量と精神症状は負相関を示したが，隣接する左鉤状束，帯状束の白質統合性の変化量は精神症状と正相関を示しており，右前帯状皮質／帯状束の結果とは一見して矛盾する結果のように見える．これら不一致は，心理的ストレスにより引き起こされる生物学的変化が脳部位によって異なることに起因すると考えられる．前帯状皮質の脳灰白質量の低下は，ストレスホルモンとして知られるコルチゾールの影響で引き起こされることが報告されており[24]，組織学的には樹状突起の縮小が主な要因であるとされている[4,11]．樹状突起の縮小は，白質統合性の低下にも直結する変化であり前帯状皮質の灰白質量低下と前帯状束の白質統合性の低下は同一の生物学的背景に起因すると考えられる．一方，眼窩前頭皮質では，慢性ストレスにより樹状突起が増加するとの報告があり[21]，鉤状束における白質統合性の増加を支持する知見である．一見して相反する結果であるが，心理的ストレスに対する脳部位ごとの神経細胞の組織学的な反応の違いが，脳形態画像変化にも反映されていたものと考えられる．複数の脳画像データの検証により，画像所見として現れる生物学的変化についてより深い考察ができた好例であり，複数の脳画像データセットによる検証の重要性が示唆されたものと考えられる．

結　語

今回紹介した脳画像研究は，大規模災害前後の脳灰白質量，白質統合性の形態変化を報告した世界で初めての研究である．災害ストレスへの適応過程に対する理解を深め，災害後精神症状の早期発見，予防に資する基礎研究として意義深いものと考える．一方で，これらは比較的軽度な被災をした健常レベルの大学生の結果であり，より強烈なトラウマ体験をした被災者への応用は慎重を期する必要がある．今後，より広い世代に渡る，さまざまなレベルのトラウマ体験をした被災者を対象とした検証が待たれるところである．

現在筆者は，震災後に東北大学に新設された東北メディカル・メガバンク機構において，宮城県沿岸部および内陸部の住民を対象とした大規模なゲノムコホート調査の立ち上げに参加しており，一部対象者から脳形態画像および認知機能データを収集する計画に従事している．本コホート調査を通して，近い将来には，脳形態，認知機能，遺伝要因，生活習慣との関連が明らかとなり，災害ストレス暴露後の精神症状の増悪に対する個別化予防，個別化医療が可能になると期待している．

謝辞　本研究を行うに際し，ご指導・ご協力いただいた東北大学加齢医学研究所，脳機能開発研究分野，認知機能発達寄附研究部門，スマートエイジング国際共同研究センター・応用脳科学研究分野のメンバーに心より感謝を申し上げる．また，本研究は厚生労働省科学研究費補助金・障害者対策総合研究事業（精神障害分野），および東北大学・災害科学国際研究所・特定プロジェクト研究（共同研究）の助成を受けて行われた．本研究に関して，報告すべき利益相反は存在しない．

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RESEARCH ARTICLE

POSITIVE EFFECTS OF THE VICTIM BY THE GROWING OF PLANTS AFTER GREAT EAST JAPAN EARTHQUAKE

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ABSTRACT

The growing of plants are said to improve individuals' physical and mental states. The growing of plants is a process through which the people are stimulated to positively change. Actually, the growing of plants has been used as a method of the psychological care of the person of the PTSD. For this reason, the growing of plants could be assumed to reflect plastic change in the brain. However, the neural basis of the growing of plants for PTSD is uncertain. This study sought to verify PTSD reaction reduction and changes in brain morphology and stress hormones by growing of plants in women with earthquake stress. Fifty-four right-handed women with mild PTSD in a disaster area participated in this randomized, permuted block method, controlled, crossover trial. Participants were randomly assigned to a horticultural therapy (HT) intervention or stress education (SE) intervention group. Within the 8-week study period, magnetic resonance imaging, psychological index for intervention evaluations, and saliva tests were performed before and after interventions. The HT group showed significantly increased regional gray matter volume (rGMV) of the left subgenual anterior cingulate cortex and left superior frontal gyrus compared with the SE group. The HT group also showed significant improvement in PTSD reactions, posttraumatic growth, and positive affect compared with the SE group. The HT group showed greatly improved salivary cortisol and alpha amylase levels compared with the SE group. These results demonstrate that the growing of plants restore people with PTSD reactions to good condition. Additionally, the growing of plants reduced stress levels in people with PTSD reactions for an earthquake disaster. The growing of plants increased the rGMV of brain areas known to be reduced in PTSD patients. Neural plasticity may underlie the psychological and physiological effects of the growing of plants.

INTRODUCTION

The coastal regions of the Tohoku area suffered significantly from the Great East Japan Earthquake on March 11, 2011. One year after the earthquake, intermittent aftershocks continue to occur in the region. The mental health problems of victims are most evident a certain amount of time after a disaster (1-3). There is growing concern that people from disaster-affected areas may develop post-traumatic stress disorder (PTSD). Previous neuroimaging studies of patients with PTSD symptoms revealed morphological changes in brain areas such as the amygdala (4), the medial prefrontal cortex (MPFC), including the anterior cingulate cortex (ACC) (4, 7, 8) and medial frontal gyrus (5); the hippocampus (4-6); and the orbitofrontal cortex (OFC) (9). Our longitudinal magnetic resonance imaging (MRI) study suggested that young healthy subjects with smaller regional gray matter volume (rGMV) in the right ventral ACC before the earthquake, and subjects with decreased rGMV in the left OFC through the Great East Japan Earthquake disaster area were likely to have PTSD symptom (10). The ACC is involved in processing fear and anxiety, and have been suggested to be related to vulnerability to development of PTSD symptoms (10). Additionally, decreased OFC volume was induced by falling to extinct conditioned fear soon after traumatic event (10). Furthermore, our study suggested that salivary cortisol levels of young healthy subjects in the disaster area were significantly increased after the earthquake compared with levels before the earthquake (11). Cortisol is considered to be an indicator of psychological and physiological stress, and salivary cortisol levels increase in people with PTSD symptoms (72).

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The growing of plants are said to improve individuals' physical and mental states. The growing of plants is a process through which the people are stimulated to positively change. Actually, the growing of plants has been used as a method of the psychological care of the person of the PTSD. It is referred to as a horticultural therapy (HT). HT is an intervention method for PTSD that was developed in the USA for psychological care and social rehabilitation of disabled soldiers and war veterans with PTSD symptoms after World War II (12). HT is usually led by a professional trained to tailor the use of plants to fit the therapy and rehabilitation needs of those individuals with whom they are working. HT is a process through which the people are stimulated to positively change. Process of HT such as seeding and growing plants itself improves people's mood and attentiveness. Besides, therapy in a group setting improves people's communication skill through collaborative horticultural activity. The people identify him or herself with plant growth, regains health and motivation, and has a chance to be happy. Through such the experiences, people are certainly improved through association with nature (21).

MRI study of horticulture exist only one so far. In a functional MRI study in patients with cerebrovascular disease, the fusiform, and supramarginal gyri, left cerebellum, and visual, inferior temporal, right motor, left supplementary motor, and right sensory areas were activated during recognition tasks using emotional photograph (pleasant or unpleasant) after HT (22).

Previous studies suggested that HT and exposure to nature can have cognitive (14, 15), psychological (12, 13, 16-18), social (19, 20), and physical benefits (16, 18). Additionally, HT has a positive effect on physiological measures, such as heart rate and salivary cortisol level (23). The change in cognitive function of elderly people or patients with PTSD or cancer after HT could be assumed to be the result of clinical efficacy and plastic change in the brain. However, the neural basis of HT as a treatment for people with PTSD is uncertain. We hypothesized that HT possibly improves a decline in brain volume in people with PTSD.

The purpose of this study was to verify the reduction in PTSD symptoms in disaster victims with earthquake stress by HT intervention, and to reveal changes in brain morphology and stress hormones produced by HT intervention.

