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Nature as Medicine: Exploring Health Benefits of Forest Bathing

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Abstract. The accelerating rate of urbanisation correlates with an increase in mental health issues, including anxiety and depression. While pharmacological treatments remain common, they come with side effects and limited long-term efficacy. In recent years, nature-based interventions, particularly forest bathing (Shinrin-yoku), have received increasing attention for their potential psychological and physiological benefits. However, the application of such nature-based public health strategy remains limited, and more future research is needed. This paper evaluates several current research in the benefits and application of forest bathing, with a special focus on the integration of forest bathing into China's public health framework. Based on empirical studies and theoretical models like Attention Restoration Theory and Stress Recovery Theory, this review examines how forest bathing contributes to emotional regulation, cortisol reduction, cardiovascular improvement, and immune system enhancement. It also analysis the efficacy of forest bathing in vulnerable populations including students, elders, and urban residents. By analyzing the research findings and cultural background of forest bathing in China through the traditional "Yang Sheng" practices, this paper argues for a broader application of this strategy in mental health improvement, elderly care, and urban planning. Future research s needed to develop standardized guidelines, address inequality in green space access, and long-term clinical outcomes in diverse populations.

Keywords: Forest bathing; mental health; public health strategy.

1. Introduction

The WHO defines mental health as a condition in which individuals can recognise their potential, manage stress, perform well, and contribute to society [1]. However, as the development of urbanization, mental illnesses represent a substantial portion of diseases globally. Urban populations are at high risk of mental health disorders such as anxiety, depression, and schizophrenia [2]. Research indicates that individuals residing in urban settings have elevated incidence of anxiety disorders compared to their rural counterparts, attributable to the rapid pace and high-stress nature of metropolitan environments. For instance, a study in the United States indicates that the prevalence of anxiety disorders was approximately 20% higher in urban populations compared to rural ones. Mental health requires more attention.

Existing pharmacological approaches to coping with stress-related and chronic mental disorders have some limitations, such as side effects, high costs, and lack of long-term efficacy. Conventional therapies such as antidepressants and antipsychotics can induce adverse effects, including weight gain, sexual dysfunction, emotional blunting, and metabolic complications. [3]. Thus, other strategies for mental health should be explored, such as nature-based approaches. There are more research in the role of environment and nature in mental health, suggesting that natural setting may enhance human health.

Forest bathing, or shinrin-yoku, originally developed in Japan in the 1980s, is a promising, nature-based public health strategy. It involves immersing oneself in a forest or nature environment through slow and mindful walking [4]. Unlike general outdoor activity, forest bathing emphasizes multisensory engagement and psychological presence. Growing evidence indicates that it can reduce stress, regulate cortisol level, and enhance immune function. Recent research indicates that forest bathing could also enhance cognitive functioning, including attention, executive skills, and working memory. Natural surroundings can encourage the activity of the prefrontal cortex, a brain area vital

for emotional control and decision-making. A study by Bratman et al revealed that those who walked in a natural environment for 90 minutes reported less subgenual prefrontal cortex neural activity and less rumination than those who walked in an urban setting [5]. However, though it is practiced as a public health measure in Japan and South Korea, forest bathing is still underutilized in China. Clinical evidence is still lacking and structured therapeutic programs are few.

This review discusses current evidence on psychological and physiological benefits of forest bathing, focusing on its potential in solving China's mental health challenges as a promising public health strategy. In addition, the purpose of this research is to provide a guideline for the promotion of forest bathing and nature-based strategy in public health.

2. Concepts and Mechanisms of Forest Bathing

2.1. Definition and Historical origins in Japan

Forest bathing, or Shinrin-yoku, originated in Japan in the early 1980s as a practice designed to help people reconnect with nature and reduce stress. The concept was officially introduced by Japan's Ministry of Agriculture, Forestry, and Fisheries as a public health initiative, in response to increasing stress-related health issues in the context of rapid urbanization. Forest therapy sites were established across Japan, promoting the practice as a preventive health measure [4]. Hafeez, a New York City-based neuropsychologist and director of Comprehend the Mind, offers three core principles of forest bathing: mindful presence, being fully engaged in the natural surroundings, participants are encouraged to engage all senses; absence of goals, forest bathing is not goal-oriented, and experience of immersing in nature itself is meaningful; connection with nature, people will gain a meaningful connection with nature in this enjoyable experience.

