Physiological and psychological relaxing effects of visual stimulation with foliage plants in high school students

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Abstract: With lifestyles in modern society becoming increasingly stressful, there is growing interest in the physiological relaxing effects of the natural environment. Particular interest has been paid to the physiological effects of indoor plants, however no studies have revealed the effects of such visual stimulation on minors. In this study 85 (41 male and 44 female; 16.5±0.9 years; mean±SD) students were exposed, or not as control, to a typical foliage plant, dracaena (*Dracaena deremensis;* Lemon Lime), for 3 min. Physiological indices included heart rate variability (HRV) and pulse rate, using an accelerated plethysmography at the fingertip, were collected continuously during the experiments. The results indicated that the high frequency component (HF), a general index of parasympathetic nervous activity, was significantly higher; the low frequency component [LF/(LF+HF)], a general index of sympathetic nervous activity, was significantly lower; and the pulse rate was significantly lower. After exposure, or not, the subjects completed a questionnaire as psychological evaluation. A 13-point rating scale was used for following parameters: "comfortable-uncomfortable," "relaxed-awakening," and "natural-artificial." Results of the study showed that subjects felt more comfortable, relaxed and natural after visualizing the dracaena plants. Overall, the physiological and psychological relaxing effects of visual stimulation with foliage plants in high school students is confirmed.

1. Introduction

Recent studies have focused on the physiological relaxing effects of the natural environment (Park *et al.*, 2009; 2012). It has been reported that staying in a forest environment enhances parasympathetic nervous activity (Park *et al.*, 2012; Tsunetsugu *et al.*, 2013), suppresses sympathetic nervous activity (Park *et al.*, 2012; Tsunetsugu *et al.*, 2013; Lee *et al.*, 2014), decreases blood pressure and pulse rate (Park and Mattson, 2009; Park *et al.*, 2012), and decreases cortisol concentration (Park *et al.*, 2012). Studies by Li *et al.* (2007, 2008 a, b) demonstrated that staying in a forest environment for three days and two nights improved the immune function of office workers (Li *et al.*, 2007), and this effect was sustained for approximately one month (Li *et al.*, 2008 a, b). Another study reported that walking in an urban park enhances parasympathetic nervous activity and decreases heart rate (Song *et al.*, 2013). In addition, spending time in rooftop gardens enhances parasympathetic nervous activity and suppresses sympathetic nervous activity in elderly people requiring care (Matsunaga *et al.*, 2011).

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Evidence-based medicine has been attracting attention globally, with physiological data from field tests making a significant contribution. We expect that accumulating physiological data from field experiments will continue to demonstrate the preventive medical effects of nature therapy in the future (Lee *et al.*, 2012).

In modern society, many individuals spend the majority of their time in intensely stressful states, and they have no time to make contact with nature outside of their immediate surroundings. High school students, who spend most of their everyday life at school, are typical examples. Previous studies have evaluated the psychological stress levels in high school students (Anda *et al.*, 2000; Takakura and Sakihara, 2001). Moreover, many high school students have stressful relationships with friends or teachers (Miura and Kawada, 2008). In a document by the Japanese Ministry of Education, the percentage of students who progressed to universities or junior colleges in 2010 was 56.9%, which was 18.5% higher than the rate in 1975 (Statistics Bureau, Ministry of Internal Affairs and Communications, 2012), and the pressure from entrance examinations is extremely high among high school students (Equal Employment, Children and Families Bureau, Ministry of Health, Labour and Welfare, 2009).

Flowers and foliage plants are common natural surroundings that can be incorporated into the school and home. We previously conducted surveys to evaluate the physiological effects of visual stimulation with fresh rose flowers in high school students (Ikei *et al*., 2013), middle-aged and elderly medical staff (Komatsu *et al*., 2013), and office workers (Ikei *et al*., 2014). The results showed enhanced parasympathetic nervous activity (Ikei *et al*., 2013; Komatsu *et al*., 2013; Ikei *et al*., 2014), suppressed sympathetic nervous activity (Ikei *et al*., 2013), and decreased pulse rates (Komatsu *et al*., 2013) during visual stimulation.