MATERIALS AND METHODS

Participants

Figure 1 presents a flowchart of this study. This study was a randomized, permuted block method, controlled, crossover trial. Participants were randomly assigned to an HT intervention or stress education (SE) intervention group. A total of 106 participants were recruited through a leaflet in the local newspaper, which is circulated exclusively in the disaster area, and screened using a questionnaire before inclusion. Fifty-two participants were excluded from a clinical trial. Fifty-four right-handed women with mild PTSD participated in this study. These women (age range: 23–55 years) were victims of the Great East Japan Earthquake of March 11, 2011, and were still living in the disaster area. They lived in cities that were devastated, such as Ishinomaki city, Onagawa town, and Higashi-Matsushima city, all in Miyagi Prefecture. To assess whether the volunteers had mild PTSD, we used the Clinician-Administered PTSD Scale (CAPS) (24-26). CAPS scores are divided into the following categories: 0–19 (asymptomatic/few symptoms), 20–39 (mild PTSD/subthreshold), 40–59 (moderate PTSD/above threshold), 60–79 (severe PTSD symptoms), and >80 (extreme PTSD symptoms). All participants were verified to have no neuropsychiatric disorder *via* the Mini-International Neuropsychiatric Interview (M.I.N.I.) (27, 28). Trained psychologists (A.O., N.A., M.S., N.S., S.T., and Y.W.) administered the Japanese version of the CAPS (26) to all subjects in structured psychiatric diagnostic interviews to screen for post-traumatic stress symptoms. All participants were diagnosed with PTSD *via* the M.I.N.I., and each had symptoms of all three PTSD symptom clusters, including re-experiencing the event, avoidance, and hyperarousal. The CAPS and M.I.N.I. were administered before and after intervention. Written informed consent was obtained from each subject in accordance with the Declaration of Helsinki (1991). This study was approved by the Ethics Committee of Tohoku University School of Medicine.

Randomized controlled trial design

This randomized, double-blind, controlled, crossover trial was registered in the University Hospital Medical Information Network Clinical Trials Registry (UMIN000006170). The trial was conducted between September 2011 and March 2012 for people who lived in the coastal areas of Miyagi Prefecture (see Supplementary Information for more details about trial design and study limitations).

HT intervention sessions

The HT intervention was designed in consultation with a horticultural therapist. The intervention comprised a total of eight weekly sessions (60 min each) at a university lab and at participants' homes. The lab sessions comprised interactive lectures and practical training. In the first two sessions, a teaching aid showed participants videos containing introductory psychology and stress management lessons. The participants then attended six horticultural lessons, including topics such as designing a garden planter, seeding, watering, weeding, and picking flowers. Participants filled out an HT intervention session checklist after each session as a self-assessment. Participants took care of plants for 15 min per day at their convenience with horticulture kits provided by the experimenters, and recorded the completion of this task daily on forms provided by the experimenters at the intervention sessions. The participants submitted these forms to the experimenters at the HT intervention session each week.

The stress education session (SE intervention session)

The SE intervention session was a 60-minute session consisting of a video lecture regarding stress education, and it was managed by teaching aids who served as psychological testers. The participants in the control group attended the SE intervention sessions once each week (a total of eight lessons). The video series used in the SE intervention sessions educated participants about the human body, such as stress mechanisms, psychology, stress management Participants filled out an SE intervention session checklist after each session. The 2nd session and the 6th session of the HT intervention session and the SE intervention session used the same teaching aid.

Psychological measures

For pre- and post-intervention evaluation, a questionnaire with the following content was administered: (a) a health interview checklist regarding drinking, smoking, and sleeping in daily life before and after the earthquake; (b) the World Health Organization Quality of Life 26 instrument (29); (c) the World Health Organization Subjective Well-Being Inventory (30, 31); (d) the Center for Epidemiologic Studies Depression Scale, which measures the respondent's level of depressive symptoms within the past week (32, 33); (e) the Cornell Medical Index, which measures the subject's physical and mental state (34, 35); (e) the General Health Questionnaire 30, which measures psychological distress (36, 37); (f) the Positive and Negative Affect Schedule (PANAS), which measures positive affects (PAs) and negative affects as states and traits (38, 39); (g) the Profile of Mood States Scale, which measures aspects of mood (40, 41); and (h) the Posttraumatic Growth Inventory (PTGI), which measures positive outcomes of people who have experienced traumatic events (42, 43), such as post-traumatic growth (PTG). Overcoming trauma and achieving human growth to recover quality of life involve (1) strengthened consideration of or kindness to others, (2) discovery of new possibilities, (3) becoming humanly strong, (4) appreciation of life and human life, and (5) a deeper understanding of something beyond human knowledge, such as religion and nature (42).

Saliva sampling

We collected saliva samples from participants to measure salivary cortisol and salivary alpha amylase (SAA) levels. Distressing psychological stimuli are associated with an increased cortisol level (44). The SAA level increases during stress and decreases during relaxation (23) (see Supplementary Information for more details about collection dates, times, and assay method).

Image acquisition

All MRI data were acquired with a 3-T Phillips Achieva scanner. Using a magnetization prepared rapid gradient echo sequence, high-resolution T1-weighted structural images (240 × 240 matrix, repetition time = 6.5 ms, echo time = 3 ms, field of view = 24 cm, 162 slices, 1.0-mm slice thickness) were collected.

Voxel-based morphometry analysis

Voxel-based morphometry (VBM) was used to investigate morphological changes in the brains of women with mild PTSD after HT intervention. All morphological data were processed as in previous studies (45, 46). All images were subsequently subjected to 12-mm Gaussian smoothing. The change in rGMV between pre- and post-intervention images was computed at each voxel for each participant. We included only voxels with GMV probabilities > 0.10 on pre- and post-intervention images in these computations to avoid possible partial-volume effects at the borders between the GM and white matter, as well as between the GM and cerebrospinal fluid. The resultant maps representing the rGMV before intervention and the rGMV change between the pre- and post-intervention scans (pre-post) were then used in the group-level analysis described below (see Supplementary Information for more details).

Statistical analyses

Psychological and salivary data were analyzed using the PASW statistical software package (ver. 18 for Windows; SPSS Inc., Chicago, IL, USA). Demographic and clinical data were subjected to one-way analyses of variance. One-way analyses of covariance were conducted with the difference between pre- and post-intervention scores included as dependent variables and pretest scores as covariates of each psychological measure. Because our primary endpoint of interest was the beneficial effect of intervention training, test-retest changes were compared between the HT and control groups using one-tailed tests ($p < 0.05$), as in previous studies (47).

In the group-level analysis of rGMV, we examined groupwise differences in rGMV changes using the factorial design option in SPM5. The effect of the intervention was estimated by comparing changes between pre- and post-intervention measures as described above, and then comparing between groups at each voxel with age, total GMV before intervention, and daily smoking reported in the health interview as covariates. The data were corrected for multiple comparisons across the whole brain at the nonisotropic adjusted cluster level (48), with an underlying voxel-level threshold of $p < 0.0025$. Nonisotropic adjusted cluster-size tests should be applied when data are known to be nonstationary (i.e., not uniformly smooth), as are VBM data (48). We did not perform region-of-interest analyses in this study.

RESULTS

Psychological measures

Demographic and clinical data are given in Table 1. Age, CAPS scores, amount of smoking per day, and amount of alcohol consumed per day did not differ significantly between the HT and SE groups. Comparisons between each group's psychological changes before and after intervention are given in Table 2. The HT group showed a significantly larger decrease between pre- and post-intervention CAPS scores [$F(1,51) = 13.526$, $p < 0.001$]. The CAPS score was significantly lower and PTSD symptoms were reduced more in the HT group than in the SE group. The HT group also showed a significantly larger increase between pre- and post-intervention PTGI-J total scores [$F(1,51) = 4.315$, $p < 0.05$]. The PTGI-J total score was significantly higher in the HT group than in the SE group, and PTG was improved by HT in comparison with SE. Moreover, the HT group showed a significantly larger pre- to post-intervention increase in PANAS-PA scores [$F(1,51) = 5.66$, $p < 0.05$]. The PANAS-PA score was significantly higher in the HT group than in the SE group, and PA was increased by HT in comparison with SE.