2.2. Differences from General Nature Exposure or Exercise

Unlike traditional outdoor exercise, which often emphasizes physical exertion, forest bathing focuses on the sensory experience of immersing oneself in the natural environment. It combines activities like slow walking, forest viewing, and simply being present in nature. The core idea of Shinrin-yoku is to engage all five senses—sight, sound, smell, touch, and taste—as a way of fostering a deep, mindful connection with the environment.

In forest bathing, individuals are encouraged to engage with nature through their senses. Vision is captivated by the subtle aspects of the natural environment, including trees, flowers, moving water, and the interplay of light and shadow. Sound has a soothing function, as the rustling of leaves, avian melodies, and the slow flow of water provide a tranquil ambience. The scents of nature, such as fresh pine, damp earth, and moss, deepen the connection with the environment. Touch is experienced through the textures of tree bark, the softness of moss, or the coolness of a stream, while taste comes through the fresh air filled with the essence of nature.

Forest bathing's core is the experience itself; not in physical effort or goal. It is a therapeutic practice meant to help people unwind, relax, and reconnect with their inner selves and the natural world, offering a unique and holistic approach to mental and physical health [6].

2.3. Attention Restoration Theroy & Stress Recovery Theory

Attention Restoration Theory (ART) and Stress Recovery Theory (SRT) are two prominent theories that elucidate the psychological and physiological advantages of nature-based activities, such as forest bathing. These ideas provide a comprehensive explanation of how natural settings enhance mental health by alleviating stress and augmenting attentiveness.

Firstly, ART formulated by Kaplan and Kaplan, posits that engagement with natural surroundings facilitates recovery from the exhaustion of attention and cognitive resources resulting from extended periods of concentration during work and study. The soft fascination in nature, such as flowing water

or rustling leaves, relaxes the brain without requiring active concentration. This theory is supported by numerous studies, like the research conducted by Basu et al., which indicates that natural environments can increase one's attention and cognitive function [7].

Secondly, Stress Recovery Theory (SRT), proposed by Ulrich in 1983, explains the role of nature in fostering positive emotions, reducing negative feelings, and promoting the recovery of physiological indicators, such as blood pressure, heart rate, and cortisol levels. Antonelli's research proves that forest bathing can lower cortisol levels in a large degree, proving its unique value in stress relief [8].

In conclusion, these two theories are complementary: while ART focuses more on cognitive recovery, SRT explains the role of nature in emotional relaxation. Forest bathing combines these two theories through multisensory experiences and mindfulness, making it a promising public health strategy for both physical and psychological well-being.

2.4. Biological Mechanisms

Forest bathing has been proved to have profound effects on both psychological and physiological levels, primarily through its impacts on the body's stress response systems. The most important biological mechanisms related to forest bathing is the modulation on cortisol levels. Cortisol is a stress-related hormone secreted by adrenal glands. Exposing to high stress level environment leads to the elevated of cortisol levels, which is harmful to the mental health. Research indicates that spending time in forest can lower the cortisol level significantly, highlighting that forest bathing can be a natural stress reducer [4].

In addition to the reduced cortisol level, forest bathing can also enhance immune system. Phytoncides, an organic chemical secreted by trees, has been proved to have the effect stimulate the production and activation of natural killer cells (NK), which plays a pivotal role in confronting pathogens and the immune response in cancer. Being exposed to these chemicals through forest bathing increase the production of NK, enhancing immune functions and promote healthy well-being [9].

Forest ecosystems significantly influence the regulation of the autonomic nervous system (ANS), which governs involuntary physiological activities like heart rate and blood pressure. Forest bathing can diminish sympathetic nervous system (SNS) activity, which governs the "fight or flight" stress response, and augment parasympathetic nervous system (PNS) activity, responsible for "rest and digest" functions. This balance helps promote relaxation, reduce blood pressure, and improve overall cardiovascular health [4].

