

Physiological and Psychological Effects of Combined Forest/Thermal Therapy on Depressive Symptoms in Individuals with Alcohol and Nicotine Dependency

Sunhee Lee¹, Heeju Ro², Jungkee Choi³, Youngran Chae⁴ and Soyeon Kim^{5,*}

¹Department of Nursing, Daewon University, Jecheon 27135, Republic of Korea

²Department of Forest Management, College of Forest and Environmental Sciences, Kangwon National University, Chuncheon 24341, Republic of Korea

³Division of Forest Science, College of Forest and Environmental Sciences, Kangwon National University, Chuncheon 24341, Republic of Korea

⁴College of Nursing, Kangwon National University, Chuncheon 24341, Republic of Korea

⁵Department of Forest Healing, College of Human Service, Catholic Kwandong University, Gangneung 25601, Republic of Korea

Abstract

This study verified the effect of a combined forest/thermal therapy (FT/TT) program on participants with depressive symptoms and smoking or alcohol dependence. The participants included 20 people in the experimental group and 18 people in the control group. The experimental group participated in the FT/TT program for 2 nights and 3 days at the National Center for Forest Healing, in Hoengseong (National Hoengseong Supchewon), and a charcoal kiln operated by the Gangwon Charcoal Farming Association. The control group carried out their daily life for the same period. Psychological, physiological, and biochemical tests were conducted to determine the effect of the program. The results showed that there were significant improvements in stress, anxiety, depression, sleep quality, sleep satisfaction, and IL-6 levels. However, no significant difference was found in the cortisol, serotonin and melatonin levels between the experimental and control groups. Thus, the FT/TT therapy had psychological and biochemical effects on individuals with depression and nicotine or alcohol dependency. Further studies should be conducted to verify the effect of forest healing in various conditions.

Key Words: forest healing, charcoal kiln, alcohol dependence, nicotine addiction

Introduction

In modern society, depression is the most common psychological disorder that an individual can experience and a mood disorder in which a persistent feeling of sadness is the main symptom. Depression can vary from a mild depressive response to stressful events in healthy individuals to

psychotic depression (Schraedley 1999). Emotions like depression are closely related to unhealthy behaviors, such as drinking and smoking (Lee 1995; Patton et al. 1996; Patton et al. 1998; Sullivan and Pfefferbaum 2005), which worsens health behavior and increases the risk of metabolic syndrome (Cohen et al. 2010). Drinking and smoking have been reported as factors affecting the presence of mental

Received: July 31, 2023. Revised: October 22, 2023. Accepted: November 22, 2023.

Corresponding author: Soyeon Kim

Department of Forest Healing, College of Human Service, Catholic Kwandong University, Gangneung 25601, Republic of Korea

Tel: +82-33-649-7572, Fax: +82-33-649-7669, E-mail: neon5947@cku.ac.kr

health conditions, such as depression and anxiety. In addition, a number of studies have linked drinking and smoking to higher levels of depression and anxiety (Gweon 2009; Seo 2011; Ko et al. 2022).

Therefore, it is necessary to study whether reducing depression can lead to abstinence from drinking or smoking (Kim 2015). The cause of alcohol and nicotine dependence disorders is the excessive secretion of dopamine due to continuous drinking and smoking, resulting in the reward center in the brain causing addiction due to unconscious cravings and desires. It is reported that withdrawal symptoms experienced in the process of quitting drinking and smoking lead to depression, and long-term exposure to alcohol and smoking also exacerbates depression by lowering the concentration of serotonin in the brain (Ministry of Health and Welfare 2017). Research results have shown that people with a tendency to 'problematic alcohol use', such as alcoholism, are genetically more likely to develop neurological diseases such as depression or become dependent on drugs and cigarettes (Zhou et al. 2020; Korea Disease Control and Prevention Agency 2022).

Among adult males and females in Korea, the rates of visiting hospitals for depression, alcohol dependence/abuse, and nicotine dependence/withdrawal disorders are 6.0%, 12.2%, and 5.0%, respectively, and a significant portion of depression cases occur as an accompanied disease of alcohol and nicotine disorders (Ministry of Health and Welfare 2017). At present, the treatment for these disorders is to administer anticraving drugs for the control and balance of dopamine levels, which is a causative neurological hormone, or to use selective serotonin reuptake inhibitors to increase the concentration of serotonin in the brain and blood (Ministry of Health and Welfare 2017). Such drug-centered treatment is expensive and has a high possibility of recurrence. Therefore, forest bathing and thermal bathing, which can stimulate the self-repair system of human cells and increase serotonin levels in the brain, are proposed as new alternative therapies to compensate for shortcomings in drug-centered treatment (Kim 2001; Shin et al. 2007; Arita 2010; Oh et al. 2016).