Salivary stress marker

Comparisons between each group's salivary cortisol and SAA levels before and after intervention are given in Figure 2. The HT group showed a significantly larger pre- to post-intervention decrease in salivary cortisol [$F(1,51) = 14.077$, $p = 0.001$] and SAA [$F(1,51) = 16.978$, $p = 0.001$] levels, indicating that stress was reduced by HT in comparison with SE.

Table 1 Demographic and clinical data

Measure	HT group Mean	HT group SD	SE group Mean	SE group SD	p^a
Age (years)	42.48	9.72	44.22	7.78	0.884
CAPS score	31.52	6.5	31.25	6.47	0.471
Amount of smoking per day (numbers of cigarette)	1.81	3.55	3.26	6.16	0.354
Amount of drinking per day (ml)	111.11	133.97	155.56	207.24	0.296

[a]One-way analysis of variance.
HT, horticultural therapy; SE, stress education; SD, standard deviation; CAPS, Clinician-Administered Post-Traumatic Stress Disorder Scale.

Table 2 Results of psychological measures before and after intervention

	HT group				SE group				Planned contrast	p^a
	Pre		Post		Pre		Post			
Measures	Mean	SD	Mean	SD	Mean	SD	Mean	SD		
CAPS score	31.52	6.5	10.0	7.05	31.25	6.47	16.11	9.32	HT < SE	**<0.001**
WHO-QOL26 total score	52.52	5.8	53.89	6.45	52.34	6.3	51.0	5.85	HT < SE	0.297
WHO-SUBI positive score	37.11	6.47	38.44	6.82	37.3	6.34	38.04	5.94	HT > SE	0.277
WHO-SUBI negative score	49.67	7.13	50.41	5.97	50.33	6.52	51.04	5.67	HT > SE	0.861
CES-D score	13.44	7.11	11.81	7.39	14.56	6.87	12.52	5.18	HT < SE	0.934
CMI somatic status score	191.89	16.13	151.81	54.33	189.63	13.45	153.63	47.62	HT < SE	0.385
CMI emotion status score	49.96	7.88	38.52	14.63	50.63	6.97	38.63	14.12	HT < SE	0.949
GHQ score	7.07	5.09	4.37	4.16	6.78	5.72	5.0	4.71	HT < SE	0.248
PANAS positive affect	20.52	6.36	23.33	7.42	23.56	7.8	20.96	7.18	HT > SE	**0.011**
PANAS negative affect	18.93	7.69	15.11	5.96	21.78	7.12	18.52	6.36	HT < SE	0.071
POMS Tension-Anxiety score	10.0	5.08	8.26	4.12	10.19	5.43	10.0	4.77	HT < SE	0.057
POMS Depression-Dejection score	13.3	8.35	9.63	6.62	12.63	10.05	10.63	7.84	HT < SE	0.191
POMS Anger-Hostility score	12.0	8.72	9.89	7.8	11.04	9.05	8.22	5.61	HT < SE	0.420
POMS Vigor-Activity score	8.74	6.23	10.74	6.37	8.0	5.2	8.52	6.1	HT > SE	0.104
POMS Fatigue-Inertia score	10.59	6.6	8.59	5.92	9.44	6.44	7.63	4.97	HT < SE	0.366
POMS Confusion score	8.93	3.83	7.22	3.18	7.89	3.7	7.0	3.23	HT < SE	0.357
POMS Total Mood Disturbance score	46.26	28.03	34.59	26.15	43.0	30.05	33.22	21.97	HT < SE	0.957
PTGI total score	66.56	18.05	72.33	15.66	68.41	18.29	66.48	17.85	HT > SE	**0.022**

aOne-way analyses of covariance with pre–post differences in psychological measures as dependent variables and pre-intervention scores as covariates (one-tailed).
HT, horticultural therapy; SE, stress education; SD, standard deviation; CAPS, Clinician-Administered Post-Traumatic Stress Disorder Scale; WHO-QOL26, World Health Organization Quality of Life 26; WHO-SUBI, World Health Organization Subjective Well-Being Inventory; CES-D, Center for Epidemiologic Studies Depression Scale; CMI, Cornell Medical Index; GHQ, General Health Questionnaire; PANAS, Positive and Negative Affect Schedule; POMS, Profile of Mood States; PTGI, Posttraumatic Growth Inventory.

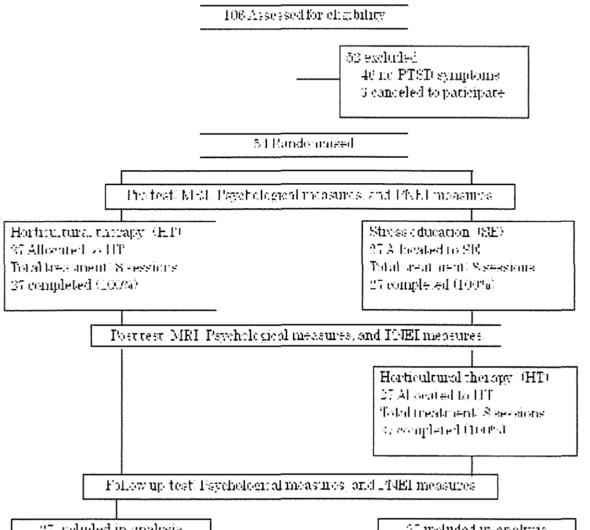

Figure 1 Flowchart of the study

Effects of HT intervention on gray matter structures

Compared with the SE group, the HT group showed a significant increase in the rGMV of the left subgenual ACC (sgACC; MNI coordinates: $x = -10$, $y = 22$, $z = -5$; $t = 3.81$; $p < 0.05$, corrected for multiple comparisons at the nonisotropic adjusted cluster level with an uncorrected cluster-determining threshold of $p < 0.0025$) and posterior and medial parts of the left superior frontal gyrus [SFG (BA8)]/MPFC ($x = -15$, $y = 16$, $z = 66$; $t = 3.90$; $p < 0.05$, corrected for multiple comparisons at the nonisotropic adjusted cluster level with an uncorrected cluster-determining threshold of $p < 0.0025$; Figure 3). The SPM contrast employed was SE group ($rGMV_{pre} - rGMV_{post}$) – HT group ($rGMV_{pre} - rGMV_{post}$). No other significant result was found in this analysis.

DISCUSSION

Our objective was to reveal a reduction in PTSD symptoms and changes in brain morphology and stress hormones in disaster victims with earthquake stress by growing of plants The present study revealed the effect of the growing of plants on rGMV, psychological scale scores, and salivary cortisol markers in women with mild PTSD in the Great East Japan Earthquake disaster area. The results are consistent with our hypothesis that the growing of plants might reduce PTSD symptoms in disaster victims with earthquake stress and change the brain structure and stress marker levels, as discussed in detail below.

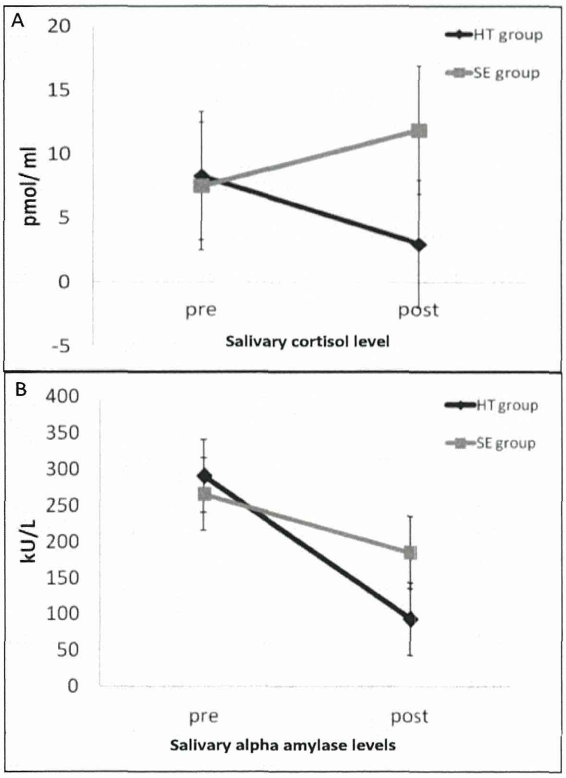

Figure 2 Pre- and post-intervention salivary cortisol levels and salivary alpha amylase levels in the horticultural therapy (HT) and stress education (SE) groups. (A) Salivary cortisol levels decreased in the HT group and increased in the SE group, showing a significant interaction with group: (HT group, SE group) × salivary cortisol level ($p < 0.01$). (B) Salivary amylase levels were significantly lower in the HT group than in the SE group, showing a significant interaction with group: (HT group, SE group) × salivary alpha amylase level ($p < 0.05$).