These biological mechanisms work together, explaing why forest bathing can bring a lot of health benefits, from releasing pressure and improving mood to enhanncing immune function and supporting cardiovascular health. The combinition of these mechanisms proves the potential of forest bathing as a holistic therapeutic method, which not only impacts psychological well-being but serves as a powerful means of promoting overall health.

3. Psychological Health Benefits

3.1. Effects on Anxiety, Depression, and Emotional Well-being

Forest bathing has significant benefits in alleviating symptoms of anxiety, depression, and emotional distress. Research has demonstrates the effects of forest bathing on psychological improvements after immersing in natural environments. For example, a randomized controlled trial conducted by Park et al. measured mood states before and after forest bathing session across 24 different forest sites in Japan. The results shows that forest bathing can significantly reduce anxiety, hostility, and depression, as well as increase vigor and positive mood among participants compared to those in urban environments [4].

A comprehensive study by Antonelli et al. highlighted that forest bathing effectively reduces stress biomarkers and enhances self-reported mental states. These enhancements encompass decreased

stress, weariness, and confusion, as assessed by standardised psychological instruments such as the Profile of Mood States (POMS). [8]. This review further supports the therapeutic value of forest bathing in emotional regulation.

Moreover, Bratman et al. conducted a study comparing individuals who walked for 90 minutes in a natural versus an urban setting. Individuals exposed to nature had markedly reduced levels of rumination, a cognitive process correlated with depression, and decreased activity in the prefrontal cortex, a brain area associated with mood disorders [5]. These neurological findings align with the idea that natural environments promote a more relaxed state.

In conclusion, these studies suggest that forest bathing contributes to improved mental health by reducing negative emotional states and enhancing psychological resilience. The benefits of forest bathing is various, including both mood and neurology.

3.2. Empirical Evidence from Trials, Surveys, and Biomarker Studies

Empirical evidence confirms the psychological benefits of forest bathing through various research methodologies, including randomized controlled trials (RCTs), self-reported questionnaires, and biomarker assessments. These complementary approaches provide robust support for forest bathing as a public health strategy.

Ochiai et al. conducted a randomised controlled trial including 20 middle-aged males in a two-day forest therapy programme. Participants ambulated and paused in sylvan settings. In comparison to the urban control group, the forest group had much lower ratings on the State-Trait Anxiety Inventory (STAI) and diminished urine adrenaline levels, signifying a reduced psychological and physiological stress response [10].

Some surveys also shows similar findings in different population. For example, Tsunetsugu et al. conducted a study among urban workers and found that those who engaged in guided forest bathing sessions reported lower levels of mental fatigue and higher emotional clarity, measured through the Semantic Differential Method (SDM) and the Profile of Mood States (POMS) [11]. The results prove that exposing to forest has immediate and measurable effects on mood and stress perception.

In addition, according to meta-analysis by Hansen et al., cortisol, a key hormone in the stress response, can be significantly reduced after immersing in forest. The reduction in cortisol was often correlated with participants' subjective reports of relaxation, demonstrating coherence between biological and experimental outcomes [12].

These empirical investigations demonstrate that forest bathing has meaningful improvements in mental well-being.

3.3. Impact on Vulnerable Populations

The psychological benefits of forest bathing are particularly significant among vulnerable populations who are more susceptible to environmental and psychological stressors. These groups, such as students, the elderly, and urban residents, often face mental health challenges that make nature-based activities especially valuable.

Among students, academic stress, screen overexposure, and social pressure contribute to high rates of anxiety and burnout. Studies have shown that the university students in South Korea found that after a single two-hour forest therapy session, participants showed significant reductions in stress and fatigue levels. Students also reported that they feel calm and clear in the forest. Older adults are another population that may benefit substantially from forest bathing [13]. Aging is often accompanied by loneliness, declining cognitive functions, and emotional vulnerability. Studies show that weekly exposing to forest can improve mood, reduce depressive symptoms, and even modest cognitive in elders, measured using the Geriatric Depression Scale (GDS) and Mini-Mental State Examination (MMSE. Moreover, urban dwellers, who often experience sensory overload, noise, and a lack of green space, are particularly prone to mental health issues like anxiety and chronic stress. In

a longitudinal study, Roe et al. found that individuals living in areas with greater tree density and green coverage reported lower levels of mental distress and higher life satisfaction over time [14]. These findings highlight the importance of forest bathing in improving mental health in the long-term, especially for the vulnerable populations. By targeting to these populations, this public strategy can maximize impact and equity.

