The effectiveness of a forest therapy (shinrin-yoku) program for girls aged 12 to 14 years: A crossover study

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Abstract

Several complementary and alternative regimens have been developed to encourage relaxation and control stress. Recently, “shinrin-yoku” (walking in a forest and viewing the forest landscapes) has been recognized as a successful relaxation activity. The objective of this study was to evaluate the effectiveness of a “shinrin-yoku” program on stress and relaxation for adolescent girls.

Twenty-seven girls, aged 12 to 14 years, participated in a program that included walking in a forest and viewing the forest landscape; performing the same activities in a city area was used as a control experience. Salivary amylase activities, the Mood Inventory, and subjective relaxation were measured. The mean values of salivary amylase activities decreased in the forest and increased in the city. The responses to the Mood Inventory indicated a relaxed mood after walking the forest. In addition, the presence of negative moods in the forest was significantly lower than in the city, and the subjective relaxation level in the forest was significantly higher than in the city. Our results indicated that the forest environment was effective in increasing relaxation and decreasing stress and fatigue. Shinrin-yoku may play a role in improving or maintaining the psychological health of adolescent girls.

Keywords: shinrin-yoku, crossover design, adolescent female, relaxation, salivary amylase activity

Shinrin-yoku, walking in a forest and viewing the forest environment, is a means of recreation and relaxation in Japan\textsuperscript{1,2}. Shinrin-yoku was introduced by the Japanese Forestry Agency in 1982, and the Society of Forest Medicine within the Japanese Society for Hygiene was established in 2007 with the purpose of promoting research on forest medicine, including the effects of forest bathing and other therapeutic benefits of forests on human health\textsuperscript{3}. In opinion research surveys conducted by the Government Cabinet office, it was found that 91.5% of Japanese feel a psychological attachment to forests. There are approximately 25 million hectares of forest in Japan, which account for 66% of all land owned by the nation\textsuperscript{4}.

The effectiveness of shinrin-yoku on adults has been explored from physiological and psychological perspectives\textsuperscript{1,5}~\textsuperscript{30}. A number of these studies have evaluated the effectiveness of shinrin-yoku on specific groups of adults (for example, those suffering from diabetes or high blood pressure) and evaluated physiological outcomes, such as blood pressure and cortisol

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values, as indices of the effectiveness of shinrin-yoku. Results from these studies revealed that shinrin-yoku protocols of walking in the forest for 3 km or 6 km, 15 minutes walking and 15 minutes viewing landscape, or 2 days walking in the forest for 20 minutes, reduced blood glucose, blood pressure, pulse rate, and salivary cortisol and salivary amylase activity, which are indices of stress. Another group of studies evaluated the psychological relaxation and stress reduction properties of shinrin-yoku in healthy young adults using self-reported questionnaires, including the Profile of Mood States (POMS), the Multiple Mood Scale-Short Form, and the State-Trait Anxiety Inventory. It was found that the forest environment decreases stress and increases relaxation. Specifically, the participants exhibited reduced anxiety, hostility, and depression, and increased liveliness, which were reflected by reduction in negative psychological feelings and increase in positive feelings through having engaged in shinrin-yoku.

However, little research has been conducted on the effectiveness of shinrin-yoku for children or adolescents. Uehara found a positive influence of shinrin-yoku in 3- to 6- year-old children’s emotional stability; however, the effectiveness of shinrin-yoku for adolescent children is unknown. In Japan, 35.2% of healthy adolescents aged between 12 and 14 years suffer from stress, with girls tending to suffer more severely than boys. These reports indicate a need for preventive mental health therapy to avert the negative effects of stress in adolescents. Adolescence is defined as the period between ages 10 and 19 years by World Health Organization, and during these years, they are subjected to many stressful developmental changes. Adolescents in their early teens experience rapid physical, cognitive, and emotional changes, and they must manage school demands, maintain relationships with family and friends, and form their own identity. Difficulties in managing these stressful developments can lead to severe mental health problems. Thus, the prevention of mental health problems in adolescents is important.

Investigating the effectiveness of the forest on adolescents’ stress and relaxation may result in finding simple ways to improve the mental health of Japanese adolescents. The aim of the present study was to evaluate the effectiveness of a shinrin-yoku program on stress and relaxation for adolescent girls.

Methods

Participants

Twenty-seven female junior high school students (first and second year) were recruited for this study. To ensure uniform physical ability, which was necessary to minimize variability in walking speed and stamina, all of the participants were recruited from a basketball club at the school. An explanation of the procedures and goals of the study was provided in writing to the participants and their parents, and written consent was obtained from all participants.

