Urban Forestry & Urban Greening 27 (2017) 246–252

Contents lists available at ScienceDirect

Urban Forestry & Urban Greening

journal homepage: www.elsevier.com/locate/ufug

Original article

Sustained effects of a forest therapy program on the blood pressure of office workers

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ARTICLE INFO

Keywords:
Middle-aged adults
Physiological relaxation
Preventive medicine
Prolonged effects
Shinrin-yoku
Stress management

ABSTRACT

We examined the sustained effects of a forest therapy program on the blood pressure of office workers. Twenty-six office workers (mean age ± standard deviation, 35.7 ± 11.1 years) participated in a 1-day forest therapy program. Systolic and diastolic blood pressure and pulse rate were used as measurement indices. The evaluations were performed three times before breakfast, lunch, and dinner 3 days before, during, and 3 and 5 days after the forest therapy program. Systolic and diastolic blood pressure significantly decreased during the forest therapy program relative to the value from 3 days before the program, and this decrease was maintained 3 and 5 days after the forest therapy program. There were no significant differences in pulse rate. We then specifically focused on nine participants whose systolic blood pressure was above 120 mmHg. For the measurement before dinner, the systolic blood pressure significantly decreased (from 133.8 to 116.6 mmHg) during the forest therapy program, and this decrease was maintained at 3 and 5 days after the program (126.4 and 124.0 mmHg, respectively). A significant decrease in diastolic blood pressure (from 88.6 to 77.1 mmHg) was observed during the forest therapy program. In conclusion, systolic and diastolic blood pressure decreased during the forest therapy program and these decreases were maintained for 5 days.

1. Introduction

There are serious social concerns over health problems caused by job stress. Job stress is defined as harmful physical and emotional responses that occur when the requirements of a job do not match the capabilities, resources, or needs of the worker (National Institute for Occupational Safety and Health, 1999). Over the past few decades, more and more research has documented that job stress is associated with a moderately elevated risk of adverse health outcomes, especially cardiovascular-related adverse effects (Kang et al., 2005; Kivimäki and Kawachi, 2015; Siegrist and Li, 2016).

According to a survey conducted in Japan (Ministry of Health, Labour and Welfare, 2012), 60.9% of Japanese workers feel stress in their jobs. This high stress state of workers has become an important social issue and, therefore, the Japanese government launched a new occupational health policy called the Stress Check Program to monitor and screen for workers experiencing high psychological stress in the workplace (Kawakami and Tsutsumi, 2016). It has become increasingly important to seek solutions for people to cope with workplace stress in Japan.

In recent years, there has been considerable and increasing attention on the use of forest environments as a setting for health promotion. Numerous studies have demonstrated that forest environments mitigate stress states and induce physiological relaxation (Tsunetsugu et al., 2007; Park et al., 2007; Lee et al., 2009; Park et al., 2009; Park et al., 2010; Lee et al., 2011; Tsunetsugu et al., 2013; Lee et al., 2014). It is well known that spending time in forest settings improves immune function and that these effects last for about 1 month (Li et al., 2007; Li et al., 2008a, 2008b). From the psychological aspect, the restorative effects of forest environments related to psychological stressors or mental fatigue and improved mood states and cognitive function have been reported (Morita et al., 2007; Shin et al., 2010; Park et al., 2011; Shin et al., 2011).

The idea of “forest therapy” has been proposed in accordance with the results of the above studies. The aim of evidence-based “forest bathing (shinrin-yoku)” is to induce preventive medical effects to improve weakened immune function and prevent diseases by achieving a state of physiological relaxation through exposure to forest-origin stimuli (Song et al., 2016). Forest therapy is now increasingly recognized as an effective relaxation and stress management tool that has been

Abbreviations: SBP, systolic blood pressure; DBP, diastolic blood pressure

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http://dx.doi.org/10.1016/j.ufug.2017.08.015
Received 7 April 2017; Received in revised form 21 August 2017; Accepted 21 August 2017
Available online 01 September 2017

demonstrated to be an effective preventive or alternative therapy (Frumkin, 2001; Lee et al., 2012), and its effects have been studied in elderly individuals and adults at risk of stress- and lifestyle-related diseases such as high blood pressure, diabetes, and depression (Ohtsuka et al., 1998; Mao et al., 2012; Shin et al., 2012; Sung et al., 2012; Lee and Lee, 2014; Kim et al., 2015; López-Pousa et al., 2015; Ochiai et al., 2015; Song et al., 2015a; Chun et al., 2017; Song et al., 2017).

The preventive medical effects induced by forest environments are increasingly being recognized; however, there is a lack of research on how long these effects last. The aim of the present study was to clarify the sustained effects of a forest therapy program on the blood pressure of office workers. We specifically focus on participants whose systolic blood pressure (SBP) was above 120 mmHg because recent research indicates that lowering SBP to less than 120 mmHg can significantly reduce the rates of major cardiovascular events and death from any case (The SPRINT Research Group, 2015).

