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The Effects of Forest Bathing on Stress Recovery: Evidence from Middle-Aged Females of Taiwan

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Abstract: Previous literature highlights the effects of forests on reviving psychological and physiological health. Given that middle-aged women are vulnerable to stress due to the transition in their lives, the purpose of this study was to investigate the effects of forest bathing on their stress recovery using a field experiment design. This study examined both psychological and physiological responses after a forest therapy program among a middle-aged female group. Sixteen middle-aged (46.88 ± 7.83 years) women were recruited for a two-day (one-night) forest therapy program in the Aowanda National Forest Recreation Area (Nantou, Taiwan). Psychological indices were measured by Profile of Mood States (POMS) and State-Trait Anxiety Inventory (STAI). Physiological indicators included pulse rate, systolic or diastolic blood pressure, and salivary α-amylase. Both psychological and physiological measurements were collected before and after the program. The results showed that negative mood states (i.e., confusion, fatigue, anger-hostility, and tension) and anxiety levels were significantly reduced after visiting forests. In contrast, positive mood state (vigor) was improved after the program. Regarding the physiological responses, a significant decrease in systolic blood pressure response was found after the program. In sum, the two-day forest therapy program benefited to mental health and systolic blood pressure among the middle-aged female group.

Keywords: forest; forest therapy program; Profile of Mood States; State Trait Anxiety Inventory-state anxiety; pulse rate; blood pressure; salivary α-amylase

1. Introduction

The term "forest bathing," derived from Japan, is defined as being in a forest environment and absorbing its atmosphere in order to restore balance, both psychologically and physiologically [1]. The literature on the subject has demonstrated the therapeutic effects of forest bathing on human health, including immune system improvement, cardiovascular disease prevention, and mental health enhancement [2–4]. In 1983, Ulrich proposed a psycho-evolutionary theory, indicating the restorative effects of natural environments on stress [5]. Moreover, the Attention Restoration Theory (ART) proposed by Kaplan and Kaplan also suggested the positive effects of natural environments on mental health [6]. According to the ART, environments with four characteristics (i.e., being away, extent, fascination, compatibility) are beneficial to mental health. Compared to the urban environment, natural environments such as forests are more likely to have the abovementioned characteristics. Empirical studies have demonstrated that forest environments could improve mental health by enhancing positive emotions and reducing negative emotions. In one study, Tsunetsugu et al. [7] compared

subjects' mood states in two different environments by adapting the Profile of Mood States (POMS). Their results show that subjects in forest environments had a lower level of negative emotions (e.g., tension–anxiety, confusion, fatigue, depression) and a higher level of vigor than those in urban environments, demonstrating the psychological benefits of forests in mental health. Similar results were reported by Takayama et al., who found that subjects' tension-anxiety, depression-dejection, and confusion decreased after viewing forests [8]. Other than POMS, some studies have assessed the change in anxiety by using the State-Trait Anxiety Inventory (STAI) [9,10]. Similar findings report that total scores of the STAI were significantly lower in the forest settings than in the urban settings, indicating the beneficial effects of forests in reducing anxiety [4,10].

The positive relationship between forest visits and physical health has been studied [11,12]. Tsunetsugu et al. [13] found that subjects' blood pressure and pulse rate were lower when immersed in the forests, compared to those in urban environments. Similar results were reported by Park et al. [14], who analyzed 280 subjects in 24 experiment sites and observed lower pulse rates and blood pressure in the forest group, compared to the urban group. Regarding other physical indicators, Lee et al. [15] found that subjects immersed in forest environments had higher high frequency power (HF) and lower low frequency power (LF) compared with those in urban environments; this result confirms the beneficial effects of forests in relaxation based on the evidence of higher parasympathetic activity. Park et al. and Lee et al. also observed higher HF in those immersing in forest environments [16,17]. Komori et al. [18] used salivary α-amylase (SAA) to investigate the activity of the autonomic (sympathetic) nervous system. They found that SAA was significantly lower in forest environments than in urban environments, providing evidence for the restorative effect of forest environments. Similar results were reported by Yamaguchi et al. [19]. They observed a decline in subjects' SAA after sitting and taking in a view of the forest, although the results were not significant. In addition to their restorative effects, forests help prevent disease by improving immune function [2,20]. Li et al. [20] observed an increase in the number of nature killer (NK) cells in subjects after a three-day (two-night) forest trip. Another study [2] reports similar results: an increase in the number and activity of NK cells among female participants on a forest trip were observed despite the influence of estradiol and progesterone due to their menstrual cycles.