Setting

The study was conducted in the Kobe Municipal Arboretum (forest area) and an area around Sannomiya station (the comparison city area) in Hyogo Prefecture in November 2007. The Kobe Municipal Arboretum is located close to the center of the city (Sannomiya district) of Kobe and is a popular forest in the area. It was established in 1940 and has an area of 142.6 hectares. Approximately 1,200 kinds of native and non-native trees grow therein.

Procedure and experimental program

The present study used a crossover design. The conceptual framework of the study is shown in Figure 1, and Figure 2 shows the program schedule. We reviewed previous shinrin-yoku studies and developed the program based on this research because there was no shinrin-yoku program that had been used with adolescents. The program lasted two days and included the basic shinrin-yoku activities: walking in the forest and viewing forest landscapes. On each day, the same activities (walking and viewing landscapes) were completed in a city or forest area. The participants were randomly assigned to two groups, A and B. Group A visited the forest area on the first day and the city area on the second day. Group B visited the locations in the reverse order.

On each experimental day, participants were transferred from their school to the experimental area by chartered bus. After the participants arrived at the experimental area, they walked around the area on a set trail for 30 minutes (between 10:00 and 10:30) and then sketched the landscape for 15 minutes (be-
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**Expected effects**

- **Decrease stress**
- **Physiological outcome:**
  - Salivary amylase activities
- **Increase relaxation**
- **Psychological outcomes:**
  - The Mood Inventory
  - Subjective relaxation

**Intervention**

- Shinrin-yoku program:
  - Walking in the forest
  - Viewing forest landscapes

**Figure 1** Conceptual framework of the present study

**Group A** (14 students)
- First day: In the forest
- Second day: In the city

**Group B** (13 students)
- First day: In the city
- Second day: In the forest

**Measurement: Time 0** (9:30-10:00)
- Demographic information
- Subjective feeling

**Program:** 10:00-10:30
- Walking in the forest or city area
  - (30 minutes)

**Measurement: Time 1** (10:30-11:00)
- Salivary amylase activity
- Subjective feeling

**Program:** 11:00-11:15
- Viewing forest or city landscapes
  - (15 minutes)

**Measurement: Time 2** (11:15-11:45)
- Salivary amylase activity
- Subjective feeling
- Subjective relaxation

**Figure 2** The experimental program
Measurements were taken three times: before the activities (Time 0, between 9:30 and 10:00), after walking (Time 1, between 10:30 and 11:00), and at the completion of the activities (Time 2, between 11:15 and 11:45). At Time 0, demographic information and subjective feelings were collected; at Time 1, salivary amylase activity and subjective feelings were measured; and at Time 2, salivary amylase activity, subjective feelings, and subjective relaxation were all measured. All participants had finished their morning meal at 7:00 and were asked not to partake any caffeinated beverages on the days of the experiment.

**Measurements**

Physiological measures.

Salivary amylase activities samples were collected to evaluate stress. Changes in salivary amylases activity are caused by stress; these changes occur rapidly in the face of stressors. An advantage in collecting salivary amylases sample is that it is non-invasive, making multiple sampling easy and stress free. Saliva was collected on a strip placed under the tongue for 30 seconds at Times 1 and 2 and analyzed using the COCORO METER (Nipro Corporation). The strip was then inserted into the COCORO METER and the value of salivary amylase activity was calculated. Reliable salivary amylase activity values of COCORO METER (under 200 kU/l) of 11 students were included in the analysis, over 200 kU/l is reported by the COCORO METER as an error.

Psychological measures.

The Mood Inventory was used to measure subjective feeling. The Mood Inventory was developed in Japan, and this self-rated questionnaire consists of 40 items in 5 domains: Tension and excitement (8 items, e.g., “I am irritated”), Refreshing mood (8 items, e.g., “I am relaxed”), Fatigue (8 items, e.g., “I can’t concentrate on any one thing”), Depressive mood (8 items, e.g., “I am depressed”), Anxious mood (8 items, e.g., “I feel anxious”). Of these 5 domains, Tension and excitement, Fatigue, Depressive mood, and Anxious moods were identified as negative moods, whereas Refreshing mood was a positive mood. Items were rated on 4-point Likert scale (1 = "not at all" to 4 = "very much"). Each domain score was calculated by summing the item scores. The Spearman-Brown coefficient of reliability of each domain ranged from 0.78 to 0.96.