It was reported in a previous study that natural views from hospital windows or the presence of indoor plants hasten the recovery of patients after surgery and decrease systolic blood pressure (Park and Mattson, 2009). These effects have also been studied in a classroom, demonstrating that the ambience of indoor space can be improved by including foliage plants (Doxey *et al*., 2009), as reflected by enhanced feelings of comfort among the students (Han, 2009). However, there have been no reports on the influence of visual stimulation with foliage plants on heart rate variability (HRV) and subjective feelings in minors. Therefore, this study was conducted to examine the effects of exposure to the foliage plant dracaena (Ministry of Agriculture, Forestry and Fisheries, 2008) on physiological and psychological variables (HRV, pulse rate, and subjective responses) in high school students.

2. Materials and Methods

The experiments were conducted in a classroom of the Chiba Prefectural Kashiwanoha Senior High School in October 2012. The room temperature was approximately 25.9°C, relative humidity approximately 52.6%, and illumination approximately 900 lux. Eighty-five high school students (41 male and 44 female; 16.5±0.9 years; mean±SD) participated in the experiment. The study was conducted with the approval of the Ethics Committee of the Center for Environment, Health and Field Sciences, Chiba University. All subjects provided written informed consent.

Three dracaena plants (*Dracaena deremensis*, Lemon Lime), 55-60 cm high, were placed at intervals of 8 cm on a desk in front of each subject (test situation). The distance from the subject's eyes to the plants was approximately 55 cm, and they were adjusted according to the height of the subjects. No exposure to foliage plants was used as the control condition. Before visual stimulation, the plants and the control were covered by a corrugated cardboard box (rest condition). Figure 1 shows the study protocol, figure 2 the rest condition, and figure 3 the visual stimuli (the dracaena

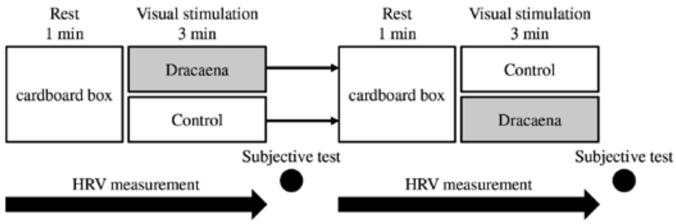

Fig. 1 - Study protocol for testing the physiological and psychological relaxing effects of visual stimulation with foliage plants in high school students.

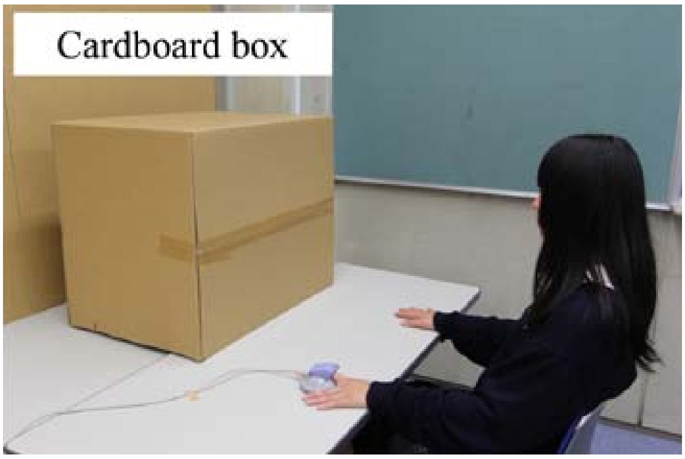

Fig. 2 - The rest condition.