2. Materials and methods

2.1. Participants

2.1.1. All participants (N = 26)

The participants were employees from a company that aims for regional creation with information technology from Tottori Prefecture. Twenty-six office workers aged 19–56 years (male: 14, female: 12, mean age ± standard deviation: 35.7 ± 11.1 years; Table 1) participated in this study.

With respect to recruitment, we posted study information on an office bulletin board. Those who wished to participate in the study applied via e-mail. All participants were thoroughly informed regarding the aims and procedures of the study. After receiving a description of the experiment, they signed an agreement to participate in the study. During the study period, the consumption of alcohol, caffeine, and tobacco was prohibited. Participants were asked to perform normal life activities on the days before and after participating in the forest therapy program. The study was conducted in accordance with the Declaration of Helsinki, and the protocol was approved by the Ethics Committee of the Center for Environment, Health and Field Sciences, Chiba University, Japan (Project identification code number: 5).

2.1.2. Higher than 120 mmHg group (N = 9)

Of the 26 participants, we focused on 9 participants (male: 8, female: 1, mean age ± standard deviation: 37.4 ± 10.0 years) whose SBP was above 120 mmHg, as measured before dinner, at the office and 3 days before participating in the forest therapy program. We named this group as the “higher than 120 mmHg group.”

2.2. Experimental sites

The forest therapy programs were conducted in Chizu, Tottori Prefecture, which is located in the Chūgoku region in Japan. More than 90% of the total area of this region is covered by forests and forestry and timber processing are its main industries. The experimental site of the present study (hereafter referred to as the forest area) was certified as a forest therapy base in 2010 and it is a mixed forest mostly composed of cedar and hardwood. Annually, around 1400 forest therapy tourists visit this town (as of April 2015).

It was sunny on the days on which the forest therapy program was run and the mean temperature, humidity, and intensity of illumination in the forest area were 18.7 ± 3.3 °C, 65.3 ± 9.8%, and 2097 ± 1910 lx, respectively.

Table 1
Participant demographics.

Parameter	Mean ± standard deviation		
	All participants	Males	Females
Total sample number	26	14	12
Age (years)	35.7 ± 11.1	35.3 ± 10.6	36.2 ± 12.2
Height (cm)	164.7 ± 8.6	170.1 ± 6.2	158.4 ± 6.4
Weight (kg)	60.7 ± 10.7	66.9 ± 10.8	53.4 ± 3.8
BMI (kg/m^2)	22.3 ± 3.1	23.1 ± 3.5	21.4 ± 2.4

BMI: Body mass index.

2.3. Measurement

SBP, diastolic blood pressure (DBP), and pulse rate were used as physiological measurement indices. A digital blood pressure monitor using oscillometric methods (HEM1020; Omron, Kyoto, Japan) was used to measure the blood pressure and pulse rate in the right upper arm. Participants rested in a seated position for 5 min and then measured their blood pressure and pulse rate twice, with their arm placed on top of a desk. Desks and chairs of the same size were used in all measurements. In the case of discrepancies in SBP exceeding 10 mmHg and/or DBP exceeding 6 mmHg between two measurements, an additional measurement was taken. The mean of two or three measurements was used in the analysis.

2.4. Experimental design

Before joining the forest therapy program, the 26 office workers attended an orientation in the meeting room of their office on September 3, 2014. The participants were randomly assigned to three groups of eight, ten, and eight individuals, and these three groups participated in the forest therapy program on September 13, and October 11 and 18, 2014, respectively.

To investigate the changes in the physiological response of the participants to the forest therapy program over time, the physiological measurements were taken 3 days before, during, and 3 and 5 days after the program (Fig. 1). The measurements were taken three times before breakfast, lunch, and dinner on each assessment day. The measurement time was based on the timing of the forest therapy program; the participants' blood pressure (SBP and DBP) and pulse rate were measured before breakfast (about 7:00, before participation in the program), before lunch (12:30), and at the end of the program (about 15:00). These measurements were also taken at the same time of day 3 days prior to the forest therapy program and 3 and 5 days after the program in their home and/or office using desks and chairs of the same size.

On the morning of the forest therapy program, the participants gathered at the parking area near the entrance of the “forest therapy road” at 8:50 and joined in the forest therapy program as a group with a guide. The program consisted of multiple timed activities over about 6 h, 12 min, with a walking distance of 4265 m, and included time for lunch and the physiological measurements. Table 2 shows the details of the forest therapy program on September 13. The programs were conducted following the same procedure at approximately the same times for all three groups.

The program and altitude map of the course showing the various activities in the forest therapy program are shown in Figs. 2 and 3, respectively. This data was obtained using an offline map-caching GPS application (Geographica, Japan).

2.5. Data analysis

The data were summarized in terms of the mean value before breakfast, lunch, and dinner 3 days before, during, and 3 and 5 days after the forest therapy program. Furthermore, average daily measures were also examined.

SPSS software (V20.0; IBM Corp., Armonk, NY, USA) was used for all statistical analyses. For all comparisons, $p < 0.05$ was considered statistically significant. A paired *t*-test with Holm correction was used to