of Mindfulness Lost its Mind? *BJPsych Bull* 2016;40(6):329-32. doi: 10.1192/pb.bp.116.053686.
82. Hungerford C, Hills S, Richards C, Robinson T, Hills D. Facilitating Mindfulness-Based Interventions for Anxiety in Older People: History, Effectiveness, and Future Possibilities. *Issues Ment Health Nurs* 2022;43(11):1014-21. doi: 10.1080/01612840.2022.2116510.
83. MacAulay RK, Halpin A, Andrews HE, Boeve A. Trait Mindfulness Associations with Executive Function and Well-Being in Older Adults. *Aging Ment Health* 2022;26(12):2399-406. doi: 10.1080/13607863.2021.1998352.
84. Vespa A, Fabbietti P, Giuliotti MV. Study of the Effects of Mindfulness Training on Quality of Life of Patients with Alzheimer’s Disease and Their Caregivers (Dyad Mindfulness Project). *Aging Clin Exp Res* 2022;34(1):65-71. doi: 10.1007/s40520-021-01907-x.