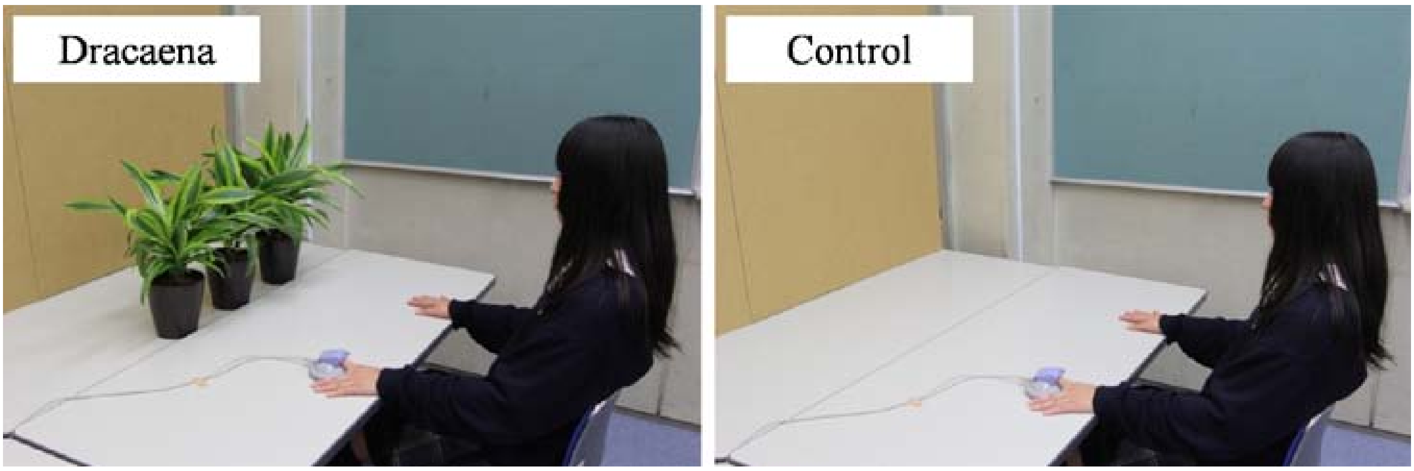

Fig. 3 -The visual stimulation condition.

plants or control). After viewing the cardboard box at rest in a sitting posture for 1 min (Fig. 2), the subject was exposed to the plants or control for 3 min (Fig. 3). After the experiments, each subject completed a questionnaire. The order of stimuli was counterbalanced among subjects.

HRV and pulse rate were measured as physiological indices. HRV was calculated by spectral analysis of the coefficient of variation of the a-a interval on an accelerated plethysmograph (APG; ARTETT, U-Medica Inc., Osaka, Japan). Previous studies have reported that the a-a interval on an APG and R-R interval on an electrocardiogram are strongly correlated (Takada and Okino, 2004; Takada *et al.*, 2008). The sampling frequency was set at 1000 Hz. The maximum entropy method was used for frequency analysis, and variance of the low frequency (LF; 0.04-0.15 Hz) and high frequency (HF; 0.15-0.40 Hz) components were calculated. The LF/(LF+HF) ratio for R-R interval variability was also assessed. The HF component was used as an index of parasympathetic nervous activity and the LF/(LF+HF) ratio was used as an index of sympathetic nervous activity (Weise and Heydenreich, 1989; Cacioppo *et al.*, 1994; Sawada *et al.*, 1997). Generally, parasympathetic nervous activity is enhanced during relaxation and sympathetic nervous activity is enhanced at the time of awakening and stress (Ackerknecht, 1974). Therefore, the pulse rate was converted by dividing 60 by the a-a interval on APG. The HRV and pulse rate data were collected continuously during the 3-min experiments and averaged.

In addition, the subjects subjectively evaluated the emotional effects of the dracaena plants and control using the modified semantic differential (SD) method (Osgood *et al.*, 1957), which uses three pairs of adjectives on 13 scales, including "comfortable-uncomfortable," "relaxed-awakening," and "natural-artificial."