In Taiwan, it is estimated that about 60 percent of the landscape is covered by forest [21]. Forest bathing is a popular forest recreational activity in China, Japan, Korea, and Taiwan, and is considered to be one approach to health promotion [15]. Nonetheless, despite the increasing interest and popularity of forest bathing, evidence regarding the beneficial effects of forest bathing in Taiwan is limited [12]. To this end, one of the purposes of this study was to provide scientific evidence by investigating the health effects of visiting forests in Taiwan. Additionally, unlike men, women have to deal with a physical transition once they have reached menopause. Symptoms of menopause include trouble focusing and sleeping, mood swings, weight gain, and more [22]. Women who fail to manage menopause well not only increase their risk of having chronic conditions but also decrease their quality of life. Other than seeking medical treatments from doctors, visiting a forest may help enhance both of their psychological and physiological health. Yu and his colleagues found that forest camps contribute to the mental and physiological stability of postmenopausal women [23]. As a result, the second purpose of this study was to explore the health improvement in middle-aged women after immersing in a forest environment. Accordingly, a two-day forest therapy program was designed and conducted in a National Forest Recreation Area in Taiwan. Middle-aged women's psychological and physiological statuses were measured before and after the program to discern the health effects of the forest bathing trip. Findings of this study were expected to provide scientific evidence in terms of the effects of forest bathing on middle-aged women.

2. Materials and Methods

2.1. Participants

Middle-aged women were recruited through the Internet for a two-day field experiment. Those who were in good conditions and capable of walking for at least two hours on trails were

eligible to attend the experiment. In total, 16 women (age: range = 36–62; Mean = 46.88; Standard Deviation = 7.83) were recruited in this study. One reason not to conduct the experiment on a large scale was because physiological measurement would require a lot of time. The delay of procedure may worsen participants' experiences. Moreover, having a large sample size in forests could lead participants to perceive it as crowded and noisy, similar to what they feel in urban environments. Consequently, the confounding effects (e.g., noise) may influence the impacts of the intervention. Many of the previous studies also used small sample sizes to avoid the abovementioned drawbacks while discerning the influences of forest bathing on health [15,24,25]. For example, Lee et al. [15] recruited twelve adult males, and Ochiai et al. [25] included nine middle-aged men to investigate the effects of forest bathing. However, it should be noted that the generalizability may be affected by the small sample size.

Before the experiment, participants were informed about the purpose of study and procedures. In order to reduce confounding errors, participants' dietary intake was controlled by following the same meal plan. Stimulants such as tobacco were prohibited during the study period. The approval of the human subject's compliance agreement (NTU-REC No. 201607HS008) was obtained before the experiment.

2.2. Study Sites

The field experiment was conducted in the Aowanda National Forest Recreation Area (ANFRA), Taiwan. This area encompasses 2787 hectares and is situated in Nantou county [26]. The altitude of the ANFRA ranges from 1100 to 2600 m, with an annual average temperature of 19 °C and an annual average humidity of 80% [26]. ANFRA is famous for its natural scenery, such as broad-leaved trees and waterfalls. The weather on the experiment days was drizzling with an average temperature of 13.8 °C, average humidity of 79.8%, and 5.6 m/s wind speed.

2.3. Procedure

This study used a pretest and posttest experimental design with a two-day (one-night) forest therapy program as intervention. Participants' psychological and physiological responses were measured before and after the intervention in the same classroom of the education center of ANFRA. Regarding the content of the program, the main activities of the field experiment included a 2.5-h guided forest walk, night walking on trails, and do-it-yourself (DIY) handcrafts. The vegetation of the forest trails was dominated by *Liquidambar formosana*, *Zelkova serrate*, *Pinus taiwanensis*, and *Cyclobalanopsis glauc*. The purpose of the guided forest walk was to stimulate four of the participants' senses: visual (e.g., forest scenery), auditory (e.g., the sound of running streams), olfactory (e.g., the smell of trees), and tactile (e.g., feeling the surfaces of leaves and trees) (see Figure 1). In the class of DIY handcrafts, a steam distillation method was applied to extract the essential oil of *Cinnamomum osmophloeum* and *Chamaecyparis formosensis*. After extraction, the essential oil was added in the liquid soap to make a body wash. The schedule of the field experiment is shown in Table 1.

