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Original article

Effects of viewing forest landscape on middle-aged hypertensive men

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ABSTRACT

With increasing attention on the health benefits of a forest environment, evidence-based research is required. This study aims to provide scientific evidence concerning the physiological and psychological effects of exposure to the forest environment on middle-aged hypertensive men. Twenty participants (58.0 ± 10.6 years) were instructed to sit on chairs and view the landscapes of forest and urban (as control) environments for 10 min. Heart rate variability (HRV) and heart rate were used to quantify physiological responses. The modified semantic differential method was used to determine psychological responses. Consequently, the high-frequency component of HRV, a marker of parasympathetic nervous activity that is enhanced in relaxing situations, was significantly higher and heart rate was significantly lower in participants viewing the forest area than in those viewing the urban area. The questionnaire results indicated that viewing the forest environment increased "comfortable," "relaxed," and "natural" feelings than viewing the urban environment. In conclusion, viewing forest landscape produces physiological and psychological relaxation effects on middle-aged hypertensive men.

1. Introduction

In recent years, there has been considerable and increased attention in using the forest environment as a place for recreation and health promotion. This approach was called "Shinrin-yoku" that means "taking in the forest atmosphere" (Selhub and Logan, 2012). It suggests that "forest bathing," which is a health promotion method and uses proven effects of a forest environment, such as relaxation, can improve the health of the body and mind. In accordance with the accumulation of data, the idea of "forest therapy" has been proposed. It means evidence-based "forest bathing (shinrin-yoku)" and aims to achieve a preventive medical effect by inducing physiological relaxation and immune system recovery.

Previous studies targeting healthy young adults have demonstrated that time spent in a forest environment can decrease cerebral blood flow in the prefrontal cortex (Park et al., 2007) decrease blood pressure (Tsunetsugu et al., 2007; Lee et al., 2009; Park et al., 2009; Park et al., 2010), reduce pulse rate (Tsunetsugu et al., 2007; Park et al., 2008; Lee et al., 2009; Park et al., 2009; Lee et al., 2011), and increase parasympathetic nervous activity that is enhanced in relaxing situations (Tsunetsugu et al., 2007; Park et al., 2008; Park et al., 2009; Park et al., 2010; Lee et al., 2011; Tsunetsugu et al., 2013; Lee et al., 2014). Sympathetic nervous activity that is enhanced in stressful situations is suppressed (Tsunetsugu et al., 2007; Park et al., 2009; Park et al., 2010; Lee et al., 2011; Tsunetsugu et al., 2013; Lee et al., 2014). In addition, the levels of salivary cortisol, a stress hormone, decrease (Miyazaki and Motohashi, 1996; Tsunetsugu et al., 2007; Park et al., 2007; Park et al., 2008; Lee et al., 2009; Park et al., 2010; Lee et al., 2011; Tsunetsugu et al., 2013). In other studies, natural killer (NK) cell activity was enhanced and immune function was improved; these effects lasted for 30 days (Li et al., 2007; Li et al., 2008a, 2008b).

Abbreviations: HRV, heart rate variability; ICC, intraclass correlation coefficient; NK, natural killer; LF, low frequency; HF, high frequency; SD, semantic differential.

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From the psychological aspect, restorative effects related to psychological stressors or mental fatigue and improved mood states and cognitive function (Miyazaki and Motohashi, 1996; Li et al., 2007; Morita et al., 2007; Shin et al., 2010; Park et al., 2011; Shin et al., 2011) have been reported.

Studies targeting elderly individuals and patients with reversible diseases have also been reported. Walking in a forest environment can improve arterial stiffness and pulmonary function in elderly women (Lee and Lee, 2014). Furthermore, it can decrease blood glucose levels in patients with non-insulin-dependent diabetes mellitus (Ohtsuka et al., 1998), provide the subjective perception of having less days of pain and insomnia and more days of wellness in patients with fibromyalgia (López-Pousa et al., 2015), and enhance NK cell activation leading to the production of two anticancer molecules in breast cancer patients (Kim et al., 2015). Other findings have indicated that cognitive behavioral therapy conducted in a forest environment was more successful in achieving depression remission than psychotherapy conducted in a hospital (Kim et al., 2009).