The Statistical Package for Social Sciences software (v20.0, IBM Corp., Armonk, NY, USA) was used for all statistical analyses. A paired t-test was used to compare the physiological responses to visual stimulation with dracaena plants or control, followed by Holm correction of the changes in each 1-min average, while the Wilcoxon signed rank test was used to compare the psychological responses to visual stimulation with dracaena plants or control. For both conditions, one-sided tests were used because of the hypothesis that humans are relaxed by visual stimulation with foliage plants. Statistical differences were considered significant at $P<0.05$.

3. Results

Significant differences were found in the values of the HF component and the LF/(LF+HF) ratio of HRV between dracaena and the control.

Figure 4 shows the HF component of HRV, an estimate of parasympathetic nervous activity. HF between 0 and 1 min was 1210.7±120.3 (mean±SE) ms^2 during the test condition and 1032.9±95.2 ms^2 during the control condition, showing a significant increase of 17.2% ($P<0.05$) (Fig. 4A) during

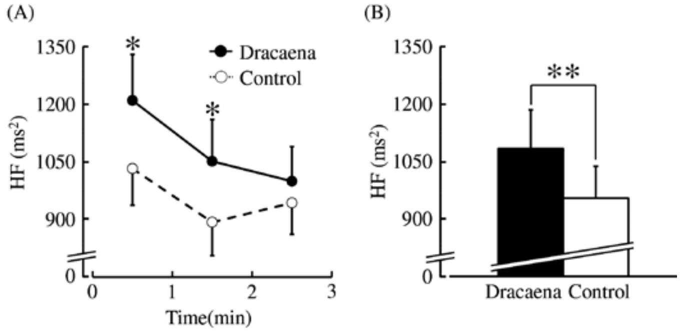

Fig. 4 - The 1-min averages and overall mean high frequency component (HF) of heart rate variability (HRV) during visual stimulation with dracaena plants and control.
(A) Changes in each 1-min average HF value over 3 min.
(B) Overall mean HF values.
n=85.
mean±SE.
*$P < 0.05$, **$P < 0.01$ as determined by the paired *t*-test, Holm correction.

the test condition. Similarly, HF between 1 and 2 min was 1052.0±109.3 ms^2 during the test condition and 893.1±87.1 ms^2 during the control condition, showing a significant increase of 17.8% ($P<0.05$) (Fig. 4A) during the test condition. There was no significant difference in HF between 2 and 3 min. The overall HF during the 3-min experiment was 1083.9 ± 101.5 ms^2 in the test condition and 954.8±83.5 ms^2 in the control condition, showing a significant increase of 13.5% ($P<0.01$) (Fig. 4B) with the test condition, indicating that parasympathetic nervous activity was significantly higher during dracaena plant exposure.

The results of the LF/(LF+HF) ratio, a marker of sympathetic nervous activity, are shown in figure 5. For 1-min segment analysis, the LF/(LF+HF) ratio between 0 and 1 min was 0.47±0.02 during the test condition and 0.52±0.02 during the control condition, showing a significant decrease of 9.6% ($P<0.05$) (Fig. 5A) with the former.

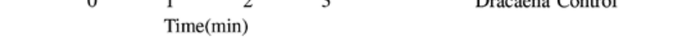

Fig. 5 - The 1-min averages and the overall mean LF/(LF+HF) ratio of heart rate variability. (HRV) during visual stimulation with dracaena plants and control.
(A) Changes in each 1-min average LF/(LF+HF) value over the 3 min.
(B) Overall mean LF/(LF+HF) values.
n=85.
mean±SE.
*$P<0.05$ as determined by the paired *t*-test, Holm correction.