Table 1. Schedule of the field experiment. ANFRA: Aowanda National Forest Recreation Area; DIY: do-it-yourself.

Date	Time	Activity
14/January/2017 (Sat.)	13:00~14:00	Orientation
	14:00~15:00	Psychological and physiological responses pretest
	15:00~17:30	Guided forest walk in ANFRA
	17:30~19:30	Dinner
	19:30~20:30	Forest walking
15/January/2017 (Sun.)	7:00~8:00	Breakfast
	8:00~11:00	DIY Handcrafts (essential oil body wash)
	11:00~12:00	Physiological and psychological responses posttest

2.4. Measurements

To access psychological factors, two questionnaires were used to discern participants' mood state. First, a Chinese version of Profile of Mood States (POMS) with satisfactory validity and reliability was adapted in the study [27]. This questionnaire is composed of seven constructs with 37 items. These constructs are confusion, fatigue, anger-hostility, tension-anxiety, depression, vigor, and self-esteem. A five-point Likert scale, ranging from (1) strongly disagree to (5) strongly agree, was used in each item to evaluate participants' mood state.

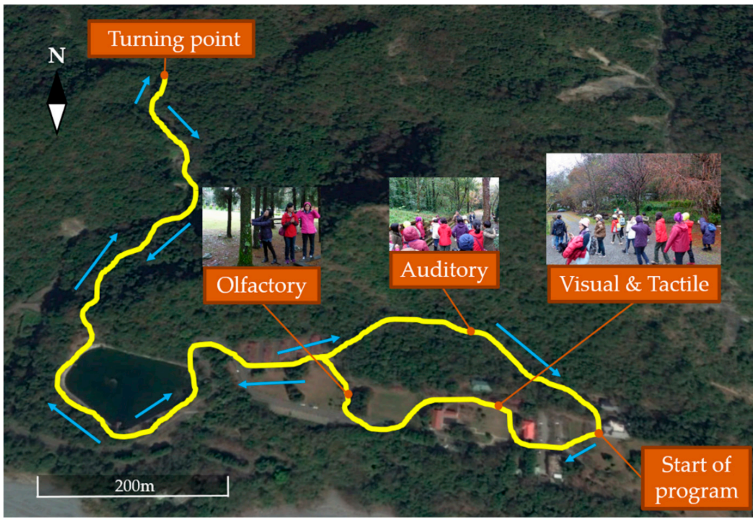

Figure 1. The route of guided forest walk.

The State-Trait Anxiety Inventory (STAI) was designed to measure two types of anxiety: state anxiety and trait anxiety [28]. State anxiety refers to anxiety induced by a particular situation, while trait anxiety refers to a personal characteristic in which anxiety occurs on a daily basis [28]. Because this study aimed to examine participants' levels of anxiety as influenced by forest environments, a Chinese version of the state part of the STAI (i.e., STAI-S) was used to measure their state anxiety [29]. A four-point Likert scale, ranging from (1) strongly disagree to (4) strongly agree, was used to evaluate participants' anxiety levels.

Regarding physiological measurements, all indicators were measured before and after the forest therapy program using portable devices. Participants' pulse rate, systolic blood pressure (SBP), and diastolic blood pressure (DBP) were measured with a blood pressure monitor (EW-BW33, Panasonic Ltd., Osaka, Japan). Moreover, salivary α-amylase (SAA) was recorded with a SAA monitor (Coroco Meter, Nipro, Osaka, Japan). SAA, reflecting the activity of sympathetic nervous system, has been validated as an indicator of stress in previous research [19,30,31]. SAA values of $\leq$30, 31–45, 46–60, and $\geq$61 kIU/L are indicative of having no stress, mild stress, moderate stress, and severe stress, respectively [32].