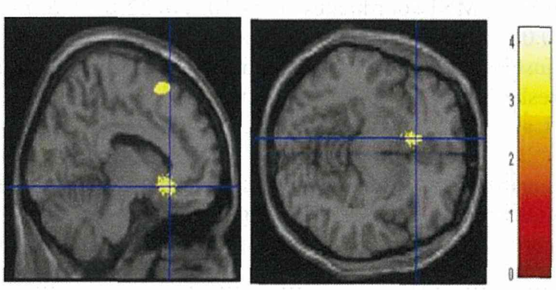

Figure 3 Regional gray matter volume increased in the horticultural therapy (HT) group compared with the stress education (SE) group in the left subgenual anterior cingulate cortex and posterior and medial parts of the left superior frontal gyrus/medial prefrontal cortex. Results are shown at a significance level of $p < 0.05$, corrected for multiple comparisons at the cluster level with an underlying voxel level of $p < 0.0025$. The color density represents the T score.

sgACC and the left SFG (BA8)/MPFC, which are considered to be the neural substrates of PTSD, as described below. VBM analysis revealed rGMV increases in the left sgACC and left SFG (BA8). Previous studies suggested that the ACC has important roles in responding to states of extreme stress, such as PTSD (7, 8). These studies have shown that stress affects brain structure, and function and VBM studies revealed structural changes in the ACC of people with PTSD (10, 49, 50). In particular, our findings show that the sgACC is involved in fundamental mental operations, such as affective processing and inhibitory control of negative affection (51). Structural studies suggested that sgACC volume is significantly reduced in people with symptoms such as anxiety, mood disorders, and PTSD (52, 53). This area is also involved in the modulation of sympathetic and neuroendocrine responses (54).

Our findings also suggest that the weak sgACC field may be enhanced initially in people who readily develop PTSD. The structure of the sgACC field was related to PTSD following the Great Earthquake in this study, as in the preceding study, and the growing of plants may have affected this structure because this area is associated with vulnerability to PTSD (10).

On the other hand, another study suggested that people with bipolar disorder have a smaller volume of this brain area compared with healthy people (56), and this may be associated with vulnerability to depression. The structure of the sgACC may be affected by acquired and vulnerability factors (10, 55). Previous studies of the connection between the posterior and medial part of the SFG (BA8)/MPFC and PTSD suggested that less activation of the SFG/MPFC is associated with downregulation of the fear response (5, 56). The PTSD subjects showed clusters of decreased SFG volumes compared with healthy subjects (57). Another study suggest that the MPFC plays an important role in modulating hypothalamo-pituitary-adrenal responses to emotional stress (58). For the aforementioned reasons, our findings reflect increases in the volumes of these PTSD-related brain areas after the growing of plants and show that structural changes involving reduction of the left sgACC volume and left SFG (BA8)/MPFC volume may be reversed with the growing of plants.

Based on the present intervention results, the growing of plants may have increased the volumes of the sgACC and SFG/MPFC, which play important roles in emotional control functions and are associated with PTSD. This effect may also have fortified relevant functions, such as suppression of cortisol secretion (59), which is the result of suppression of the stress reaction derived from sympathetic nerves (60, 61) as well as improvement in positive emotion (62).

These results are also consistent with our hypothesis that the growing of plants may recover the mental and physical functions of PTSD-afflicted women, which were probably weakened due to the traumatic experience; the HT group showed improved CAPS scores compared with the SE group, indicating that the growing of plants reduced PTSD symptoms. This finding extends the previous findings of the effect of the growing of plants on severe PTSD in men to that on mild PTSD in women. Furthermore, the HT group showed improved PTGI-J total scores and PANAS-PA scores after intervention compared with the SE group. Thus, HT may induce a positive psychological state. The HT group showed reduced salivary cortisol and SAA levels compared with the SE group, indicating that the growing of plants reduced the stress level. These salivary stress marker findings are similar to those of previous studies (23, 63).

Previous studies suggested that HT intervention for patients with depression improves mental health indices, including PANAS scores (64). Few studies have used CAPS scores to evaluate the effect of the growing of plants, however, we believe that the HT group showed decreased CAPS scores because their PTSD symptoms decreased, suggesting positive effects of the growing of plants such as mood improvement and stress reduction (16-18). Few previous studies have investigated the relationship between PTGI-J results and the growing of plants, however, a study of the PTG process reported that people suffer emotional pain due to trauma to their personal growth resulting from the traumatic experience. As described below, people struggle with or feel conflicted about prior trauma. However, they use PTG to react in diverse ways, such as remembering their status before the event, referring to their own personality characteristics, relying on the support of others, and self-disclosing their own experiences with the negative event (65, 66). Victims of the Great East Japan Earthquake had varying experiences, such as coping with the effects of the tsunami or living as refugees or evacuees in the days following the earthquake. Victims in coastal areas encountered especially serious situations. However, support groups from nearby and outside of the disaster areas began to offer various types of assistance shortly after the disaster. Through support activities, victims and those who provided support developed compassion, respect, and humanity toward others. After experiencing the earthquake as a very negative event, victims who participated in our study seemed able to attain peace of mind and compassion by remaining in their own homes for 2 months and by attending gardening sessions in a university laboratory once per week for 2 months. It can be considered that horticultural activity changed victims' confused recognition behaviors caused by the earthquake to controllable behaviors within themselves, changed the process of understanding the series of events related to the earthquake, and helped them to find possible meanings for the traumatic occurrence in association with PTG (67).

Salivary cortisol and SAA levels decreased after the growing of plants. Although the growing of plants is related more weakly to SAA levels than to salivary cortisol levels, SAA levels notably respond more rapidly to stress (68). Previous studies suggested that PTSD is associated with behavioral and physiological pathologies, including disruption of the hypothalamic–pituitary–adrenal axis (69), which is involved in the mediation of physiological responses to stress and secretion of the stress hormone cortisol (70). Cortisol is considered to be an indicator of psychological and physiological stress and can be used to examine the pathophysiology of PTSD (71). People with severe PTSD due to the Hanshin-Awaji earthquake had significantly higher cortisol levels (72). A previous study showed increased SAA levels in unpleasant conditions and decreased SAA levels in pleasant conditions (73). The sgACC is associated with the modulation of sympathetic and neuroendocrine responses, such as cortisol and amylase secretion (54). A previous study suggested that impaired sgACC function in mood disorders may contribute to cortisol hypersecretion in depression (74). In addition, depressive subtypes showing regional reductions in GMV (e.g., bipolar disorder, familial pure depressive disease) also show evidence of increased cortisol secretion during stress (75). Our findings suggest that salivary cortisol and SAA level changes might be influenced by sgACC function. In addition, a previous study suggested that salivary cortisol levels were significantly decreased and PANAS-PA scores were fully restored after horticultural activity (23). We consider that the change in psychological measures and cortisol levels could be influenced by the sgACC.