Similarly, between 1 and 2 min, the ratio was 0.48±0.02 during the test condition and 0.54±0.02 during the control condition, showing a significant decrease of 11.1% ($P<0.05$) (Fig. 5A) during the test. No significant difference was observed between 2 and 3 min. For the entire 3-min duration, LF/(LF+HF) was 5.6% lower during the test condition than during the control condition (dracaena: 0.51±0.02, control: 0.54±0.02; $P<0.05$) (Fig. 5B), indicating that sympathetic nervous activity was significantly lower during dracaena plant exposure.

Clear differences in pulse rate were observed between dracaena and control exposure. The pulse rate between 0 and 1 min was 71.9±1.2 beats/min during the test condition and 72.7±1.2 beats/min during the control condition, showing a significant decrease of 1.1% ($P<0.05$) (Fig. 6A) during the test condition. Similarly, between 1 and 2 min, the pulse rate was 72.6±1.2 beats/min during the test condition and 73.3±1.2 beats/min during the control condition, showing a significant decrease of 1.0% ($P<0.05$) (Fig. 6A) during dracaena plant exposure. No significant difference was observed between 2 and 3 min. The mean pulse rate was 0.1% lower during the test condition than during the control condition (dracaena: 72.4±1.2 beats/min, control: 73.0±1.2 beats/min; $P<0.05$) (Fig. 6B).

The subjective evaluation data clearly showed the effect of the two different visual stimuli on the psychological states of participants. Participants felt significantly more comfortable (dracaena: "slightly comfortable"; control: "indifferent"; $P<0.01$) (Fig. 7, left), relaxed (dracaena: "slightly relaxed"; control: "indifferent"; $P<0.01$) (Fig. 7, center), and natural (dracaena: "slightly natural"; control: "indifferent"; $P<0.01$) (Fig. 7, right) in the dracaena condition than in the control condition after stimuli.

4. Discussion and Conclusions

An improved ambience resulting from the placement of foliage plants in a classroom may significantly enhance physiological relaxation and mental health in high school students, as shown in the present investigation.

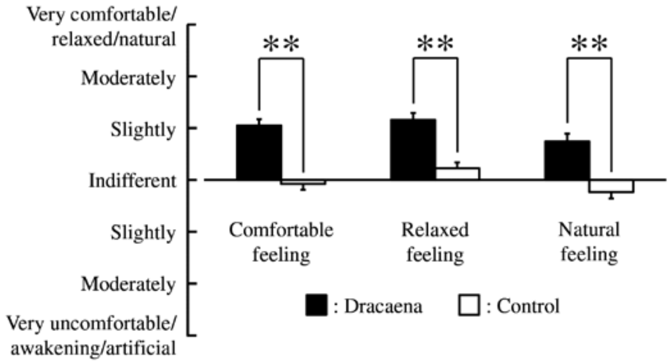

Fig. 7 - Changes in subjective evaluation for "comfortable–uncomfortable," "relaxed–awakening," and "natural–artificial" with dracaena plant exposure and control exposure.
n=85.
mean±SE.
**$P < 0.01$ as determined by the Wilcoxon signed-rank test.

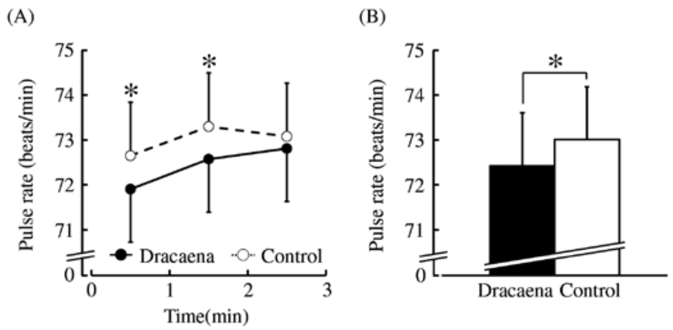

Fig. 6 - The 1-min averages and overall mean pulse rate during visual stimulation with dracaena plants and control.
(A) Changes in each 1-min average pulse rate over the 3 min.
(B) Overall mean pulse rates.
n=85.
mean±SE.
*$P < 0.05$ as determined by the paired t-test, Holm correction.