2.5. Data Analysis

All data were stored and analyzed using SPSS 21.0. Besides descriptive analysis, a series of paired sample *t* tests were conducted to discern physiological and psychological differences before and after the forest therapy program.

3. Results

Table 2 shows the results of paired sample t tests regarding the psychological differences before and after the forest therapy program. There was a significant decrease in four negative emotional states

in the posttest, including confusion ($t = -3.514$, $p < 0.01$), fatigue ($t = -6.127$, $p < 0.01$), anger-hostility ($t = -3.656$, $p < 0.01$), and tension ($t = -2.162$, $p < 0.05$). In contrast, participants' level of vigor increased significantly after the therapy program ($t = 5.014$, $p < 0.01$). Regarding anxiety, participants' level had a significant decrease in the posttest ($t = -3.341$, $p < 0.01$).

Table 2. Effect of the forest therapy program on emotional state and anxiety.

Variables	Pretest	Posttest	*t*	*p*	Rate of Change (%)
	Mean ± SD	Mean ± SD			
Emotional State (POMS)					
Confusion	1.75 ± 0.72	1.21 ± 0.31	−3.514	0.003 **	−31.12
Fatigue	2.46 ± 1.05	1.23 ± 0.36	−6.127	0.000 **	−50.00
Anger-hostility	1.29 ± 0.32	1.00 ± 0.00	−3.656	0.002 **	−22.58
Tension	1.59 ± 0.74	1.30 ± 0.48	−2.162	0.047 *	−18.63
Depression	1.38 ± 0.53	1.19 ± 0.40	−1.126	0.278	−13.64
Vigor	3.46 ± 0.87	4.32 ± 0.53	5.014	0.000 **	25.06
Self-esteem	4.08 ± 0.64	4.30 ± 0.65	1.725	0.105	5.36
Anxiety (STAI-S)	30.19 ± 8.26	25.44 ± 5.15	−3.341	0.004 **	−15.73

Note: POMS: Profile of Mood States; STAI: State-Trait Anxiety Inventory. * $p < 0.05$, ** $p < 0.01$.

Table 3 shows the results of paired sample *t* tests, examining physiological differences between the pretest and the posttest. Compared with the pretest, there was a significant decline in systolic blood pressure in the posttest ($t = -2.533$, $p < 0.05$). Nonetheless, there was no significant difference regarding participants' pulse rate, diastolic blood pressure, or SAA (all $p > 0.05$).

Table 3. Effect of the forest therapy program on physiological stress indices.

Physiological Indices	Pretest	Posttest	*t*	*p*	Rate of Change (%)
	Mean ± SD	Mean ± SD			
Pulse rate (Bpm)	73.44 ± 8.01	73.00 ± 9.12	−0.281	0.782	−0.60
Systolic blood pressure (mmHg)	122.81 ± 17.7	117.19 ± 15.20	−2.533	0.023 *	−4.58
Diastolic blood pressure (mmHg)	86.06 ± 11.89	82.56 ± 12.63	−1.506	0.153	−4.07
Salivary α-amylase (kIU/L)	25.75 ± 13.94	23.19 ± 9.64	−0.586	0.471	−9.95

Note: * $p < 0.05$.

4. Discussion

4.1. Psychological Effect

Consistent with previous studies [4,6,14,15,20,24,25,33], findings of this study suggest that the two-day forest therapy program had psychological benefits on middle-aged women. Participants' negative emotions (i.e., confusion, fatigue, anger-hostility, tension) and levels of anxiety were reduced after the program. Meanwhile, positive emotions such as vigor increased in the posttest, demonstrating the program's restorative effect on middle-aged women's mental health. Sharifi et al. [34] indicate that the causes of middle-aged women's emotional stress could derive from their undesirable psychological and physiological changes. Undesirable changes, such as signs of aging, increased physical conditions, negative menopausal changes, and decreased energy could deprive mental health among middle-aged women. Given that forests have a restorative effect on mental health, visiting them may be promoted as an alternative therapy to middle-aged women with disadvantaged mental health.