Serotonin is a neurotransmitter that affects emotional regulation and sleep (Zhou et al. 2001). A lack of serotonin increases depression and anxiety (Svenningsson et al. 2006), and a high level of serotonin can stimulate feelings of

comfort and happiness (Bondy et al. 2000). Generally known physiological activity effects of serotonin are awakening of the cerebral cortex to maintain a clear and pleasant state of consciousness, and autonomously regulating the autonomic nervous system (sympathetic and parasympathetic nervous systems) (Arita 2010). The use of a forest healing program, which promotes inhaling phytoncide in a forest through forest bathing, is considered to be effective in stimulating the body's secretion of serotonin. In addition, a dry sauna, which is representative thermal bathing, is popular in Northern Europe and used as an alternative therapy to improve health (Cho et al. 2019). In particular, charcoal kiln saunas, used for a traditional type of thermal bathing in Korea, have been used for health since ancient times (Hayasaka et al. 2008). The beneficial effect of a charcoal kiln is that far-infrared rays from red clay and negative ions from hardwood charcoal penetrate the body and cause the excretion of heavy metals and wastes from the body through sweat, feces, and urine, thereby promoting metabolism and assisting with treating various diseases (Park 1997). A recent study tested the effect of a dry sauna on 10 patients with chronic fatigue syndrome for 4 weeks, and reported that fatigue, anxiety, and depression decreased (Soejima et al. 2015). It heats the air in small rooms or wooden buildings. It is a method of sweating with the bare body and is characterized by dry air and high temperatures. Most wood used is spruce or aspen, and spraying water into the air temporarily increases humidity (Hannuksela and Ellahham 2001; Wilson 2010).

Another study presented that far-infrared rays penetrate subcutaneous tissue cells through thermal bathing, and promote the metabolism and blood circulation of cells, increase body temperature, and have positive effects on autonomic nerve responses (Michalsen et al. 1999). Therefore, it is expected that forest bathing and thermal bathing can promote body secretion of the serotonin hormone and increase the excretion of blood toxins and waste products accumulated in the body.

Forest bathing reduces depression by suppressing cortisol and noradrenaline, which stimulate the sympathetic nerve, and activating serotonin, which maintains the balance of the autonomic nervous system (Arita 2011). It has also been reported that far-infrared rays are effective in serotonin activation as well as in balancing and promoting the

autonomic nervous system (Michalsen et al. 1999). Insomnia is a symptom of several depressive and anxiety disorders, and many studies have reported a relationship between insomnia, depression, and anxiety (Breslau et al. 1996; Jansson-Fröjmark and Lindblom 2008). Park et al. (2014) demonstrated that insomnia, suicide, and serotonin levels are all related to each other in depressed patients. In particular, during meditation, stress is reduced by lowering cortisol secretion and stress index, and emotions stabilize by the stimulated secretion of dopamine. Repetitive and light dry sauna thermal therapy could be a new patient- and elderly-friendly thermal therapy treatment for health promotion by suppressing excessive sympathetic nerve dominance and promoting immunity, as well as by minimizing the burden on the body (Tomiyama et al. 2015). Accordingly, this study examined the effect of combined therapy of forest bathing and thermal bathing on reducing anxiety and stress for a subject group with depressive symptoms accompanying alcohol consumption and smoking. The results of this study are expected to be used as basic data for disease prevention and to allow the development of an effective combined therapy program in Korea using its abundant forest resources.

Materials and Methods

Research design

To determine the effect on stress, anxiety, and depression, a quasi-experimental study of nonequivalence control group design was conducted using combined forest/thermal therapy (FT/TT: applying both forest bathing, FT, and thermal bathing, TT) as an intervention program.

Participants

The participants in this study were those who scored ≥ 16 points on the depression scale and ≥ 12 points on the alcohol dependence scale or ≥ 4 points on the nicotine dependence scale. The study was conducted with the approval of the Kangwon National University Institutional Review Board (KWNUIRB-2022-03-005-001), obtained prior to commencement of the study. The specific selection criteria for the participants were adults (aged ≥ 19 years) without communication disabilities who could respond to the contents of the questionnaire and had no restrictions on their

movements. Study participants were fully informed about the need for and purpose of the study, invasive nature of treatment, method of conducting the study, and duration of the study. They were also informed that participation could be withdrawn at any time without any disadvantage. Subsequently, those who voluntarily agreed to participate in the study for 2 nights and 3 days signed a consent form. Among the 40 participants (all provided written informed consent), 20 participants who were available to go camping were assigned to the experimental group, and those who were not available for the experimental program were assigned to the control group. Finally, 38 participants were included in the study, as two participants in the control group did not participate owing to personal reasons (Fig. 1).

Experimental design

The experiment was conducted for 2 nights and 3 days on May 6-8, 2022 combined forest healing program by applying FT/TT. The experiment site was the National Center for Forest Healing in Hoengseong (National Hoengseong Supchewon), where the experimental group performed activities for FT/TT, including forest bathing in the morning and thermal bathing in the afternoon, for 2 nights and 3 days. Forest bathing was conducted under the guidance of a forest therapy instructor using forest roads within National Hoengseong Supchewon, applying various forest therapy programs, such as meditation and walking. Thermal bathing was conducted based on the experimental design of previous research and modified according to the situation in Korea (Masuda et al. 2005; Cho et al. 2019). It proceeded for about 3 h with a freely chosen routine of the following activities: participants entered a traditional charcoal kiln in Gangwon Charcoal Farming Association at 80-100°C for

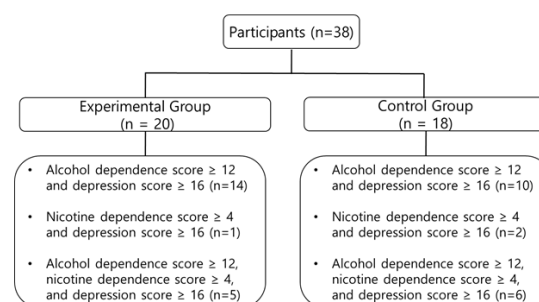


Fig. 1. Study participants.