4. Physiological Health Benefits

4.1. Impact on Cardiovascular Health

Forest bathing has been increasingly recognized for its ability to promote cardiovascular health, particularly by regulating blood pressure and enhancing heart rate variability (HRV), two important indicators of autonomic nervous system function and cardiovascular stability.

Participants in studies who engaged in forest walks had a significant reduction in blood pressure compared to those walking in urban areas, suggesting the beneficial physiological effect [4]. This supports the theory that immersing in natural environments facilitates parasympathetic nervous system activation, promoting a state of rest. HRV, as an important indicator of cardiovascular and emotional regulation, shows the balance between sympathetic and parasympathetic nervous system activity. Studies demonstrate that forest bathing significantly increases HRV in middle-aged participants. This implies improved autonomic balance and reduced stress-related cardiovascular strain, reducing the risk of heart disease. These findings confirms the capacity of forest bathing to improve cardiovascular function through both immediate relaxation responses and long-term autonomic regulation.

4.2. Endocrine Effects

One of the most important physiological effects of forest bathing is its influence on the endocrine system, particularly in relation to stress hormones such as cortisol, adrenaline, and noradrenaline. These hormones are essential elements of the hypothalamic-pituitary-adrenal (HPA) axis, regulating the stress response.

Cortisol, often referred to as the “stress hormone”, increases when individuals exposed to chronic stress. Multiple studies have shown that forest environment can significantly reduce cortisol levels. Additionally, forest environments may also stimulate the release of serotonin and dopamine, neurotransmitters involved in mood regulation. Some animal studies and preliminary human data suggest that natural surroundings may influence brain chemistry through sensory pathways, but further research is needed to fully prove these effects. The endocrine benefits of forest bathing offer compelling support for its role as a natural intervention for stress management. By modulating hormonal pathways linked to anxiety and fatigue, forest bathing not only promotes immediate relaxation but may also protect against long-term hormone disruption [8].

4.3. Immune Responses

In addition to hormone regulation, forest bathing enhances immune function, particularly by stimulating NK cell activity. NK cells play a critical role in defending body against external infection and tumor formation.

A three-day forest therapy program significantly shows that forest bathing increases both the number and the activity of NK cells in participants. The immune enhancements remain high for over a week after immersing in nature-based intervention, proving that the effects are not only immediate but also sustained [9].

Phytoncides, volatile organic compounds released by trees, play a pivotal role in enhancing immune responses. Inhaling these substances when immersing in natural environment may stimulate immune pathways. However, there are more research to conduct in order to fully clarify the mechanisms.

While the precise relationship between forest exposure and immune function is not fully investigated, preliminary findings indicate promising health benefits of forest bathing, both psychological and physiological.

4.4. Evidence on Chronic Disease Prevention

Emerging evidence suggests that forest bathing may also contribute to the prevention of chronic diseases, particular those related to stress and inflammation, such as hypertension, type w diabetes, and cardiovascular conditions. For example, Part et al. found that repeated exposure to forest environments not only reduced stress biomarkers but also improved cardiovascular and metabolic indicators, which are closely tied to chronic disease risk [4]. From this evidence, forest bathing may serve as a complementary preventive strategy when integrated into a healthy lifestyle.

In conclusion, although long-term clinical trials are limited, some findings indicate that nature-based interventions have the potential to reduce disease burden through holistic mechanisms, including stress reduction, endocrine regulation, and immune enhancement.