Relatively brief (3 min) visualization of foliage plants resulted in significantly enhanced parasympathetic nervous activity (13.5%), suppressed sympathetic nervous activity (-5.6%), and decreased pulse rate (-0.8%), results which are consistent with previous studies involving the visualization of a forest scene (Park *et al.*, 2010; Tsunetsugu *et al.*, 2010; Park *et al.*, 2011). Furthermore, our findings are consistent with those of our previous report on the calming effects of roses in high school students (Ikei *et al.*, 2013), where similar physiological responses were found. Also in line with our findings, visual stimulation with fresh roses enhanced parasympathetic nervous activity and significantly decreased the heart rate in middle-aged and elderly medical staff (Komatsu *et al.*, 2013), while it enhanced parasympathetic nervous activity in office workers (Ikei *et al.*, 2014).

According to our analysis of the three questionnaires, the subjects in the present study felt more comfortable, relaxed, and natural after visualizing the dracaena plants. This result is consistent with that of our previous report on the calming effects of roses (Ikei *et al.*, 2013; Komatsu *et al.*, 2013; Ikei *et al.*, 2014).

The results of this study support the hypothesis that placement of foliage plants in classrooms can induce a relaxing effect, improve physiological activity, and improve the psychological state in high school students. Because of the growing interest in mental health in modern times (Murray and Lopez, 1996), the psychological benefits of indoor plants are expected to play an important role in the promotion of mental health in the future.

However this study had limitations. First, we only evaluated HRV. Thus, the results cannot be interpreted in terms of a complete physiological evaluation. Other experimental indices such as brain activity and stress hormone levels should be assessed to determine the effects of visual stimulation with natural objects, such as foliage plants on human response. Second, only dracaena plants were used.

In future experiments, we will examine human responses to exposure to multiple types of foliage plants. We predict that the physiological data will support the physiological and psychological relaxing effects of foliage plants, which may subsequently lead to their increased use in educational establishments in attempts to decrease stress among students.

A brief visual stimulation of foliage plants shifted the sympathetic/parasympathetic balance and improved mood, suggesting a simple method to decrease stress and improve the health of high school students.

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References

ACKERKNECHT E.H., 1974 - *The history of the discovery of the vegetative (autonomic) nervous system*. - Med. Hist., 18: 1-8.

ANDA D., BARONI S., BOSKIN L., BUCHWALD L., MORGAN J., OW J., GOLD J.S., WEISS R., 2000 - *Stress, stressors and coping among high school students*. - Child Youth Serv Rev., 22: 441-463.

CACIOPPO J.T., BERNTSON G.G., BINKLEY P.F., QUIGLEY K.S., UCHINO B.N., FIELDSTONE A., 1994 - *Autonomic cardiac control. II. Noninvasive indices and basal response as revealed by autonomic blockades*. - Psychophysiology. 31: 586–598.

DOXEY J.S., WALICZEK T.M., ZAJICEK J.M., 2009 - *The impact of interior plants in university classrooms on student course performance and on student perceptions of the course and instructor.* - HortScience, 44: 384-391.

EQUAL EMPLOYMENT, CHILDREN AND FAMILIES BUREAU, MINISTRY OF HEALTH, LABOUR AND WELFARE, 2009 - 2-6-1. *Anxiety and worries of current. Nationwide Survey on Families and Children 2009*. - Japan Ministry of Health, Labour and Welfare, Tokyo, Japan.

HAN K.T., 2009 - *Influence of limitedly visible leafy indoor plants on the psychology, behavior, and health of students at a junior high school in Taiwan*. - Environ. Behav., 41: 658-692.

IKEI H., KOMATSU M., SONG C., HIMORO E., MIYAZAKI Y., 2014 - *The physiological and psychological relaxing effects of viewing rose flowers in office workers*. - J. Physiol. Anthropol., 33: 6.