Several studies have demonstrated the beneficial effects of forest therapy in hypertension. Forest therapy programs such as walking, guided activity, or educational sessions can reduce blood pressure (Mao et al., 2012; Ochiai et al., 2015), urinary adrenaline concentration (Ochiai et al., 2015), and serum and salivary cortisol levels (Sung et al., 2012; Ochiai et al., 2015) in hypertensive individuals. Hypertension is a critical public health challenge worldwide, and the prevention, detection, treatment, and control of this condition have been emphasized (Kearney et al., 2005). Forest therapy is expected to play a key role in this respect. A previous study examined the effects of walking in a forest environment on middle-aged hypertensive men (Song et al., 2015a). Walking in a forest environment can enhance parasympathetic nervous activity and decrease heart rate in hypertensive individuals compared with walking on the city streets (Song et al., 2015a). However, these findings included not only the impact of forest environment on humans but also incorporated an element of exercise; thus, one must be careful not to over-interpret the health-giving properties of a forest environment alone. Evidence-based research concerning only the influence of exposure to a forest environment while remaining sedentary is lacking. To the best of our knowledge, there are no studies that have examined the physiological and psychological effects of viewing a forest environment in a seated position in hypertensive individuals.

The present study aimed to clarify the effects of viewing forest landscape on the autonomic nervous activity of middle-aged hypertensive men who remained sedentary while viewing the landscape.

2. Materials and methods

2.1. Participants

Japanese men between the ages of 40 and 75 years and whose blood pressures were above the upper boundary of normal (120/80 mmHg) were recruited. Researchers contacted applicants face-to-face before the start of the study, and those who were taking daily medication for chronic conditions, such as diabetes, hyperlipidemia, and hypertension, were excluded. In total, 20 Japanese men aged 40–72 years (mean age, 58.0 ± 10.6 years; Table 1) participated. Among them, eight participants lived in cities with more than 50,000 residents, nine lived in towns with more than 8000 residents, and three lived in villages with less than 8,000 residents.

Of these 20 participants, five had a high-normal blood pressure (systolic, 130–139 mmHg or diastolic, 85–89 mmHg) that was considered to be on the higher range of pre-hypertension. Of the remaining 15 participants, 10 had hypertension stage 1 (systolic, 140–159 mmHg or diastolic, 90–99 mmHg) and five had hypertension stage 2 (systolic, 160–179 mmHg or diastolic, 100–109 mmHg). For classification, the values measured in the morning (8:30–8:45) of the first experimental day at the Nagano Prefectural Kiso Hospital were used. Furthermore, systolic and diastolic blood pressures were measured according to the oscillometric method using a digital blood pressure monitor (HEM1020; Omron Corp., Kyoto, Japan).

Table 1
Participant demographics.

Parameters	Value (Mean ± Standard deviation)
Total sample number	20
Sex	Male
Age (years)	58.0 ± 10.6
Height (cm)	167.9 ± 6.2
Weight (kg)	66.1 ± 10.6
BMI (kg/m^2)	23.4 ± 3.3
SBP (mmHg)	151.2 ± 17.9
DBP (mmHg)	90.7 ± 5.0

At the beginning of the experiment, the participants were informed about 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. The study was conducted in accordance with the Declaration of Helsinki, and the protocol was approved by the Ethics Committees of the Nagano Prefectural Kiso Hospital, Japan and of the Center for Environment, Health and Field Sciences, Chiba University, Japan (Project identification code number: 5).

2.2. Experimental sites

The field experiment was conducted in a natural coniferous forest that included many Japanese cypress trees (Akasawa natural recreation forest) and was located in Agematsu town of Nagano Prefecture, which is situated in central Japan (hereafter referred to as the forest area). In Japan, Japanese cypress is a well-known and common tree, and coniferous forests are typical. The urban environment is used as a control, which is a common exposure in everyday life. The urban areas were downtown near the Japan Railway station (hereafter referred to as the urban area).

The weather was sunny on the days of experiments. During viewing of the forest area, the average temperature was 24.3 °C ± 0.1 °C with an average humidity of 70.5% ± 0.9%, whereas in the urban area, the average temperature was 29.9 °C ± 0.1 °C with an average humidity of 52.0% ± 0.8%.

2.3. Experimental design

The 20 participants were randomly assigned to two groups of 10 that participated in the experiment over 2 consecutive days. On the first day (September 14), one group moved to the forest area and the other moved to the urban area by car (an approximately 45-min journey). On the second day (September 15), the groups switched experimental areas to eliminate an order effect.

The participants moved within their respective experimental site. After arriving at the site, participants were instructed to sit on a chair. After resting for 5 min, they viewed each landscape for a period of 10 min in the afternoon (Fig. 1). Conversation among participants was prohibited. Furthermore, the participants viewed the two areas at approximately the same time of day to eliminate the influence of diurnal changes on physiological rhythms.

After viewing, participants answered the questionnaires.