CONCLUSION

The purpose of this study was to reveal the neural basis of the growing of plants for PTSD reactions. Our research has demonstrated that the growing of plants improves PTSD reactions and feelings, promotes PTG, and decreases physiological stress in women with mild PTSD. In terms of a neural basis, the growing of plants can also increase GMV in known brain areas. These results support the hypothesis that the growing of plants is effective for women with mild PTSD and can change the neural basis of PTSD. In the future, we would like to examine whether the same effect can be confirmed in other diseases and healthy groups. Although 4 year has passed since the Great East Japan Earthquake, we would like to continue examining time-dependent changes in the affected areas while simultaneously supporting disaster victims.

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RESEARCH ARTICLE

EFFECTS OF HORTICULTURAL INTERVENTION ON COGNITIVE FUNCTION IN ELDERLY WOMEN OF MILD PTSD TWO YEARS AFTER THE EAST JAPAN GREAT EARTHQUAKE

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ABSTRACT

The Great East Japan Earthquake had a psychological impact on many people and such natural disasters can affect the cognitive function of survivors. However, the specific benefits of HT on cognitive functions of earthquake survivors are not clearly understood. This study aimed to determine whether cognitive functions in elderly women living in the Great East Japan Earthquake disaster area would improve following horticultural therapy (HT) using a randomized, open-label, assessor-blind, crossover trial design. Thirty-nine right-handed elderly women participants were divided into an HT group (n = 20) and a control group (n = 19). The HT group underwent eight weeks of HT, and the control group underwent eight weeks of stress control education. We administered four questionnaires to assess changes in participants' pre- and postintervention cognitive functions. The HT group's depression, posttraumatic stress disorder symptoms, and cognitive function improved postintervention, particularly in attentional functions and processing capacity, relative to the control group. These findings suggest that HT may improve cognitive functions in elderly women following a disaster.

INTRODUCTION

On March 11, 2011, the Great East Japan Earthquake caused significant damage in the Tohoku area. Many people who lived in this area experienced extremely strong tremors, which left them with varying degrees of psychological damage. Previous studies have reported that psychological and physical changes occur in survivors following serious events (Fukuda *et al.* 2000; Song *et al.* 2008; Kotozaki and Kawashima 2012). The survivors' cognitive functions can be affected, which leads to deficits in attentional and executive functions, memory, and learning (Yehuda *et al.* 2004).

For example, cognitive performance test were performed before and after the major earthquake that occurred in New Zealand Christchurch, cognitive performance of after the earthquake including reaction speed had clearly reduced (Helton & Head, 2012). In other words, it was suggested that the natural disaster was more likely to have a negative influence on the cognitive function of the victim. The psychological effects of natural disasters on survivors have been examined (Galea*et al.* 2005); results from these studies indicated that women are more likely to have posttraumatic stress disorder (PTSD), in addition to emotional instability and anxiety disorders, following natural disasters (Bland *et al.* 1996; Tural *et al.* 2004). However, few studies have examined the psychological effects of the Great East Japan Earthquake on women or evaluated simple, effective methods for recovery. This study focused on psychological treatment using horticultural therapy (HT).

HT treatment for PTSD was developed in the United States after World War II to provide psychological care and social rehabilitation for disabled soldiers and war veterans with PTSD symptoms (Detweiler *et al.* 2010). Previous studies have suggested that HT can have cognitive (Cimprich 1993), psychological (Ulrich and Parson 1992; Detweiler *et al.* 2010), social (Perrins-Margails *et al.* 2000), and physical benefits (Van den Berg and Custers 2011). Some of the psychological effects of HT on earthquake induced stress have been recently studied (Kotozaki 2013a, 2013b); however, the specific benefits of HT on cognitive functions of earthquake survivors are not clearly understood. This study aimed to determine whether cognitive function in elderly women living in the Great East Japan Earthquake disaster area would improve following HT intervention. After a disaster, elderly people are more likely to develop PTSD and general psychiatric morbidity than young people (Ticehurst *et al.* 1996; Liu *et al.* 2006; Jia *et al.* 2010). Therefore, we conducted an experimental study with elderly women participants between 60 and 75 years of age. To our knowledge, no previous research has considered the effects of horticultural therapy on elderly women living in disaster areas. We hypothesized that HT would help these elderly women by improving cognitive functions impacted by trauma.

MATERIAL AND METHODS

Participants

The participants were female residents of the coastal areas of Miyagi Prefecture, aged 60 to 75 years, who experienced the

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Great East Japan Earthquake on March 11, 2011. An invitation to participate in the study was published in newspapers serving the earthquake-affected areas, and 100 residents from Kesennuma City to Watari Town responded. The respondents were screened for PTSD using the Mini International Neuropsychiatric Interview (MINI) (Sheehan *et al.* 1998; Otsubo *et al.* 2005) and the Clinician-Administered PTSD Scale (CAPS) (Blake *et al.* 1995; Asukai *et al.* 2003). MINI is a short structured diagnostic interview, developed jointly by psychiatrists and clinicians in the United States and Europe, for the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV) and the International Classification of Diseases (ICD-10) psychiatric disorders. MINI was designed to meet the need for a short but accurate structured psychiatric interview for multicenter clinical trials and epidemiology studies and to be used as a first step in outcome tracking in nonresearch clinical settings. The CAPS is widely considered to be the "gold standard" in PTSD assessment. It is a structured interview providing a categorical diagnosis, as well as a measure of the severity of PTSD symptoms as defined by DSM-IV. The CAPS scores are divided into the following categories: 0–19 (asymptomatic/few symptoms), 20–39 (mild PTSD/subthreshold), 40–59 (moderate PTSD/above threshold), 60–79 (severe PTSD symptoms), and >80 (extreme PTSD symptoms). For the CAPS, applicants were regarded as symptomatic if they scored ≥1 on frequency and ≥2 on intensity (the F1/2 method). After the exclusion of 61 applicants who had no PTSD symptoms and a CAPS score of ≦40, 39 right-handed elderly women were selected for participation in the study, which was part of an ongoing project investigating associations between brain structure and mental health. All participants were diagnosed with symptoms of PTSD on the MINI and had one to two symptoms in each of the three PTSD symptom clusters—re-experiencing the event, avoidance, and hyperarousal. The CAPS and MINI were administered before and after the intervention. Written informed consent was obtained from each subject in accordance with the Declaration of Helsinki (1991). This study was approved by the Research Ethics Committee of Tohoku University Graduate School of Medicine following ethical screening.

The study was a randomized, open-label assessor-blind crossover trial, registered at the University Hospital Medical Information Network Clinical Trials Registry (UMIN 000008936). Testers were blind to the study's hypothesis and participants' group membership. The participants were divided into two groups, a HT group (n = 20) and a stress education (SE) group (n = 19), using the permuted block method.

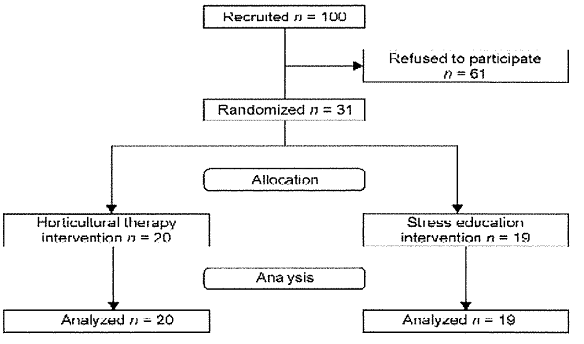

Figure1

This study design was similar to a previous study (Kotozaki 2013a, 2013b).

Psychological measures

To assess changes in participants' cognitive functions, we administered the following psychological measures before and after the intervention: (a) the Frontal Assessment Battery at Bedside (FAB) to assess executive functions (Dubois *et al.* 2000), (b) the Geriatric Depression Scale-15 (GDS-15) to assess depressive symptoms (Niimi *et al.* 1999), and (c) the Wechsler Memory Scale-Revised (WMS-R) to assess memory functions (Sugishita 2001). Participants received instructions from the researcher and completed the psychological measures within 120 min. The total experimental time was approximately 120 min.