10 min, and then took a break outside with a blanket for 15 min. The control group was allowed to perform daily activities as usual, with no treatment applied.

Data collection

A pre-experimental inspection was conducted in the laboratory of Kangwon National University, and participants in the experimental group and control group were asked to directly fill out the structured questionnaire regarding their levels of stress, anxiety, depression, sleep quality, and sleep satisfaction. Thereafter, their blood cortisol, serotonin, melatonin, and IL-6 levels were measured in a quiet laboratory where external noise was blocked. Blood collection was performed between 08:00 and 10:00 LST with an empty stomach for > 8 h.

A post-experimental inspection was conducted in the same order as the pre-experimental inspection after the completion of the 3 day FT/TT. The tests for the experimental group were conducted at National Hoengseong Supchewon, and the tests for the control group were conducted at a laboratory of Kangwon National University where the pre-experimental inspection was conducted.

Demographic characteristics of participants

The following demographic characteristics were obtained from the participants: gender, age, education, religion, marital status, average monthly income, alcohol consumption, and nicotine dependency.

Stress

To determine the psychosocial stress status, the Psychosocial Wellbeing Index short form (PWI-SF) questionnaire with 18 items was used, which was reconstructed in Korean style based on the general health measurement table of Goldberg and Hillier (1979) (Jang 2000). In the PWI-SF questionnaire, each answer is assigned 0 points for 'always,' 1 point for 'mostly,' 2 points for 'somewhat,' and 3 points for 'not at all.' Negative questions were inversely scored. The lower the sum score, the lower the stress level. A PWI-SF score of ≤ 8 indicated a healthy individual, a score of 9-26 indicated a potentially at-risk individual, and a score of ≥ 27 indicated an at-risk individual. At the time of scale development, Cronbach's α was 0.920, and in this study, Cronbach's α was 0.941.

Anxiety

The State-Trait Anxiety Inventory (STAI) was used to determine the level of anxiety, which was developed by Spielberger et al. (1971) and standardized for Koreans (Kim and Shin 1978). This scale consists of 20 items measuring the level of anxiety currently felt (state anxiety) and 20 items measuring the degree of anxiety felt all of the time (trait anxiety). STAI is Likert scale assigns answers 1 point for 'not at all,' 2 points for 'a little bit,' 3 points for 'moderately,' and 4 points for 'extremely.' The anxiety score is the sum of each item ranging from a minimum of 20 to a maximum of 80, in which positive items are scored inversely. A higher score means a higher level of anxiety. Cronbach's α was 0.890 in Kim and Shin (1978), and in this study, Cronbach's α was 0.967.

Depression

The Korean Version of the Center for Epidemiologic Studies Depression Scale (K-CES-D) was used to determine level of depression, which was developed by Radloff (1977) and adapted by Chon et al. (2001). It consists of 20 items on depression symptoms, and participants were asked to indicate how often they have felt this way during the past week. A -point Likert scale is used that ranges from 0 (extremely rarely) to 3 (almost all the time), with a total score ranging from 0 to 60. A score of 0 to 20 is classified as normal, a score of 21 to 40 is classified as a risk group for depression, and a score of 41 to 60 points is classified as a high risk group for depression. A higher score indicates a higher level of depression. Cronbach's α was 0.910 at the time of development, and was 0.950 in this study.

Sleep-related tests

For sleep-related tests, a self-questionnaire representing sleep patterns and a questionnaire on sleep satisfaction were used. A measurement scale for sleep patterns is the Korean Version of the Sleep Habits Questionnaire developed by Oh et al. (1998), which consists of 15 items. On a 4-point Likert scale, the level of sleep for several days is scored on a scale from 1 (very much so) to 4 (not at all), with a total score ranging from 15 to 60. A higher score indicates a higher quality of sleep. Cronbach's α was 0.750 at the time of development, and 0.841 in this study. Sleep satisfaction is a subjective satisfaction score for one's sleep, and this is in-

licated from 0 (not satisfied at all) to 10 (very satisfied).

Biochemical test

Blood tests were conducted for measurements of cortisol, serotonin, melatonin, and IL-6 levels. Blood sampling was performed between 8:00 and 10:00 LST with an empty stomach. Then, 6 mL of whole blood was collected, divided into two SSTs, centrifuged at room temperature at 3,000 rpm for 7 min, stored frozen, and then placed into a dry ice box and sent to the E analysis center for analysis. A higher level of cortisol means a higher level of stress, and a higher level of serotonin means a lower level of anxiety (that is, a higher level of comfort). An increase in melatonin secretion is associated with an improvement of sleep quality, and a lower level of IL-6 indicates a lower inflammatory level.