5. Forest Bathing in China

While forest bathing has gained significant attention in countries like Japan and South Korea, its practice and public health potential in China remain relatively underexplored. China is undergoing rapid urban expansion and has growing mental health burden, so understand the application and challenges of forest bathing in China is crucial. As of 2023, over 65% of China's population live in urban areas, presenting a dual challenge, that is, rising rates of mental disorders and declining access to natural environments. A 2020 nationwide epidemiological survey revealed that approximately 16.6% of Chinese adults experience mental illness, such as depression and anxiety. Fast-paced urban life, social isolation, and environmental stressors have all contributed to the rising level of mental disorders in China.

Despite growing awareness of mental health, the implementation of nature-based interventions, typically forest bathing, remain limited. One major obstacle is the inequality in green space distribution. Studies have shown that large cities like Beijing and Shanghai have more access to parks and tree cover than suburban or lower-income areas, exacerbating health disparities [15]. This spatial inequality restricts access to forest bathing and integration of nature-based activities into daily life.

However, some local governments and regions have begun to explore forest-based wellness programs, indicated as the concept of "Yang Sheng", which refers to traditional Chinese health cultivation. For example, in Hangzhou, abundant green space have created an ideal urban environment for forest-based practices and forest bathing. The city is home to a wide range of natural landscapes, from the iconic West Lake with willows and lotuses, to the dense woods of Phoenix Mountain and the tranquil trails of Longjing Tea Plantation. Urban parks such as Hupao Park, known for its bamboo groves and mineral spring water, offers immersive multisensory experiences. In Sichuan, public forest parks are being used for forest health preservation, combining elements of traditional Chinese medicine with modern forest bathing. These efforts demonstrate how forest bathing can be adapted to local cultural values under the broader concept of "Yang Sheng" in China, emphasizing balance, tranquility, and health. In China, forest bathing is beginning to gain recognition, especially in elderly care and ecotourism, but more research and policy implications are needed to unleash the full potential of forest bathing in China. In summary, forest bathing is promising nature-based public health strategy for mental health in China. With more integration into health policy and urban green space design, it could bridge the gap between traditional healing practices and modern public health development.

6. Challenges and Future Potentials

Despite the growing interest in forest bathing, several challenges limit its broader application in public health. Current research remains geographically concentrated, with a majority of studies conducted

in East Asia, particularly in Japan and South Korea. In China, forest bathing lacks standardized guidelines, long term clinical data, and political support. Moreover, inequality in the distribution of green space, especially in high-density urban areas, may further restrict forest-based interventions for vulnerable populations [15]. In some regions, public awareness is also low, making forest bathing even more hard to popularize.

However, the future of forest bathing holds great potentials. As urban populations grow and mental health challenges rise, nature-based activities may also play an increasingly vital role in the prevention of diseases. More research in interdisciplinary fields, relating to environmental science, psychology, and medicine, can help lead a stronger scientific foundation for the development of forest bathing. In addition, integrating forest bathing into ecotourism, elderly care, and urban planning could drive policy advancement and innovation. With continued research, localized practice, and increased public awareness, forest bathing could become a more effective and powerful tool for promoting healthy lifestyle in modern societies.

7. Conclusion

In the context of growing urbanization and rising mental health challenges, forest bathing has been a prosing, low-cost, and effective public health strategy. Through reviewing theoretical frameworks, biological mechanisms, and empirical studies, this paper has shown that forest bathing offers measurable psychological and physiological benefits, ranging from reduced stress level and cortisol levels to improved cardiovascular and immune function. Vulnerable populations, including students, the elderly, and urban dwellers, may especially benefit from this nature-based intervention. In China, although forest bathing remains underutilized, it connects with traditional Chinese concept, “Yang Sheng”. Cities like Hangzhou offer a glimpse into its potential for integration into urban planning, mental health services, and elderly care. However, disparities in green space access, lack of clinical trials, and low public awareness are obstacles to implementing forest bathing in China.

In the future, more interdisciplinary research, public engagement, and policy support are needed to fully realize forest bathing’s value in modern healthcare systems. By connecting individuals with nature, forest bathing not only offers relief from stress, nut also presents a hopeful direction for sustainable lifestyle.

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