



ISSN: 0976-3031

Available Online at <http://www.recentscientific.com>

*International Journal of Recent Scientific Research*  
Vol. 6, Issue, 2, pp.2833-2836, February, 2015

*International Journal  
of Recent Scientific  
Research*

## 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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#### ARTICLE INFO

##### Article History:

Received 14<sup>th</sup>, January, 2015  
Received in revised form 23<sup>th</sup>,  
January, 2015  
Accepted 13<sup>th</sup>, February, 2015  
Published online 28<sup>th</sup>,  
February, 2015

##### Key words:

cognitive function, earthquake,  
elderly women, horticultural  
therapy, intervention

#### 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.

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#### 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

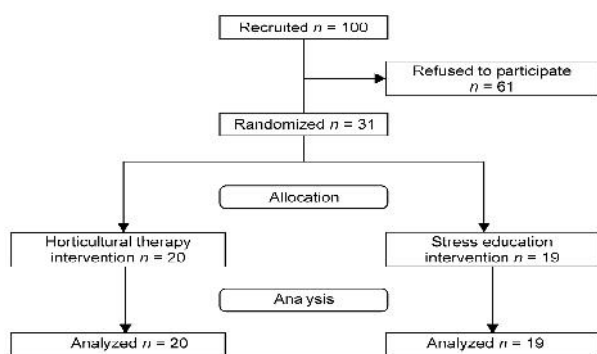
The participants were female residents of the coastal areas of Miyagi Prefecture, aged 60 to 75 years, who experienced the

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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 Kesenuma 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  $\leq 40$ , 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

Measures	HT group (n = 20)				Control group (n = 19)				p <sup>a</sup>
	Pre		Post		Pre		Post		
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.

<sup>a</sup>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.

## Funding

This study was supported by a Grant-in-Aid for Challenging Exploratory Research (KAKENHI 23650103) from the Ministry of Education, Culture, Sports, Science and Technology.

## Acknowledgments

The author thanks Satomi Nishiyama, Ayaka Sato, Mio Sato, Kana Ohkiri, Ayumi Goto, Rei Takamatsu, Mayu Fujita, and Misaki Chiba for assisting with psychological testing. The contributions of Taeko Shishido, a horticultural therapist who provided advice during the development of the intervention program, are also appreciated.

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#### How to cite this article:

Yuka Kotozaki .Effects of horticultural intervention on cognitive function in elderly women of mild ptsd two years after the east japan great earthquake. *International Journal of Recent Scientific Research Vol. 6, Issue, 2, pp.2833-2836, February, 2015*

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