Method of analysis

The homogeneity of the experimental group and control group was tested through the t-test, χ^2 test, and Fisher's exact test. To verify the effect on stress and anxiety, an independent t-test was performed on the variables of the experimental group and the control group. A p-value of

< 0.05 was considered to indicate significance. Analysis was performed using IBM's statistical program SPSS Statistics for Windows, Version 26.0 (IBM CO., Armonk, NY, USA).

Results

Demographic characteristics

The experimental group consisted of 11 males (55%) and nine females (45%), with an average age of 44.40 (± 16.538). The control group consisted of nine males (50%) and nine females (50%), with an average age of 44.94 (± 17.339). No significant difference was observed between the experimental and control groups in terms of gender, age, education, religion, marital status, average monthly income, alcohol consumption, and nicotine dependency, confirming that the two groups were homogeneous (Table 1).

Degree of stress, anxiety, and depression; quality of sleep; sleep satisfaction; and cortisol, serotonin, melatonin, and IL-6 levels were the experimental indices. No significant difference was observed between the experimental

Table 1. Demographic characteristics and nicotine dependency for the groups (N=38)

Characteristics	Categories	Mean \pm SD/n (%)		z, X^2 , or t	p
		Exp. (n=20)	Cont. (n=18)		
Gender	Male	11 (55.0%)	9 (50.0%)	0.095	0.758
	Female	9 (45.0%)	9 (50.0%)		
Age (years)		44.40 \pm 16.538	44.94 \pm 17.339	-0.099	0.922
Education	\leq High school	13 (65.0%)	9 (50.0%)	0.874	0.350
	\geq College	7 (35.0%)	9 (50.0%)		
Religion	Yes	8 (40.0%)	10 (55.6%)	0.920	0.338
	No	12 (60.0%)	8 (44.4%)		
Marital status	Married	10 (50.0%)	8 (44.4%)	1.173	0.556
	Single	9 (45.0%)	10 (55.6%)		
	Other	1 (5.0%)	-		
Monthly income (unit: 1,000 KRW)	$< 2,000$	7 (35.0%)	3 (16.7%)	1.643	0.440
	2,001-4,000	6 (30.0%)	7 (38.9%)		
	$> 4,000$	7 (35.0%)	8 (44.4%)		
Alcohol consumption (unit: drinks)	$\leq 1-2/\text{week}$	12 (60.0%)	15 (83.3%)	2.508	0.113
	$\geq 3-4/\text{week}$	8 (40.0%)	3 (16.7%)		
Nicotine dependency	No	11 (55.0%)	9 (50.0%)	0.095	0.758
	Yes	9 (45.0%)	9 (50.0%)		

Cont., control group; Exp., experimental group; SD, standard deviation.

and control groups with respect to these indices, indicating that the two groups were homogeneous (Table 2).

Effects of FT/TT

According to the stress score (PWI-SF), the stress level of the experimental group was significantly lower than that of the control group after the FT/TT ($t=-6.120$, $p=0.000$) than before intervention. Compared with the control group, the experimental group exhibited significantly decreased state anxiety (currently felt stress level; $t=-6.246$, $p=0.000$) and trait anxiety (stress level that is always felt; $t=-6.224$, $p=0.000$). The depression score also significantly decreased in the experimental group compared with that in the control group after the FT/TT ($t=-4.086$, $p=0.000$). The quality of sleep improved significantly in the experimental group compared with that in the control group after the FT/HT intervention, which contrasted with the levels before the intervention ($t=4.711$, $p=0.000$). Sleep satisfaction also increased significantly in the experimental group compared with that in the control group ($t=6.275$, $p=0.000$). No significant difference was observed between the experimental and control groups for the physiological indicators, including cortisol ($t=0.616$, $p=0.542$), serotonin ($t=-1.586$, $p=0.121$), and melatonin ($t=-0.106$, $p=0.916$) levels. However, the level of IL-6, a biochemical indicator and an inflammatory marker, significantly decreased in the experimental group compared with that in

the control group ($t=-2.305$, $p=0.027$) (Table 3).

Discussion

This study examined the effectiveness of FT/TT, which involves both forest and thermal bathing. For 20 participants in the experimental group and 18 participants in the control group with depressive symptoms as well as alcohol or nicotine dependence, their demographic characteristics and psychological characteristics, including stress, anxiety, depression, quality of sleep, and sleep satisfaction levels, were analyzed. Biochemical characteristics were assessed through cortisol, serotonin, melatonin, and IL-6 levels.

The participants of this study had high alcohol or nicotine dependence and, compared to the general adult population studied previously, a higher level of anxiety (Lee and Lee 2013) and depression (Sim et al. 2021), as well as poorer sleep quality than elderly people (Park 2007).

