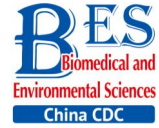


Letter to the Editor



Current Status of Forest Medicine Research in China*

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In recent years, due to regional pollution and deteriorating environment, combined with intense social competition and heavier life pressure, an increasing number of people are affected by lifestyle-related diseases and remain in a state of being sub-healthy. Therefore, health issue has been receiving unprecedented attention.

It is well known that the forest environment has a favorable influence on the human body and mind. Studies conducted since the past decade have systematically elucidated the effects of forest therapy on human health^[1-3]. In this article, we give a brief introduction of the current status of forest therapy research in China and then propose a model of forest medicine.

According to ancient records, Chinese people have been using the smell of trees to prevent and cure diseases since more than two thousand years ago. However, it was only in 2010 that Mao G et al. conducted a clinical trial that applied modern medical knowledge to explore the effects of forest environment on human health in China^[4]. In the subsequent years, several studies on forest therapy were initiated in China.

The first study on forest bathing was conducted in September 2010^[4]. That study explored the effects of short-term forest bathing on human health using 20 healthy college students who were randomly divided into two groups, one to the Wuchaoshan National Forest Park and the other to the urban area. No significant differences were observed in the baseline values of the indicators between the two groups. However, subjects exposed to the forest environment showed reduced oxidative stress and pro-inflammatory levels, as evidenced by the decreased levels of malondialdehyde, interleukin-6, and tumor necrosis factor- α (TNF- α) compared with those in the urban group. Serum cortisol levels were also lower in the group exposed to the forest

environment than in the urban group. Particularly, the concentration of plasma endothelin-1 (ET-1) was much lower in subjects exposed to the forest environment. Evaluation of the profile of mood states (POMS) revealed that after forest bathing, the participants had lower scores in the negative subscales, whereas the score for vigor was increased.

In contrast to the above mentioned study that experimented on healthy college students in their 20s, another study evaluated 24 elderly participants with hypertension (HTN)^[5]. After a 7-day forest therapy, there was a significant reduction in blood pressure compared to that in the city group. Mechanically, exposure to the forest environment significantly inhibited the activities of the renin-angiotensin system (RAS), which is involved in blood pressure regulation, implying that forest bathing has therapeutic effects on human HTN possibly by the inhibition of the RAS activities.

Regarding the benefits of forest environment and forest bathing in terms of human health, the first aspect that we think about is their 'washing effect' on the human respiratory tract. To test this hypothesis, 20 elderly patients with chronic obstructive pulmonary disease (COPD) were recruited in August 2013 to take a 3-day forest-bathing trip^[6]. The results showed a significant reduction in the expression of perforin and granzyme B, as well as that of pro-inflammatory cytokines and stress hormones, in the forest group. Meanwhile, the scores in the negative subscales of POMS were significantly decreased after the forest-bathing trip. These results indicated the positive effects of forest bathing on the health of elderly patients with COPD by reducing the inflammation and stress levels.

The close association between air pollution and cardiovascular events and death has been well

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documented^[7]. To determine whether forest therapy could be used as an adjunctive therapy for chronic heart failure (CHF), a clinical syndrome that develops as a result of various cardiovascular diseases, a total of 36 elderly participants with CHF were randomly divided in a ratio of 2:1 into two groups, 24 in the forest and 12 in an urban control area, for a 4-day trip^[8]. The subjects exposed to the forest site showed a significant reduction in the levels of brain natriuretic peptide (BNP), a widely used biomarker of CHF in the clinic, compared to those in the city group and their own baseline levels. Moreover, the values of the pathological factors related to cardiovascular diseases, including ET-1, and the constituents of the RAS, including renin, angiotensinogen (AGT), angiotensin II (ANGII), and ANGII receptor type 1 or 2 (AT1 or AT2), in subjects exposed to the forest environment were lower than those in the urban control group. Obviously, the forest group exhibited a decreased level of inflammatory cytokines and improved antioxidant function compared to that in the city group. In addition, the POMS assessment showed that the negative emotional mood state was alleviated after forest bathing.

To further investigate the impact span and the optimal frequency of the forest-bathing trip in patients with CHF, those who experienced the first forest-bathing trip were included again after 4 weeks and were then randomly included in the urban control group (city) and the forest-bathing group (forest), respectively^[9]. After a second 4-day forest-bathing trip, the subjects showed a steady decline in BNP levels and an attenuated inflammatory response as well as oxidative stress. This exploratory study indicated the additive benefits of twice forest-bathing trips in the elderly patients with CHF, which further paves the way for its application in the treatment of cardiovascular disorders.

Taken together, the current data obtained from studies on forest therapy in China have demonstrated the benefits of forest environments in terms of physiological relaxation and improvement in immune functions, as well as the adjuvant therapeutic effects in patients with HTN, COPD, and CHF.