Subjective relaxation was evaluated by a self-anchoring scale, “How relaxed are you?”; responses were registered on a 5-point Likert scale (0 = “I am relaxed” to 4 = “I am not relaxed at all”).

**Statistical analyses**

All analyses were performed using SPSS 15.0J for Windows. Descriptive statistics are presented as mean values with standard deviation (SD). We also performed Wilcoxon signed-rank tests to compare values of salivary amylase activity between measurement times. To examine changes in moods across measurement times, a Friedman test was used. For multiple comparisons, Wilcoxon signed-rank tests were calculated and the Bonferroni correction was used to reduce the chances of obtaining false-positive results (type I errors). In addition, to examine the difference in values of salivary amylase activity, moods, and subjective relaxation between the forest and city areas, Mann-Whitney U tests were conducted. For all analyses, p<0.05 was considered significant.

**Results**

Temperatures in the forest on the first and second days were 20.5°C and 20.1°C, respectively. Similarly, temperatures in the city were 22.9°C for the first day and 19.8°C for the second. Humidity was 45.0% and 51.7% in the forest for the first and second days, respectively, and 49% and 50.1% in the city for the first and second days, respectively.

**Physiological Measures**

Salivary amylase activity.

Of 27 participants, 11 whose salivary amylase activities were within the reliable value range were included in the analysis. The mean age of this group was 13.1 years (range 12 to 14 years). Four participants had a chronic illness (two with atopic dermatitis, one with allergic reaction skin trouble, and one with sinusitis).

The values of salivary amylase activity between the forest and city area did not differ significantly, either after walking or after viewing landscapes (p = 0.767 and 0.490, respectively, Mann-Whitney U tests). The change of salivary amylase activities within same area was indicated by the median values; in the forest area, mean values at Time 1 and 2 were 52.0 and 48.18
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Table 1 Change in salivary amylases activity values

<table>
<thead>
<tr>
<th>Area</th>
<th>Measurement time</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Time 1 (n = 11)</td>
<td>Time 2 (n = 11)</td>
</tr>
<tr>
<td></td>
<td>Median Range</td>
<td>Median Range</td>
</tr>
<tr>
<td></td>
<td>p&lt;</td>
<td>p&lt;</td>
</tr>
<tr>
<td>Forest</td>
<td>53.0 11-83</td>
<td>42.0 4-110</td>
</tr>
<tr>
<td>City</td>
<td>47.0 27-91</td>
<td>50.0 26-89</td>
</tr>
</tbody>
</table>

Salivary amylases activity: kU/l

aMann-Whitney U test was used to test differences between forest area and city area of each Time of measurement.
bWilcoxon signed-rank test was used to test differences between Time 1 and Time 2 in each area.

Table 2 Change of subjective feeling (the Mood Inventory) by measurement time and area

<table>
<thead>
<tr>
<th>Domain</th>
<th>Area</th>
<th>Time 0 Median</th>
<th>Time 1 Median</th>
<th>Time 2 Median</th>
<th>Differences p&lt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tension and excitement</td>
<td>Forest</td>
<td>12</td>
<td>9</td>
<td>9</td>
<td>*</td>
</tr>
<tr>
<td></td>
<td>City</td>
<td>13</td>
<td>14</td>
<td>11</td>
<td>**</td>
</tr>
<tr>
<td>Refreshing mood</td>
<td>Forest</td>
<td>20</td>
<td>18</td>
<td>19</td>
<td></td>
</tr>
<tr>
<td></td>
<td>City</td>
<td>19</td>
<td>16</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>Fatigue</td>
<td>Forest</td>
<td>14</td>
<td>12</td>
<td>12</td>
<td>*</td>
</tr>
<tr>
<td></td>
<td>City</td>
<td>16</td>
<td>16</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>Depressive mood</td>
<td>Forest</td>
<td>10</td>
<td>9</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td></td>
<td>City</td>
<td>12</td>
<td>12</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>Anxious mood</td>
<td>Forest</td>
<td>13</td>
<td>10</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td></td>
<td>City</td>
<td>14</td>
<td>13</td>
<td>12</td>
<td></td>
</tr>
</tbody>
</table>

n = 27

aWilcoxon singed-rank test (Bonferroni correction): *p<0.016
bFriedman test: *p<0.05, **p<0.01
cMann-Whitney U test: *p<0.05

(a 7.3% decrease after viewing the forest landscape) and median values were 53.0 and 42.0, in the city area, the mean values at Time 1 and 2 were 50.00 and 76.60 (a 53% increase after viewing city landscapes) and median values were 47.0 and 50.0 (Table 1).