The results of this study indicated that FT/TT significantly improved psychological characteristics, quality of sleep, and sleep satisfaction. The results were consistent with those of previous studies presenting positive psychological effects of activity in forests on depression, anxiety, and stress (Kim and Lee 2014; You et al. 2014; Shin et al. 2015; Park and Koo 2018; Park et al. 2021). However, direct comparison was difficult as there have been no previous studies on forest and thermal bathing treatment for partic-

Table 2. Values of dependent variables for the groups (N=38)

Categories	Variables	Mean \pm SD		z, X^2 , or t	p
		Exp. (n=20)	Cont. (n=18)		
Stress scale	PWI-SF	30.90 \pm 8.72	28.44 \pm 6.72	0.964	0.342
Anxiety scale	STAI-S	54.05 \pm 11.57	50.28 \pm 9.84	1.076	0.289
	STAI-T	54.70 \pm 11.83	49.78 \pm 8.59	1.453	0.155
Depression scale		28.95 \pm 14.32	24.78 \pm 8.91	1.089	0.284
Quality of sleep		33.70 \pm 6.88	36.56 \pm 5.07	-1.466	0.158
Sleep satisfaction		4.50 \pm 2.16	4.83 \pm 2.00	-0.491	0.627
Cortisol level ($\mu\text{g/dL}$)		12.36 \pm 5.86	14.18 \pm 4.05	-1.104	0.277
Serotonin level (ng/mL)		126.73 \pm 65.67	141.85 \pm 91.12	-0.591	0.558
Melatonin level (pg/mL)		3.66 \pm 3.95	2.46 \pm 2.66	1.089	0.283
IL-6 level (pg/mL)		3.15 \pm 1.88	3.63 \pm 3.51	-0.542	0.591

Cont., control group; Exp., experimental group; SD, standard deviation; PWI-SF, psychosocial wellbeing index short form; STAI-S, state-trait anxiety inventory (state anxiety); STAI-T, state-trait anxiety inventory (trait anxiety).

Table 3. Effect of forest/thermal combined therapy (N=38)

Variables	Group	Mean±SD			t, z	p	
		Baseline	After	Difference			
Stress scale (PWI-SF)	Exp.	30.90±8.72	12.55±6.49	-18.35±11.07	-6.120	0.000**	
	Cont.	28.44±6.72	27.00±9.52	-1.44±5.23			
Anxiety scale STAI-S	Exp.	54.05±11.57	31.55±7.56	-22.50±13.95	-6.246	0.000**	
	Cont.	50.28±9.84	49.94±10.43	-0.33±7.19			
	STAI-T	Exp.	54.70±11.83	35.30±5.29			-19.40±12.69
		Cont.	49.78±8.59	50.06±9.14			0.28±5.91
Depression scale	Exp.	28.95±14.32	12.75±8.70	-16.20±14.36	-4.086	0.000**	
	Cont.	24.78±8.91	24.00±10.41	-0.78±8.42			
Quality of sleep	Exp.	33.70±6.88	41.80±7.96	8.10±6.94	4.711	0.000**	
	Cont.	36.56±5.07	35.89±5.84	-0.89±4.38			
Sleep satisfaction	Exp.	4.50±2.16	7.55±1.54	3.05±2.24	6.275	0.000**	
	Cont.	4.83±2.00	4.39±2.33	-0.44±1.04			
Cortisol level (µg/dL)	Exp.	12.36±5.86	14.62±3.79	2.26±4.89	0.616	0.542	
	Cont.	14.18±4.05	15.62±4.31	1.44±3.00			
Serotonin level (ng/mL)	Exp.	126.73±65.67	106.66±49.62	-20.07±22.32	-1.586	0.121	
	Cont.	141.85±91.12	137.69±73.51	-4.16±38.20			
Melatonin level (pg/mL)	Exp.	3.66±3.95	6.75±6.40	3.09±7.89	-0.106	0.916	
	Cont.	2.46±2.66	5.78±4.83	3.32±4.92			
IL-6 level (pg/mL)	Exp.	3.15±1.88	2.64±1.88	-0.50±0.99	-2.305	0.027*	
	Cont.	3.63±3.51	4.20±4.67	0.56±1.79			

Cont., control group; Exp., experimental group; PWI-SF, psychosocial wellbeing index short form; STAI-S, state-trait anxiety inventory (state anxiety); STAI-T, state-trait anxiety inventory (trait anxiety).

*p < 0.05, **p < 0.01.

ipants with high alcohol and nicotine dependence and high depression level. Overall, it was confirmed that the activities conducted in FT/TT had a positive effect on the psychological state of the experimental group with depressive symptoms. According to Park et al. (2012), forest healing has a greater effect on participants with “Mibyeong (subhealth)” symptoms, which refers to abnormal symptoms that cause discomfort in daily life or abnormal findings obtained on tests. Thus, forest healing helps to control the accumulated stress of modern people with various characteristics and enables them to find mental stability. Forest healing uses forests as a place for weary modern people to enhance their health, regain their vitality, relieve depressive symptoms accompanying alcohol and nicotine dependence, prevent addiction, and promote recovery.