Then, what are forest bathing and forest medicine? As a type of nature therapy, forest bathing was first proposed in the 1980s and has emerged as a recognized relaxation and/or stress management activity in Japan^[10]. It is commonly

defined as a visit to a forest field for the purpose of relaxation and recreation by breathing in volatile substances known as phytoncides (wood essential oils), which are antimicrobial volatile organic compounds derived from plants (trees), such as alpha-pinene and limonene^[10]. Regarding the concept of nature therapy, it is defined as a set of practices aimed at achieving 'preventive medical effects' through exposure to natural stimuli that result in a state of physiological relaxation and boost the weakened immune functions to prevent diseases^[11].

As shown in Figure 1, the concept of nature therapy, proposed by Miyazaki Y et al.^[11] in 2015, was focused only on physiological relaxation and improvement in immune functions. However, scientific data accumulated since the past two decades have supported the increase in the awareness of the positive benefits of the forest environment not only on physiological relaxation and immune functions but also in terms of the therapeutic effects in several chronic diseases, including HTN, COPD, CHF, diabetes mellitus type II (DMII), depression, stroke, and insomnia^[1,2,5,6,8,9,12-14]. Consequently, this rapid advancement in forest therapy encourages us to treat it not only as a treatment method but also as a discipline, i.e., forest medicine.

Although the concept of forest medicine was first proposed as early as 2006 in Japan (Shinrin-yoku) and its English name was used in Japan 1 year later^[15], it was not until 2012 that Li Q defined forest medicine as 'a new interdisciplinary science and a focus of public attention,' and as 'the study of the effects of forest environments on human health'^[15]. In our study, based on the results of existing research, we concluded that although there are

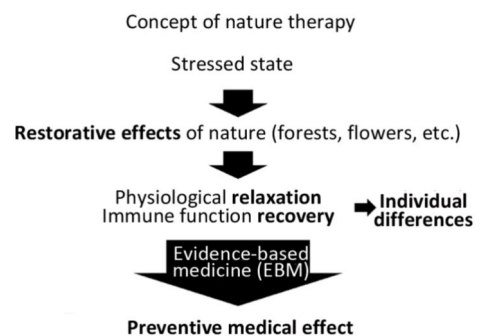


Figure 1. Concept of nature therapy^[11]. Permission to publish was obtained from Yoshifumi Miyazaki.

validated benefits of forest therapy of certain forest environments in specific populations and certain diseases, the primary aims of forest medicine include health promotion, prevention of lifestyle-related diseases, as well as rehabilitation and adjuvant therapy for diseases (Figure 2). Forest medicine belongs to the concept of preventive medicine and complementary and alternative medicine (CAM)^[11].

As mentioned above, an increasing number of studies have been performed to confirm the benefits of forest environment in terms of human health. However, several limitations exist, and further research is needed to comprehensively understand the preventive and adjuvant therapeutic effects of the forest.

First, 'What might be an optimal duration and frequency, namely dose, of forest therapy to obtain optimal benefits for participants?' The results of the studies conducted by Mao G and Sung J demonstrated that the protective benefits in patients with CHF and HTN could not last for 4 weeks^[9,16]. However, Li Q reported that high activities of natural killer (NK) cells could be maintained for 1 month^[17]. The possible factors leading to the discrepancies among these studies include the different experimental designs, different participants, different observation indexes, and so on. For example, BP is so constantly fluctuating that it is difficult to obtain a sustained effect, and the half-life of BNP is only 22 min, whereas the half-life of anticancer proteins in NK cells has been reported

to be very long. On the other hand, the duration of forest bathing ranged from 15 min/twice 1 day^[18], 2 h/twice 1 day^[19], 3-day/2-night^[10], and 7-day/6-night^[5] to 8 weeks^[16]. Therefore, it is important to initiate additional studies on forest medicine to determine how the benefits of forest environment can be maintained and how long and how often people should take forest-bathing trips.

Second, it is reasonable to speculate that different forest environments in different seasons and different activities (e.g., walking, contemplating, yoga, tai chi, qigong, etc.) have different influences on different subjects. Therefore, 'are specific tree species and certain types of activities more effective than others?' To partly answer this question, a project (registration number: ChiCTR-IOR-17011799) on the effects of *Cinnamomum camphora* forest environment, in different seasons and different periods in a day, is in progress in China.

Third, a recently published meta-analysis, including 20 trials, reported that the sample size ranged from 6 to 268, with the median size being 12^[20]. Thus, trials with larger sample sizes and well-designed, e.g., randomized, controlled, are required to improve the quality of the results.

Finally, healthcare professionals, including clinicians, are the primary service providers in the healthcare system. Therefore, as a part of the integrated healthcare model, studies on the effect of the forest environment in various subjects with different diagnoses and different disease states are also required in the future.