Interventions

The interventions took place between October 2012 and May 2013. The HT intervention was designed by a horticultural therapist. This intervention included eight weekly sessions (60 min each) at a university lab and 15 minutes per day at participants' homes. The sessions at a university lab comprised interactive lectures and practical horticultural training. The participants attended six horticultural lessons, which included topics such as designing a garden planter, seeding, watering, weeding, and picking flowers. Participants filled out an HT intervention session checklist after each session as a self-assessment. Participants cared for plants for 15 min per day at their homes using horticulture kits provided by the experimenters and recorded the completion of this task daily on forms provided by the experimenters at the intervention sessions. The participants submitted these forms to the experimenters at the HT intervention session each week.

The SE intervention consisted of eight 60-minute sessions, which included lectures and a video series about stress mechanisms, psychology, and stress management. The SE intervention was managed by a member of the research team with a background in psychology. Participants filled out an SE intervention session checklist after each session. The second and sixth HT and SE interventions sessions used the same teaching aid.

Statistical analyses

The data were analyzed using PASW statistical software (ver. 18 for Windows; SPSS, Inc., Chicago, IL, USA). One-way analysis of covariance was conducted with differences between the pre- and postintervention scores as dependent variables and pretest scores as covariates for each psychological measure. Because our primary point of interest was identifying the beneficial effects of HT, test–retest changes were compared between the HT and control groups using one-tailed tests ($p < 0.05$), in the same manner as in previous studies (Kotozaki 2013a, 2013b).

RESULTS

Table 1 shows the comparisons of pre- and postintervention psychological changes between the two groups. The HT group demonstrated a significant increase in postintervention FAB scores ($F[1, 36] = 7.90$, $p < 0.01$), WMS-R attention/concentration scores ($F[1, 36] = 3.42$, $p < 0.05$), and

WMS-R delayed recall scores ($F[1, 36] = 4.29$, $p < 0.05$), relative to the control group. In addition, the HT group had a significant decrease in postintervention CAPS ($F[1, 36] = 3.43$, $p < 0.05$) and GDS scores ($F[1, 36] = 6.67$, $p < 0.01$), relative to the control group.

HT on PTSD symptoms to elderly women living in the disaster area who were likely to have experienced earthquake-related stress. The HT group also had lower postintervention GDS scores than the control group did, indicating that HT improved their depressive symptoms.

Table 1 Participants' psychological data

	HT group (*n* = 20)				Control group (*n* = 19)				
	Pre		Post		Pre		Post		
Measures	Mean	SD	Mean	SD	Mean	SD	Mean	SD	p^a
CAPS score	23.50	6.03	6.60	5.25	21.84	4.83	10.63	8.90	0.036
FAB score	17.80	0.41	17.95	0.22	17.89	0.32	17.68	0.48	0.004
GDS score	3.25	1.29	1.85	2.06	3.11	2.26	3.63	2.27	0.007
WMS-R General memory score	107.50	13.85	108.75	10.30	106.11	12.77	108.68	8.18	0.490
Verbal memory score	108.95	11.70	109.30	9.91	109.32	9.12	109.58	9.11	0.493
Visual memory score	105.40	17.45	107.70	13.80	105.74	13.09	107.89	9.07	0.498
Attention/concentration score	94.55	19.19	103.40	11.16	102.26	14.64	100.42	11.69	0.037
Delayed recall score	102.10	15.94	109.90	11.11	104.68	11.12	105.11	11.99	0.028

Abbreviations: CAPS, the Clinician-Administered PTSD Scale; FAB, Frontal Assessment Battery at Bedside; GDS, Geriatric Depression Scale; HT, Horticultural Therapy; SD, Standard Deviation; WMS-R, Wechsler Memory Scale-Revised.

[a]One-way analysis of covariance with pre–post differences in psychological measures as dependent variables and pre-intervention scores as covariates (one-tailed).

DISCUSSION

This study aimed to investigate the effects of HT intervention on cognitive functions in elderly women living in the Great East Japan Earthquake disaster area. Results revealed that the HT intervention improved cognitive functions, particularly attentional function and processing capacity, in addition to depression and PTSD symptoms. These results supported our hypothesis that HT may improve cognitive functions in elderly women affected by a traumatic natural disaster experience.

In the HT group, postintervention FAB, WMS-R attention/concentration, and WMS-R delayed recall scores were significantly higher than the scores of the control group, which indicated that HT improved cognitive functions. Previous studies have reported confusion with respect to cognition such as attention, processing of information, and mental clarify following disasters (Cardena and Spiegel 1993), which suggested that disasters induce negative feelings, and levels of intrusive thoughts increase after negative mood induction (Smallwood *et al.* 2009). Disasters can indirectly disrupt cognitive performance via their impact on mood and thought (McVay and Kane 2010); in a sustained attention to response task study administered before and after the 7.1-magnitude earthquake in Christchurch, New Zealand, errors of omission increased following the earthquake (Yehuda *et al.* 2004). It is possible that similar omissions may have been present in survivors of the Great East Japan Earthquake. Our findings support the results of previous studies that found HT improved cognitive function, attention, and processing capacity (Cimprich 1993; Rappe and Kivelä 2005). In this study, the HT group demonstrated significantly increased postintervention cognitive functions, including frontal lobe function (measured by the FAB) and attention and processing capacity (measured by the WMS-R), relative to the control group. Thus, HT may be effective in restoring cognitive functions affected by the disaster.

In addition, postintervention CAPS scores were significantly lower in the HT group than the scores in the control group, indicating that HT reduced PTSD symptoms. This finding was similar to results of our previous intervention study (Kotozaki 2013a, 2013b) and extends the positive effects of

Several other HT studies examined depression in elderly people (Herzog *et al.* 1997; Taylor *et al.* 2001), finding that HT is associated with a reduction in depression and stress.

CONCLUSION

This study found that HT improved cognitive function in elderly women living in the Great East Japan earthquake disaster area relative to women receiving stress therapy. We believe that HT may be a viable and effective intervention for earthquake-related stress and cognitive problems. We hope that HT will be used more frequently as a means of psychological support in natural disaster areas.

Declaration of Conflicting Interests

The author has no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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The nutritional status of women of the coastal region of the Great East Japan Earthquake disaster area: Three years after

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Abstract

Three and a half years have passed since the Great East Japan Earthquake. The life of residents has recovered close to pre-disaster conditions. However, previous studies reported that disaster survivors occurred in the past have a low standard of nutrition among residents. The purpose of this study was to investigate the nutritional status of women in the coastal region of the disaster area three years after the Great East Japan Earthquake. The participants included 145 healthy women volunteers. Participants lived in the coastal region of the disaster area immediately after the earthquake. All participants were interviewed by trained psychologists using the Japanese version of the Clinician-Administered Posttraumatic Stress Disorder Scale (CAPS). In addition, participants answered a brief self-report dietary history questionnaire. No significant differences were found between age groups on the CAPS. Significant differences between age groups in nutritional intake were found, including in protein, vegetable protein, animal protein, fat, animal fat, calcium, iron, saturated fatty acid, total dietary fiber, and cholesterol.

Introduction

Following the 2011 Great East Japan Earthquake, many residents, in particular those of the coastal region, lived in shelters for the first few months after the earthquake [1]. Standards of living were marked by a deterioration in the quantity and quality of food intake [1]. Three and a half years have passed since the Great East Japan Earthquake, with the life of residents recovering to close to pre-earthquake conditions. However, studies investigating the experience of residents have found the nutritional status of residents to be low post-disaster.

The purpose of this study was to investigate women's nutritional status in the coastal region of the disaster area, three years after the Great East Japan Earthquake.

Materials and methods

Participants

The study participants included 145 healthy women volunteers (aged 21–68 years; mean: 47.74 ± 8.78 years). Participants lived in the coastal region of the disaster area immediately after the earthquake up until the time of the study. They were recruited through local newspapers notices. Participants gave written informed consent following explanation of the nature of the study. Neuropsychiatric disorders were screened for using the Mini International Neuropsychiatric Interview (MINI) [2,3]. No participants were found to have a history of neurological or psychiatric illness. All procedures were conducted according to the Declaration of Helsinki. The experimental protocol was approved by the ethics committee of the Tohoku University School of Medicine.