The results of sleep-related tests were significantly better in the experimental group compared with those in the control group. This finding is consistent with the results of pri-

or studies that confirmed the effect of forest healing as improved sleep quality in participants with chronic pain (Han et al. 2016) and patients with gastrointestinal cancer (Kim et al. 2019a). Various addictions can be factors that affect the quality of sleep (Kim et al. 2019b), which could be improved by FT/TT, as per the implications of the present study’s results.

In contrast, the result of the cortisol test was not statistically significant. Strickland et al. (2002) reported that cortisol levels do not increase significantly in patients with depressive disorder compared with those in healthy individuals, which is consistent with the results of the present study. However, Bratek et al. (2015) reported that the frequency of depression was high when cortisol levels were elevated. Therefore, further extended studies are needed in the future.

There was no significant difference in serotonin levels between the experimental group and the control group in

this study. Conversely, Park et al. (2020) reported a statistically significant change in serotonin levels in middle-aged women undergoing forest healing for 2 nights and 3 days.

The present study did not show a significant difference between the experimental group and the control group for melatonin levels either, which is consistent with the results of Shin et al. (2015), who applied forest healing for 10 weeks to menopausal women. However, the results differed from those of Kim et al. (2017) who applied forest healing for 16 weeks to a group of elderly people. The level of melatonin in blood varies greatly among individuals and is affected by the amount and time of exposure to light (Wetterberg et al. 1976). Therefore, to verify the effect, repeated studies are needed to carefully investigate the application period and content of the program.

IL-6 levels were significantly different between the experimental group and the control group, indicating that FT/HT for 2 nights and 3 days reduced the level of inflammation. As IL-6 is known to play the role of myokine with anti-inflammatory action, it is known to have both inflammatory and anti-inflammatory properties (Wellen and Hotamisligil 2003).

This study inevitably had the difficulty of not being able to conduct a multi-session program due to the COVID-19 pandemic. For follow-up studies of similar participants, the application of a systematical plan for long term program is planned.

The significance of this study is as follows. First, while previous studies applied forest bathing and thermal bathing separately, this study attempted to verify the effect of FT/TT, which includes both forest and thermal bathing. Second, forest healing is made up of various elements of the forest environment, in which charcoal is also considered a resource for this. In this context, the present study suggests a positive effect when using forests and charcoal simultaneously in Korea, which has a forest area of 64% of the territory. Third, through the inclusion of participants with depression, this study showed the potential of FT/TT as an alternative therapy to reduce negative emotions and suggested forest and thermal bathing as practical methods for treatment.

However, a limitation of this study is that the place of the pre-test and post-test were different. This means that physiological indexes may be affected depending on environ-

mental conditions such as temperature and humidity at the site. In future, the psychological and physiological conditions as well as biochemical conditions of participants should be monitored, and the number of participants included in research should be increased.

Conclusion

The results of this study showed that, for participants with depressive symptoms accompanied by nicotine or alcohol dependence, FT/TT therapy reduced depression, anxiety, and stress and improved the quality of sleep. Among physiological indicators, the level of IL-6 was significantly changed but that of cortisol, serotonin, and melatonin did not show. To verify the applicability of forest and thermal bathing, further studies need to be conducted while considering various participant types, program lengths, and program contents. The results of this study can be used as basic data for combined healing programs.

Acknowledgements

This study was carried out with the support of 'R&D Program for Forest Science Technology (Project No. C1015831-01-03)' provided by Korea Forest Service (Korea Forestry Promotion Institute).

References

- Arita H. 2010. *5 Minutes in the Morning for Happiness*. Midasbooks, Seoul.
- Arita H. 2011. *Serotonin 100% Activation Method*. Firforest, Seoul.
- Bondy B, Erfurth A, de Jonge S, Krüger M, Meyer H. 2000. Possible association of the short allele of the serotonin transporter promoter gene polymorphism (5-HTTLPR) with violent suicide. *Mol Psychiatry* 5: 193-195.
- Bratek A, Zawada K, Beil-Gawelczyk J, Beil S, Sozańska E, Krysta K, Barczyk A, Krupka-Matuszczyk I, Pierzchała W. 2015. Depressiveness, symptoms of anxiety and cognitive dysfunctions in patients with asthma and chronic obstructive pulmonary disease (COPD): possible associations with inflammation markers: a pilot study. *J Neural Transm (Vienna)* 122(Suppl 1): S83-S91.
- Breslau N, Roth T, Rosenthal L, Andreski P. 1996. Sleep disturbance and psychiatric disorders: a longitudinal epidemiological study of young adults. *Biol Psychiatry* 39: 411-418.