It is worth noting there was not a significant change in participant's depression and self-esteem after the forest therapy program. This finding is not consistent with previous studies [9,12,14]. The insignificant change of depression may be attributed to the weather and the season during the experiment dates. The experiment was conducted during winter with cloudy weather and intermittent drizzle. Given that the length of sunshine exposure and the winter season are correlated with depression [35–37], the magnitude of effect of forests on alleviating depression may be depleted

due to insufficient sunshine exposure. Regarding self-esteem, the rationale underlying the insignificant change is not known. However, it could be postulated that seniors have a more stable mental character compared with youth [38], suggesting a limited improvement in self-esteem of middle-aged women.

4.2. Physiological Effect

4.2.1. Response of Pulse Rate

The majority of previous studies indicate that subjects had a significantly decreased pulse rate after entering a forest, denoting the restorative effects of forests on health [14,24,25,39]. Nonetheless, we did not observe a decreased pulse rate in this study. This non-significant finding may be attributed to the arrangement of the activity. Before the posttest measurement, participants were instructed to make essential oil. Participants had to walk around the classroom while making this essential oil, which may have influenced their pulse rate. In other words, the influence of conducting the activity may be carried over to the posttest due to the lack of rest time in-between.

4.2.2. Response of Blood Pressure

Consistent with previous studies [3,22,24,25,40], our study results showed a decrease in middle-aged women' SBP and DBP after the forest therapy program. Though the decline of DBP was not statistically significant in this study, our results suggest the positive effects of forest environments on physical health among middle-aged women. According to reports [41], women's chances of developing hypertension increase with age. It is estimated that about 13% of women under the age of forty-four are affected by hypertension in the United States (US). Moreover, the number boosts to 50% when women reach their sixties, increasing their risks of having a stroke and heart diseases [42]. Even though many previous studies indicate the positive effects of visiting forests in alleviating high blood pressure, the findings of prior research are not totally consistent [13,15,43]. Therefore, it is necessary for more studies to investigate the relationship between forest environments and blood pressure to fill the literature gap.

4.2.3. Response of SAA

SAA has been used as an indicator of the activity of sympathetic nervous system [18,19,44]. A lower concentration of SAA represents the inhibition of sympathetic nervous activity, indicating a relaxed status. In our study, the results showed that middle-aged women's SAA decreased in the posttest, but the amount was not statistically significant. Our findings are consistent with some of previous studies [19,44]. Both Yamaguchi et al. [19] and Hohashi & Kobayashi [44] claim that, although the SAA concentration did not have a significant change after visiting forests, the tendency toward a decline of SAA suggests its potential effects on relaxation. Positive effects of forest bathing on relaxation have been confirmed in other studies with different experimental designs [18]. Komori et al. [18] compared participants' SAA in two different environmental settings. They found that participants in a forest setting had a significant lower SAA than those in an urban setting, proving the function of forests in reducing stress.

4.3. Experimental Limitations

There are some limitations in this study. First, environmental factors such as temperature, humidity, negative air ions, and illumination were not considered in this study. Previous studies have confirmed that many environmental factors are associated with psychological and physiological health [3,14,45]. Therefore, it is suggested that the above-mentioned factors be controlled in future studies in order to give a more precise estimation regarding the effects of visiting a forest. Second, this study targeted middle-aged women who may be experiencing psychological and physical changes due to menopause. Because this study was not restricted to women who are going through menopause, the implication of study findings is limited. Third, information about each participant's substance use

was not acquired. Given that substance use may be related to a participant's mental health status, it is suggested that future studies control each participant's substance use. Lastly, this study did not have a control group, which may threaten its internal validity. Extraneous factors, potentially influencing the results, should be controlled in the study protocol. Therefore, it is suggested that a randomized controlled trial (RCT) should be applied to this type of study to reduce bias.

5. Conclusions

This study examined the effects of forest environments on middle-aged women's psychological and physiological health by employing a forest therapy program. The results show that participants' level of negative emotions (i.e., confusion, fatigue, anger-hostility, tension, anxiety) decreased while their positive emotions (i.e., vigor) increased after the program. Additionally, their systolic blood pressure decreased after the forest therapy program, providing scientific evidence regarding the beneficial effects of forest recreation experiences.

Author Contributions: H.-T.C. contributed to data acquisition and manuscript preparation. C.-P.Y. conceived and designed the experiment and conducted data analysis. H.-Y.L. was responsible for results interpretation and manuscript revision. All authors read and approved the final manuscript submitted for publication.

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