Psychological instruments

All participants were interviewed by trained psychologists using the Japanese version of the Clinician-Administered Post-Traumatic Stress Disorder (PTSD) Scale (CAPS [4,5]). The CAPS is a 22-item scale with three associated features assessing validity, severity, and improvement. The CAPS contains separate 5-point frequency and intensity rating scales (0–4) for symptoms identified with PTSD in the DSM-IV. Nutritional status was evaluated using a brief self-report dietary history questionnaire containing questions about the frequency of consumption of 75 principal foods [6].

Analysis of psychological instruments

Data obtained from the psychological instruments were analyzed using SPSS (Version 21.0, IBM, Armonk, New York). Physical status was compared across age groups using Tukey's multiple comparison test after analysis of variance (ANOVA). Differences in nutrient and food intake between age groups were analyzed using an item-by-item one-way ANOVA. Statistical significance was assessed according to a probability of $p<0.05$.

Results

The age groups of participants are shown in Table 1. The number of participants in their 20s and 60s was relatively low; while the number of participants in their 40s was high. Table 2 shows the CAPS score for each age group. The CAPS score for those in their 60s was higher compared to other age groups. However, the CAPS score was considered low for

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Key words: *great east japan earthquake, post-quake; post-disaster, women's health, nutritional sta*

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Table 1. Age groups of participants.

	Number of people	%
20s	6	4.1
30s	17	11.7
40s	62	42.8
50s	55	37.9
60s	5	3.4
Total	145	100

Table 2. CAPS score by age group.

	CAPS score
20s	3.00 ± 4.69
30s	1.00 ± 3.43
40s	2.39 ± 5.57
50s	1.91 ± 4.04
60s	7.40 ± 4.88

Table 3. Height, weight and BMI by age group.

	Height	Weight	BMI
20s	154.03 ± 3.48	49.62 ± 8.17	20.86 ± 2.97
30s	157.15 ± 5.12	56.85 ± 9.06	23.04 ± 3.60
40s	158.00 ± 4.74	58.04 ± 8.16	23.28 ± 3.36
50s	156.72 ± 5.39	55.26 ± 9.14	22.49 ± 3.47
60s	152.12 ± 3.23	52.40 ± 6.65	22.65 ± 2.79

Table 4. Nutrient and food intake by age group.

	Protein (g/day)	Animal protein (g/day)	Vegetable protein (g/day)	Fat (g/day)
20s	54.42 ± 18.90	30.58 ± 16.11	23.84 ± 7.36	46.27 ± 18.32
30s	55.03 ± 15.50	27.79 ± 9.15	27.24 ± 9.70	43.28 ± 14.57
40s	77.89 ± 28.79	43.27 ± 21.22	34.62 ± 14.49	60.13 ± 20.75
50s	75.18 ± 26.57	42.74 ± 21.20	32.44 ± 8.88	53.50 ± 19.24
60s	75.16 ± 31.81	36.58 ± 21.20	38.58 ± 12.02	53.71 ± 29.82
	Animal fat (g/day)	**Carbohydrate (g/day)**	**Sodium (mg/day)**	**Calcium (mg/day)**
20s	22.04 ± 11.15	204.97 ± 59.07	3273.16 ± 1539.03	347.58 ± 172.25
30s	18.03 ± 6.46	221.60 ± 71.41	3746.98 ± 1003.25	365.48 ± 155.53
40s	28.05 ± 10.59	266.90 ± 92.11	4488.74 ± 1448.89	593.03 ± 236.73
50s	25.20 ± 11.79	239.45 ± 64.42	4272.93 ± 1449.96	610.17 ± 192.80
60s	22.87 ± 17.28	258.46 ± 60.55	4497.70 ± 1696.55	674.33 ± 307.84
	Iron (mg/day)	**ω-3 fatty acid (g/day)**	**ω-6 fatty acid (g/day)**	**Saturated fatty acid (g/day)**
20s	5.92 ± 2.13	2.06 ± 1.23	9.24 ± 4.23	12.34 ± 4.90
30s	6.47 ± 2.46	2.09 ± 0.75	9.12 ± 3.14	11.00 ± 3.96
40s	8.90 ± 3.69	2.82 ± 1.27	11.40 ± 4.55	16.84 ± 5.49
50s	8.78 ± 2.71	2.93 ± 1.31	10.29 ± 3.48	14.45 ± 5.36
60s	10.90 ± 3.31	2.91 ± 1.87	10.68 ± 6.39	13.61 ± 73.68
	Salt equivalent (g/day)	**Total dietary fiber (g/day)**	**Alcohol (g/day)**	**Cholesterol (mg/day)**
20s	8.27 ± 3.91	9.12 ± 3.71	0.00 ± 0.00	300.25 ± 141.85
30s	9.45 ± 2.52	10.66 ± 4.64	6.65 ± 10.27	264.84 ± 102.08
40s	11.33 ± 3.66	14.17 ± 5.89	5.74 ± 10.93	405.02 ± 168.44
50s	10.78 ± 3.66	14.47 ± 4.47	7.85 ± 15.55	375.78 ± 167.87
60s	11.34 ± 4.28	19.45 ± 6.48	0.11 ± 0.25	418.64 ± 202.06

all age groups. Furthermore, there were no significant differences in CAPS scores between age groups (CAPS score: p0.117). Table 3 shows the physical status for each age group. Examination of average height and weight showed no large differences between age groups. Average body mass index (BMI) was within the normal healthy range (BMI18.5 to 24.9 kg/m^2) for all age groups. For height, weight, and BMI, no significant differences were found between age groups (height: p0.052, weight: p0.096, BMI: p0.445).

Table 4 shows nutrient and food (protein, vegetable protein, animal protein, fat, animal fat, carbohydrate, sodium, calcium, iron, ω-3 fatty acid, ω-6 fatty acid, saturated fatty acid, salt equivalent, total dietary fiber, alcohol, and cholesterol) intake for each age group. Intake of the following items differed significantly between age groups: protein (F(4, 140)3.32, p<.05), vegetable protein (F(4, 140)2.49, p<.05), animal protein (F(4, 140)3.07, p<.05), fat (F(4, 140)2.90, p<.05), animal fat (F(4, 140)3.04, p<.05), calcium (F(4, 140)6.52, p<.01), iron (F(4, 140)3.75, p<.01), saturated fatty acid (F(4, 140)4.82, p<.01), total dietary fiber (F(4, 140)4.54, p<.01), and cholesterol (F(4, 140)2.90, p<.05).

Protein intake significantly differed between the 30s and 40s groups (p.017). Animal protein intake was significantly different between the 30s and 40s (p.021) and the 30s and 50s (p.032) groups. Fat intake was significantly different between the 30s and 40s (p.019) groups. Animal fat intake was significantly different between the 30s and 40s (p.009) groups. Calcium intake was significantly different between the 20s and 50s (p.038), 30s and 40s (p.001), 30s and 50s (p.001), 30s and 60s (p.039) groups. Iron intake was significantly different between the 30s and 40s (p.048) groups. Saturated fatty acid intake differed significantly between the 30s and 40s (p.001) groups, while total dietary fiber intake significantly differed between the 20s and 60s (p.011) and 30s and 60s (p.010) groups. Finally, cholesterol intake significantly differed between the 30s and 40s (p.016) groups.

Discussion

The present study sought to measure the nutritional status of women living in the coastal region of the Great East Japan Earthquake disaster area. The CAPS score, as a measure of PTSD, was higher for the 60s age group compared to the other age groups. However, the CAPS scores were low for all age groups, with no subjects assessed as having PTSD. There were no significant differences between age groups on the CAPS. Nutrient and food intake of protein, vegetable protein, animal protein, fat, animal fat, calcium, iron, saturated fatty acid, total dietary fiber, and cholesterol was significantly different between generations.