Psychological measures

Subjective relaxation and the Mood Inventory.

For these measurements, the data of all participants were analyzed. Changes in the Mood Inventory by measurement time are shown in Table 2. The scores of Tension and excitement and Anxious mood between at Times 0 and 2 for both forest and city area decreased significantly (p<0.016).

Differences in the Mood Inventory scores between forest area and city area by measurement time were also shown in Table 2. Refreshing mood and Depressive mood were significantly different between the forest and city areas at Time 1. Also, Fatigue showed significant differences between the forest and city areas at both Time 1 and 2. Tension and excitement showed difference between the forest and city areas at Time 2.

The median value of subjective relaxation in the forest area at Time 2 was 1.0 and in the city area was 3.0, and these were significantly different (p < 0.001, Mann-Whitney U test).
Discussion

Our crossover design study revealed the effectiveness of shinin-yoku for the adolescent girls in this study. We conducted the shinin-yoku program, walking and viewing the landscape in the forest and analyzed the data of the participants, adolescent girls aged between 12 and 14. The results indicated that the shinin-yoku program decreased stress, improved mood, and increased relaxation for a short duration after the shinin-yoku program.

Physiological effectiveness of shinin-yoku

We found decreased of salivary amylases activity after viewing the forest environment. Although there was no significant difference, salivary amylases activity of forest area decreased, whereas it increased in the city area. In addition to these, this decrease might be related to viewing the forest environment since salivary amylase activity changes within a few minutes or less in response to stress. Yamaguchi et al. reported a reduction in salivary amylases activities from the forest to the city environment in a crossover design study with 10 healthy university students. Our study results extend this finding to a younger age group.

Psychological effectiveness of shinin-yoku

In this study, we found that the forest environment increased positive mood (Refreshing mood) and decreased negative mood (Tension and excitement, Fatigue, and Depressive mood) using the Mood Inventory questionnaire. Furthermore, we found a significantly higher subjective feeling of relaxation for the participants after the shinin-yoku program than after the program in the city area. Morita et al. reported the effectiveness of shinin-yoku on acute emotions using the Multiple Mood Scale-Short Form; the scores for hostility and depression decreased significantly and liveliness increased as a result of participation in shinin-yoku. These results are supported by the results of the current study. Fatigue is a frequent complaint in the general school population, and an association between fatigue and school absenteeism has been reported. Therefore, the effectiveness of shinin-yoku for junior high school girls has the potential to reduce fatigue and absenteeism.

Limitations

We selected the COCORO METER to measure salivary amylase activities because method for the collection of saliva was quite easy for adolescents. However, the data of over one-half of the participants had to be excluded due to results of over 200kU/l (an “error” reading on the COCORO METER). Since salivary amylase activity changes within a few minutes or less in response to stress, repetition of the measurement of salivary amylase activity may cause stress, leading to an impact on value of salivary amylase activity.

Therefore, we collected salivary just once at each measurement time. However, the small number of salivary amylase activity data might have affected the result because the small sample size may have precluded obtaining a significant result. Previous studies that used the COCORO METER to evaluate salivary amylase activity of adults have not reported errors. Further research is needed to clarify why we had so many false results. Mitsuhash et al., who investigated salivary amylase of children aged between 5 and 9, reported that the results of children’s amylase levels tended to be unstable. Therefore, it is possible that the errors in this study were not from COCORO METER, but caused by instability of salivary amylases in adolescents. Salivary amylase activity as an appropriate index of stress in adolescents should be investigated.

Another limitation of this study is that salivary amylase activities of Time 0, which were expected to be baseline data, were not collected. The reason why we did not collect Time 0 salivary amylases activity is because we needed to coach instruction to collect salivary to junior high school children on the day of survey, and believed this might cause stress and influence values of salivary amylases activities.

Third, we evaluated rapid responses to stress and emotional changes; therefore, the long-term effectiveness of shinin-yoku with adolescent girls is unknown. Further, we conducted shinin-yoku program in a homogeneous sample, therefore, generalizability of the results is limited.

Conclusions

Our results indicate that the forest environment was effective in increasing positive mood and relaxa-
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tion and decreasing stress and fatigue. Shinrin-yoku may play a role in improving or maintaining the psychological health of adolescent girls.

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