IKEI H., LEE J., SONG C., KOMATSU M., HIMORO E., MIYAZAKI Y., 2013 - *Physiological relaxation of viewing rose flowers in high school students*. - Jpn. J. Physiol. Anthropol. (Japan), 18: 97-103.

KOMATSU M., MATSUNAGA K., LEE J., IKEI H., SONG C., HIMORO E., MIYAZAKI Y., 2013 - *The physiological and psychological relaxing effects of viewing rose flowers in medical staff*. - Jpn. J. Physiol. Anthropol. (Japan), 18: 1-7.

LEE J., LI Q., TYRVAINEN L., TSUNETSUGU Y., PARK B.J., KAGAWA T., MIYAZAKI Y., 2012 - *Nature therapy and preventive medicine*, pp. 325-350. - In: MADDOCK J. (ed.). *Public Health-Social and Behavioral Health*. InTech, pp. 582.

LEE J., TSUNETSUGU Y., TAKAYAMA N., PARK B.J., LI Q., SONG C.R., KOMATSU M., IKEI H., TYRVÄINEN L., KAGAWA T., MIYAZAKI Y., 2014 - *Influence of forest therapy on cardiovascular relaxation in young adults*. - Evid. Based Complement. Alternat. Med., Vol. 2014, 834360, pp. 7.

LI Q., MORIMOTO K., KOBAYASHI M., INAGAKI H., KATSUMATA M., HIRATA Y., HIRATA K., SHIMIZU T., LI Y.J., WAKAYAMA Y., KAWADA T., OHIRA T., TAKAYAMA N., KAGAWA T., MIYAZAKI Y., 2008 b - *A forest bathing trip increases human natural killer activity and expression of anti-cancer proteins in female subjects*. - J. Biol. Regul. Hoemeost. Agents, 22: 45-55.

LI Q., MORIMOTO K., KOBAYASHI M., INAGAKI H., KATSUMATA M., HIRATA Y., HIRATA K., SUZUKI H., LI Y.J., OHIRA T., MATSUI N., KAGAWA T., MIYAZAKI Y., KRENSKY A.M., 2008 a - *Visiting forest, but not a city, increases human natural killer activity and expression of anti-cancer proteins*. - Int. J. Immunopathol. Pharmacol., 21: 117-127.

LI Q., MORIMOTO K., NAKADAI A., INAGAKI H., KATSUMATA M., SHIMIZU T., HIRATA Y., HIRATA K., SUZUKI H., MIYAZAKI Y., KAGAWA T., KOYAMA Y., OHIRA T., TAKAYAMA N., KRENSKY A.M., KAWADA T., 2007 - *Forest bathing enhances human natural killer activity and expression of anti-cancer proteins*. - Int. J. Immunopathol. Pharmacol., 20(Suppl. 2): 3-8.

MATSUNAGA K., PARK B.J., KOBAYASHI H., MIYAZAKI Y., 2011 - *Physiologically relaxing effect of a hospital rooftop forest on elderly women requiring care*. - J. Am. Geriatr. Soc., 59: 2162-2163.

MINISTRY OF AGRICULTURE, FORESTRY AND FISHERIES, 2008 - *Report of the statistical survey on the distribution of flowers in 2008*. - Ministry of Internal Affairs and Communications Statistics Statistical Research and Training Institute, Tokyo, Japan.

MIURA M., KAWADA F., 2008 - *Development of a school stressor scale for high school students (SSS)*. - Jpn. J. Couns. Sci. (Japan), 41: 73-83.

MURRAY C.J.L., LOPEZ A.D., 1996 - *Evidence-based health policy-lessons from the Global Burden of Disease Study*. - Science, 274: 740-743.

OSGOOD C.E., SUCI G.J., TANNENBAUM P., 1957 - *The measurement of meaning*. - University of Illinois Press, Champaign, Urbana, Illinois, USA.