- Cho EH, Kim NH, Kim HC, Yang YH, Kim J, Hwang B. 2019. Dry sauna therapy is beneficial for patients with low back pain. *Anesth Pain Med (Seoul)* 14: 474-479.
- Chon KK, Choi SC, Yang BC. 2001. Integrated adaptation of CES-D in Korea. *Korean J Health Psychol* 6: 59-76.
- Cohen BE, Panguluri P, Na B, Whooley MA. 2010. Psychological risk factors and the metabolic syndrome in patients with coronary heart disease: findings from the Heart and Soul Study. *Psychiatry Res* 175: 133-137.
- Goldberg DP, Hillier VF. 1979. A scaled version of the General Health Questionnaire. *Psychol Med* 9: 139-145.
- Gweon HS. 2009. Effects of problem drinking of elderly on life satisfaction mediated by depression and self-esteem: a latent means analysis application between poor and non-poor elderly. *J Korean Gerontol Soc* 29: 1521-1538.
- Han JW, Choi H, Jeon YH, Yoon CH, Woo JM, Kim W. 2016. 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* 13: 255.
- Hannuksela ML, Ellahham S. 2001. Benefits and risks of sauna bathing. *Am J Med* 110: 118-126.
- Hayasaka S, Nakamura Y, Kajii E, Ide M, Shibata Y, Noda T, Murata C, Nagata K, Ojima T. 2008. Effects of charcoal kiln saunas (Jjimjilbang) on psychological states. *Complement Ther Clin Pract* 14: 143-148.
- Jang SJ. 2000. Stress. In: *Standardization of Health Statistics Data Collection and Measurement (Korean Society for Preventive Medicine, ed)*. Gyeochuk Munwhasa, Seoul, pp 92-143.
- Jansson-Fröjmark M, Lindblom K. 2008. A bidirectional relationship between anxiety and depression, and insomnia? A prospective study in the general population. *J Psychosom Res* 64: 443-449.
- Kim DJ, Lee SS. 2014. Effects of forest therapy program in school forest on employment stress and anxiety of university students. *J Korean Soc People Plants Environ* 17: 107-115.
- Kim EJ. 2015. Occupational stress, depression, drinking of heavy industrial male workers. *J Korea Acad Ind Coop Soc* 16: 4758-4767.
- Kim H, Lee YW, Ju HJ, Jang BJ, Kim YI. 2019a. An exploratory study on the effects of forest therapy on sleep quality in patients with gastrointestinal tract cancers. *Int J Environ Res Public Health* 16: 2449.
- Kim JT, Shin DK. 1978. A study based on the standardization of the STAI for Korea. *New Med J* 21: 69-75.
- Kim JY, Shin CS, Lee JK. 2017. The effects of forest healing program on mental health and melatonin of the elderly in the urban forest. *J Korean Soc People Plants Environ* 20: 95-106.
- Kim SH, Min JW, Park BK. 2019b. The effect of smartphone addiction and stress on sleep quality among university students. *J Korea Acad Ind Coop Soc* 20: 112-120.
- Kim YK. 2001. Perceived Effects after Using the Loess-Room. *Korean J Womens Health* 2: 25-50.
- Ko KS, Im YJ, Moon JH, Nam HE. 2022. A study on the structural relationship between drinking and smoking, physical health, depression and anxiety in middle-aged and elderly people. *J Korea Acad Ind Coop Soc* 23: 359-366.
- Korea Disease Control and Prevention Agency. 2022. Knowledge of the Harmful Effects of Tobacco. Korea Disease Control and Prevention Agency, Cheongju.
- Lee BK, Lee HH. 2013. Effects of occupational and social stresses after forest therapy. *J Naturop* 2: 108-114.
- Lee YS. 1995. A study on the effective alcohol education strategies for the prevention of alcohol problems. *Korean J Health Educ Promot* 12: 139-145.
- Masuda A, Nakazato M, Kihara T, Minagoe S, Tei C. 2005. Repeated thermal therapy diminishes appetite loss and subjective complaints in mildly depressed patients. *Psychosom Med* 67: 643-647.
- Michalsen A, Löer D, Melchart D, Dobos G. 1999. [Changes of short-time heart rate variability during hyperthermia treatment with infrared A whole body irradiation]. *Forsch Komplementarmed* 6: 212-215. German.
- Ministry of Health and Welfare. 2017. The Survey of Mental Disorders in Korea. Ministry of Health and Welfare, Sejong.
- Oh CH, Park SG, Park JH, Oh IJ. 2016. The Effects of the Forest Environment on Internet Addiction Treatment. *J Korea Acad Ind Coop Soc* 17: 489-499.
- Oh JJ, Song MS, Kim SM. 1998. Development and validation of Korea Sleep Scale A. *J Korean Acad Nurs* 28: 563-572.
- Park BJ, Shin CS, Shin WS, Chung CY, Lee SH, Kim DJ, Kim YH, Park CE. 2020. Effects of forest therapy on health promotion among middle-aged women: focusing on physiological indicators. *Int J Environ Res Public Health* 17: 4348.
- Park KJ, Shin CS, Yeon PS. 2021. Identification of the effectiveness of forest therapy factors by disease through review of forest therapy experience essays. *J Korean Inst For Recreat* 25: 1-12.
- Park MK. 1997. Professor Baek Woo-hyun, who discovered the far-infrared effect of loess - loess saves even dying life. *Wolgan Saemteo* 28: 10-14.
- Park SH, Koo CD. 2018. Needs analysis for the development of forest therapy program utilizing the urban forest-focused on the visitors of Incheon Grand Park. *J Korean Inst For Recreat* 22: 11-24.
- Park SM, Woo JM, Kim W, Lee YJ. 2012. Sub-populations and disorders that can be applied to forest therapy. *J Korean Inst For Recreat* 16: 35-42.
- Park YH. 2007. Physical activity and sleep patterns in elderly who visited a community senior center. *J Korean Acad Nurs* 37: 5-13.
- Park YM, Kang SG, Lee HJ, Kim L. 2014. Insomnia in relation to suicide and serotonin in patients with major depressive disorder. *Sleep Med Psychophysiol* 21: 29-32.
- Patton GC, Carlin JB, Coffey C, Wolfe R, Hibbert M, Bowes G. 1998. Depression, anxiety, and smoking initiation: a prospective