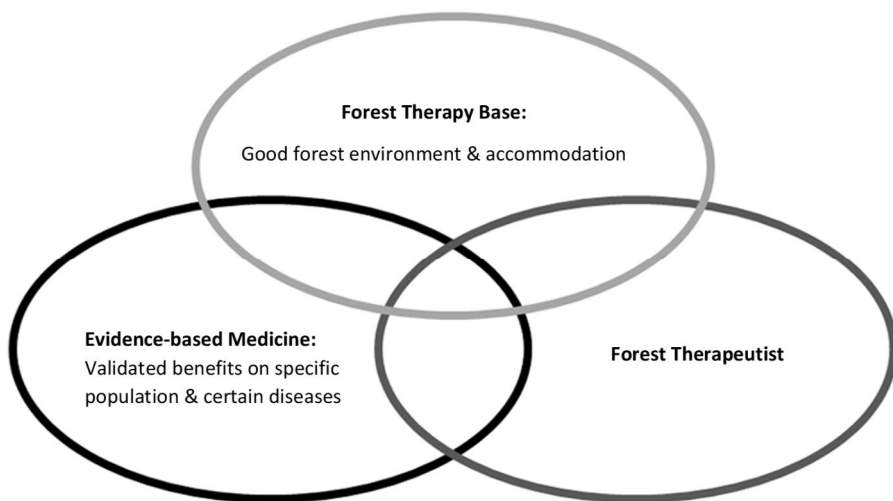


Figure 2. Model of forest medicine.

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REFERENCES

- Ochiai H, Ikei H, Song C, et al. Physiological and Psychological Effects of a Forest Therapy Program on Middle-Aged Females. *Int J Environ Res Public Health*, 2015; 12, 15222-32.
- Ochiai H, Ikei H, Song C, 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; 12, 2532-42.
- Lee J, Tsunetsugu Y, Takayama N, et al. Influence of forest therapy on cardiovascular relaxation in young adults. *Evid Based Complement Alternat Med*, 2014; 2014, 834360-6.
- Mao GX, Lan XG, Cao YB, et al. Effects of Short-Term Forest Bathing on Human Health in a Broad-Leaved Evergreen Forest in Zhejiang Province, China. *Biomed Environ Sci*, 2012; 25, 317-24.
- Mao GX, Cao YB, Lan XG, et al. Therapeutic effect of forest bathing on human hypertension in the elderly. *J Cardiol*, 2012; 60, 495-502.
- Jia BB, Yang ZX, Mao GX, et al. Health Effect of Forest Bathing Trip on Elderly Patients with Chronic Obstructive Pulmonary Disease. *Biomed Environ Sci*, 2016; 29, 212-8.
- Liu Y, Chen X, Huang S, et al. Association between Air Pollutants and Cardiovascular Disease Mortality in Wuhan, China. *Int J Environ Res Public Health*, 2015; 12, 3506-16.
- Mao G, Cao Y, Wang B, et al. The Salutary Influence of Forest Bathing on Elderly Patients with Chronic Heart Failure. *Int J Environ Res Public Health*, 2017; 14, 368-79.
- Mao GX, Cao YB, Yang Y, et al. Additive Benefits of Twice Forest Bathing Trips in Elderly Patients with Chronic Heart Failure. *Biomed Environ Sci*, 2018; 31, 159-62.
- Li Q, Morimoto K, Nakada A, et al. Forest bathing enhances human natural killer activity and expression of anti-cancer proteins. *Int J Immunopathol Pharmacol*, 2007; 20, 3-8.
- Miyazaki Y, Song C, Ikei H. Preventive medical effects of nature therapy and their individual differences. *Jpn J Physiol Anthropol*, 2015; 20, 19-32.
- Li Q. Effect of forest bathing trips on human immune function. *Environ Health Prev Med*, 2010; 15, 9-17.
- Chun MH, Chang MC, Lee SJ. The effects of forest therapy on depression and anxiety in patients with chronic stroke. *Int J Neurosci*, 2016; 127, 199-203.
- Morita E, Imai M, Okawa M, et al. 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; 5, 1-7.
- Li Q. *Forest Medicine*, New York, Nova Science Publishers, Inc., 2012; 5.
- Sung J, Woo JM, Kim W, et al. 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*, 2011; 34, 1-7.
- Li Q, Morimoto K, Kobayashi M, et al. A forest bathing trip increases human natural killer activity and expression of anti-cancer proteins in female subjects. *J Biol Regul Homeost Agents* 2008; 22, 45-55.
- Tsunetsugu Y, Park BJ, Ishii H, et al. Physiological effects of Shinrin-yoku (taking in the atmosphere of the forest) in an old-growth broadleaf forest in Yamagata Prefecture, Japan. *J Physiol Anthropol*, 2007; 26, 135-42.
- Li Q, Otsuka T, Kobayashi M, et al. Acute effects of walking in forest environments on cardiovascular and metabolic parameters. *Eur J Appl Physiol*, 2011; 111, 2845-53.
- Ideno Y, Hayashi K, Abe Y, et al. Blood pressure-lowering effect of Shinrin-yoku (Forest bathing): a systematic review and meta-analysis. *BMC Complement Altern Med*, 2017; 17, 409-21.