Although PTSD symptoms decrease over time (from the time of exposure to trauma), symptoms have been shown to persist over long periods [7,8]. In the current study, the CAPS scores of participants were between 0 and less than 20. This result supports the spontaneous (that is, the absence of any kind of intervention) recovery of participants over the three years following the earthquake.

With regard to nutrient and food intake, most were lower for participants in their 20s compared to the other age groups (e.g., protein, calcium, iron, and total dietary fiber). Additionally, nutrient and food intake of participants in their 40s and 60s was higher than the intake of those of other age groups, depending on the nutrient (e.g., the 40s had higher protein, animal protein, fat, animal fat, carbohydrate, ω-6 fatty acid, and saturated fatty acid intake; the 60s had higher vegetable protein, sodium, calcium, iron, salt equivalent, total dietary fiber, and cholesterol intake).

In the following paragraphs, we will discuss protein, calcium, and iron in relation to national averages. The average protein intake of iron for participants in their 20s and 30s was less than Japan's average intake [9] 20s: 67.2 ± 23.5 mg; 30s: 66.8 ± 21.8 mg). Protein is one of the most important components of the human body. When protein is broken down, glucose is produced. When protein intake is insufficient, and stress hormones are continually produced over the long term, the internal protein resolution is enhanced and invites a drop in immunity. Adequate levels of intake must take into account the maintenance of immunity proteins and the necessary compensation due to stress [10]. Previous studies have documented the insufficient protein levels of young women in Japan [11-14]. Although this finding may not be a direct result of the earthquake, it can be said to support the conventional findings mentioned above that were talked about originally.

Calcium plays an important role in the brain. The passing of the electrical signal from neurons to cells occurs through voltage-dependent calcium ion channels, present in the cell membrane nerve cells. Once the electrical signal produced by the cations has flowed through the channels, neurotransmitters, such as acetylcholine and noradrenaline, are released from synaptic vesicles [15]. The difference in calcium intake for participants in their 20s and 60s was about 2-fold (20s: 347.58 ± 172.25mg; 60s: 674.33 ± 307.84 mg). Looking at historical data on calcium intake, the calcium intake of young people has decreased [9]. One of the key explanations for this is considered to be the modern diet of young people, which features excessive consumption [9]. In other words, there are few calcium intakes of the youth. It should also be noted that calcium is connected with stress [16]. Applying the mental stress and physical stress, absorption rate of calcium in the intestinal tract is reduced and cortisol and noradrenaline, which is secreted in times of stress to promote the urinary excretion of calcium.

Iron is a cofactor of many enzymes that participate in the process of energy production [5]. Reduced hemoglobin concentration can lead to iron deficiency, a reduction in the oxygen-carrying capacity of the blood, a decrease in the efficiency of glucose utilization [16]. Iron is also involved in the immune system with the production of antibodies [17,18]. The average intake of iron for participants in their 20s, 30s, and 60s was lower than the national average [9] 20s and 30s: 6.9 ± 2.7 mg; 60s: 8.5 ± 3.3 mg). The intake of iron for all other age groups was higher than the national average (40s: 7.2 ± 2.6 mg; 50s: 7.8 ± 2.8 mg). A study on the Sichuan Earthquake in 2008 reported iron deficiencies in infants and adult women (including pregnant women and lactating women) one year post-disaster [8]. It is difficult to make comparisons between the Sichuan Earthquake study and the current study because of the difference in time elapsed since the disaster. We consider the low levels of iron in young women to be due to factors outside of any direct effects of the earthquake. Given the three-year post-disaster period, the direct effects of the earthquake would have faded. Low levels of iron in young Japanese women may be due to slimming diets. In addition, previous studies suggest that iron-deficiency anemia is common among women of childbearing age [11,12].

The current study has several limitations. First, our sample size was not large enough to sufficiently represent all age groups. In future studies, we will seek to investigate a larger number of people living in the disaster area. Second, the number of factors that we investigated was somewhat limited. Other psychological variables, including health and quality of life, were not featured in the current study and may be looked at through future research.

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Horticultural Therapy as a Means of Psychological Support for Persons with Intellectual Disabilities Living in Disaster Areas

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Three years have passed since the Great East Japan Earthquake. People in the disaster area are gradually recovering; however, some still suffer from earthquake-related stress. Previous studies have suggested that victims suffer various psychological problems that were caused by the experience of being involved in the earthquake [1-6]. The mental health of victims continues to be of concern, because problems can emerge long after a disaster occurs [7-10]. Three years after the earthquake, the general public is a belief that Japan should be engaged in psychological support for victims on a national level. Many people with intellectual disabilities also suffered severe psychological damage, and the provision of psychological support is important for these individuals. Various types of psychological support, including horticultural therapy, were provided immediately after the earthquake.

Horticultural therapy was developed in the United States to provide psychological care and social rehabilitation for disabled soldiers and war veterans diagnosed with Post-Traumatic Stress Disorder (PTSD) following World War II [11]. Previous studies have suggested that horticultural therapy has cognitive [12,13], psychological [14,15], social [16,17], and physical [18] effects. Further, our previous findings indicated that mild PTSD symptoms, depression, and salivary cortisol levels decreased and posttraumatic growth improved with horticultural therapy in women living in the disaster area [19-21]. Several previous studies have examined the use of horticultural therapy for adults and children with intellectual disabilities [22-27]. However, not many have focused on psychological support for earthquake-related problems in people with intellectual disabilities. In this study, we describe a psychological support method using horticultural therapy for people with intellectual disabilities living in the disaster area. We believe that horticultural therapy may reduce anxiety in people with intellectual disabilities. Previous studies reported that people with intellectual disabilities were more prone to anxiety, and the prevalence of anxiety disorders among people with intellectual disabilities was approximately 5–10% [28-31]. These findings suggest that experiencing disasters increased feelings of insecurity in people with intellectual disabilities. Some previous studies have suggested that horticultural therapy reduces anxiety [32-34]. In light of the above evidence, we conducted an exploratory analysis prior to providing full-scale psychological support for people with intellectual disabilities in future.

One facility that treats people with intellectual disabilities in the disaster area agreed to participate in the study and provided a location in which to conduct the intervention. The participants, five adults with intellectual disabilities, were undergoing treatment at this facility and attended horticultural therapy sessions. Horticultural therapy sessions were conducted by one Horticultural Therapist (TS) and seven support staff. The horticultural therapist presented a general lecture and seven support staff assisted the participants. Participants attended three 60 minute horticultural therapy sessions. The program was based on a procedure used in a previous study [19,20]. Specifically, the horticultural therapist described contents of a lecture during the first 20 minutes of the session. Participants spent the remaining time producing potted flower arrangements from flowers and herbs, with the support of support staff. The horticultural therapist observed and evaluated the participants, as the participants found it difficult to reply to questionnaires.

Results showed that the participants were initially indifferent and quiet. However, once they began to pot the plants, all of the participants were smiling and appeared excited once they had completed the potted flower arrangements. They also appeared relaxed when touching the plants. Further, participants took the initiative with respect to the work and became involved in conversations with other participants.

The purpose of this study was to describe a psychological support method that involves the use of horticultural therapy for people with intellectual disabilities living in the Great East Japan Earthquake disaster area. Horticultural therapy was found to be effective and affected the participants positively. However, the study had some limitations, namely, the small sample size and evaluation method. Regarding the sample size, there was only one facility willing to participate in the study in the aftermath of the earthquake. In addition, people with severe disorders were unable to participate in horticultural therapy sessions for the purposes of the study. With respect to the evaluation method, we used observation because the participants found it difficult to reply to questionnaires. However, subjective evaluation may be necessary in future studies.

Based on these results, we plan to offer psychological support to people with intellectual disabilities in disaster areas. However, the provision of full-scale psychological support in disaster areas is a future goal. We will continue to support individuals with and without disabilities with respect to assisting them in achieving psychological health.

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