- study over 3 years. *Am J Public Health* 88: 1518-1522.
- Patton GC, Hibbert M, Rosier MJ, Carlin JB, Caust J, Bowes G. 1996. Is smoking associated with depression and anxiety in teenagers? *Am J Public Health* 86: 225-230.
- Radloff LS. 1977. The CES-D Scale: a self-report depression scale for research in the general population. *Appl Psychol Meas* 1: 385-401.
- Schraedley PK, Gotlib IH, Hayward C. 1999. Gender differences in correlates of depressive symptoms in adolescents. *J Adolesc Health* 25: 98-108.
- Seo YS. 2011. A study on health status by social-economic status of middle-aged and elderly. *J Korean Gerontol Soc* 31: 1135-1153.
- Shin CS, Yeon PS, Jo MN, Kim JY. 2015. Effects of forest healing activity on women's menopausal symptoms and mental health recovery. *J Korean Soc People Plants Environ* 18: 319-325.
- Shin WS, Yeoun PS, Lee JH, Kim SK, Joo JS. 2007. The Relationships Among Forest Experience, Anxiety and Depression. *J Korean Inst For Recreat* 11: 27-32.
- Sim NS, Shin CS, Shin MJ. 2021. The effect of forest healing program on resilience and depression of baby boomer retirees. *Korean J Environ Ecol* 35: 424-434.
- Soejima Y, Munemoto T, Masuda A, Uwatoko Y, Miyata M, Tei C. 2015. Effects of Waon therapy on chronic fatigue syndrome: a pilot study. *Intern Med* 54: 333-338.
- Spielberger CD, Gonzalez-Reigosa F, Martinez-Urrutia A, Natalicio LFS, Natalicio DS. 1971. Development of the Spanish edition of the State-Trait Anxiety Inventory. *Interam J Psychol* 5: 145-158.
- Strickland PL, Deakin JF, Percival C, Dixon J, Gater RA, Goldberg DP. 2002. Bio-social origins of depression in the community. Interactions between social adversity, cortisol and serotonin neurotransmission. *Br J Psychiatry* 180: 168-173.
- Sullivan EV, Pfefferbaum A. 2005. Neurocircuitry in alcoholism: a substrate of disruption and repair. *Psychopharmacology (Berl)* 180: 583-594.
- Svenningsson P, Chergui K, Rachleff I, Flajolet M, Zhang X, El Yacoubi M, Vaugeois JM, Nomikos GG, Greengard P. 2006. Alterations in 5-HT_{1B} receptor function by p11 in depression-like states. *Science* 311: 77-80.
- Tomiyama C, Watanabe M, Honma T, Inada A, Hayakawa T, Ryufuku M, Abo T. 2015. The effect of repetitive mild hyperthermia on body temperature, the autonomic nervous system, and innate and adaptive immunity. *Biomed Res* 36: 135-142.
- Wellen KE, Hotamisligil GS. 2003. Obesity-induced inflammatory changes in adipose tissue. *J Clin Invest* 112: 1785-1788.
- Wetterberg L, Arendt J, Paunier L, Sizonenko PC, Donselaar W, Heyden T. 1976. Human serum melatonin changes during the menstrual cycle. *J Clin Endocrinol Metab* 42: 185-188.
- Wilson L. 2010. *Infrared Sauna Therapy*. L.D. Wilson Consultants, Inc., Prescott, AZ.
- You YS, Kim HC, Lee CJ, Jang NC, Son BK. 2014. A study of effects of sallimyok(forest therapy)-based mental health program on the depression the psychological stability. *J Korean Soc Sch Community Health Educ* 15: 55-65.
- Zhou FC, Sari Y, Zhang JK, Goodlett CR, Li T. 2001. Prenatal alcohol exposure retards the migration and development of serotonin neurons in fetal C57BL mice. *Brain Res Dev Brain Res* 126: 147-155.
- Zhou H, Sealock JM, Sanchez-Roige S, Clarke TK, Levey DF, Cheng Z, Li B, Polimanti R, Kember RL, Smith RV, Thygesen JH, Morgan MY, Atkinson SR, Thursz MR, Nyegaard M, Mattheisen M, Børglum AD, Johnson EC, Justice AC, Palmer AA, McQuillin A, Davis LK, Edenberg HJ, Agrawal A, Kranzler HR, Gelernter J. 2020. Genome-wide meta-analysis of problematic alcohol use in 435,563 individuals yields insights into biology and relationships with other traits. *Nat Neurosci* 23: 809-818.