PARK B.J., FURUYA K., KASETANI T., TAKAYAMA N., KAGAWA T., MIYAZAKI Y., 2011 - *Relationship between psychological responses and physical environment in forest settings*. - Landsc. Urban Plan, 102: 24-32.

PARK B.J., TSUNETSUGU Y., KASETANI T., KAGAWA T., MIYAZAKI Y., 2010 - *The physiological effects of Shinrin-yoku (taking in the forest atmosphere or forest bathing): evidence from field experiments in 24 forests across Japan*. - Environ. Health Prev. Med., 15: 18-26.

PARK B.J., TSUNETSUGU Y., KASETANI T., MORIKAWA T., KAGAWA T., MIYAZAKI Y., 2009 - *Physiological effects of forest recreation in a young conifer forest in Hinokage town*, Japan. - Silva. Fenn., 43(2): 291-301.

PARK B.J., TSUNETSUGU Y., LEE J., KAGAWA T., MIYAZAKI Y., 2012 - *Effect of the forest environment on physiological relaxation using the results of field tests at 35 sites throughout Japan*, pp. 55-65. - In: LI Q (ed.) *Forest medicine*. Nova Science Publishers Press, New York.

PARK S.H., MATTSON R.H., 2009 - *Ornamental indoor plants in hospital rooms enhanced health outcomes of patients recovering from surgery*. - J. Altern. Complement. Med., 15: 975-980.

SAWADA Y., OHTOMO N., TANAKA Y., TANAKA G., YAMAKOSHI K., TERACHI S., SHIMAMOTO K., NAKAGAWA M., SATOH S., KURODA S., IIMURA O., 1997 - *New technique for time series analysis combining the maximum entropy method: its value in heart rate variability analysis*. - Med. Biol. Eng. Comput., 35: 318-322.

SONG C., JOUNG D., IKEI H., IGARASHI M., AGA M., PARK B.J., MIWA M., TAKAGAKI M., MIYAZAKI Y., 2013 - *Physiological and psychological effects of walking on young males in urban parks in winter*. - J. Physiol. Anthropol., 32: 18.

STATISTICS BUREAU, MINISTRY OF INTERNAL AFFAIRS AND COMMUNICATIONS, 2012 - *16–1. School-Based Education*. - MINISTRY OF INTERNAL AFFAIRS AND COMMUNICATIONS STATISTICS STATISTICAL RESEARCH AND TRAINING INSTITUTE (ed.) *Statistical Handbook of Japan 2012*. Japan Statistical Association, Tokyo, Japan.

TAKADA H., OKINO K., 2004 - *An evaluation method for heart rate variability by using acceleration plethysmography*. - Health Eval. Promot., 3: 547-551.

TAKADA M., EBARA T., SAKAI Y., 2008 - *The acceleration plethysmography system as a new physiological technology for evaluating autonomic modulations*. - Health Eval. Promot., 35: 373-377.

TAKAKURA M., SAKIHARA S., 2001 - *Psychosocial correlates of depressive symptoms among Japanese high school students.* - J. Adolesc Health., 28: 82-89.

TSUNETSUGU Y., LEE J., PARK B.J., TYRVAINEN L., KAGAWA T., MIYAZAKI Y., 2013 - *Physiological and psychological effects of viewing urban forest landscapes assessed by multiple measurements*. - Landsc. Urban Plan, 113: 90-93.

TSUNETSUGU Y., PARK B.J., MIYAZAKI Y., 2010 - *Trends in research related to "Shinrin-yoku" (taking in the forest atmosphere or forest bathing)*. - Environ. Health Prev. Med., 15: 27-37.

WEISE F., HEYDENREICH F., 1989 - *Effects of modified respiratory rhythm on heart rate variability during active orthostatic load. Biomed*. - Biochim. Acta, 48: 549-556.