Trauma & Treatment

Short Communication Open Access

Medium- to Long-term Psychological Support for Women Living in Areas Affected by the Great East Japan Earthquake: Empirical Studies on the Impact of Horticultural Therapy

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In the near future, three years will have passed since the Great East Japan Earthquake. Despite the passage of time, several residents living off the Pacific coast of Tohoku continue to suffer from mental and physical repercussions of the event. In other words, numerous survivors of the Great East Japan Earthquake continue to live with emotional trauma and stress. Previous studies suggest that mental health problems among natural disaster survivors are most pronounced within a specified period after the event [1]. Although recovery among survivors is progressing incrementally in the disaster area of Tohoku, one may argue that availability of medium- to long-term psychological care for these people is important. Immediately following the earthquake, our research team provided horticultural therapy as a medium- to long-term psychological support to the survivors. The motivation behind this study is based on previous research suggesting that women are more susceptible to experiencing anxiety in post-disaster environments than men [2], that women are more likely to be diagnosed with Post-Traumatic Stress Disorder (PTSD) than men after experiencing natural disasters [3], and that weak social support is associated with a higher susceptibility to PTSD.

Horticultural Therapy (HT) is a psychological care method for treating PTSD that was developed in the United States for psychological care and social rehabilitation of disabled soldiers and war veterans diagnosed with PTSD following World War II [2]. Previous studies have suggested that HT and exposure to nature can have cognitive [4,5], psychological [6,7], social [8], and physical [9] benefits. Since the earthquake, our research group has reported psychological effects of horticultural therapy on women living in the disaster areas [10,11]. The psychology scores that measured PTSD, post-traumatic growth (PTGI), and intervention group mood improved after horticultural therapy intervention in both studies. Furthermore, the intervention group exhibited improved salivary cortisol levels, an indicator of stress in both studies. In addition, the intervention effect on the intervention group was sustained for a certain period in both groups. These findings suggest that horticultural therapy has an effect on earthquake-related stress symptoms among women living in the disaster area, and that this effect may endure for a prolonged period. However, these studies were not conducted in the disaster areas, but in an experimental format in which intervention participants were studied in research facilities.

Based on these results, we are currently conducting an empirical intervention study in the coastal regions of the disaster areas of Miyagi Prefecture, where earthquake damage was considerable. Currently, the disaster areas of Tohoku are undergoing a period of rebuilding. However, for practical reasons rebuilding has progressed slowly, and limited reproduction within the disaster areas will become a serious future issue as victims move away from the vicinity. The purpose of this study is to understand the effect of horticultural therapy as a means of rebuilding local communities in disaster areas, and to establish a system of horticultural therapy as a regional community support that is available to these communities. This study has recently begun and the results have not yet been obtained; however, in the near future, it will provide information to the current state of knowledge in this field. We believe that HT may prove to be an effective intervention strategy for earthquake-related stress. We hope to spread awareness about HT as a source of psychological support for medium- to long-term natural disaster-related stress.

Acknowledgements

We thank the study participants and all our colleagues at the Institute of Development, Ageing and Cancer and at Tohoku University for their support. In addition, the authors thank Ms. Satomi Nishiyama, Ms. Ayaka Sato, Ms. Mio Sato, Ms. Kana Ohkiri, Ms. Ayumi Goto, Ms. Rei Takamatsu, Ms. Mayu Fujita, and Mr. Misaki Chiba for their assistance with the psychological testing. We also appreciate the contribution of Mrs. Taeko Shishido, a horticultural therapist who provided advice during the preparation of the intervention program. This study was supported by a Grant-in-Aid for Young Scientists (B) (KAKENHI 24730566) from the Ministry of Education, Culture, Sports and Science to Dr. Y. K.

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Received January 03, 2014; **Accepted** February 18, 2014; **Published** February 20, 2014

Citation: Kotozaki Y (2014) Medium- to Long-term Psychological Support for Women Living in Areas Affected by the Great East Japan Earthquake: Empirical Studies on the Impact of Horticultural Therapy. J Trauma Treat 3: 187. doi:10.4172/2167-1222.1000187

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Citation: Kotozaki Y (2014) Medium- to Long-term Psychological Support for Women Living in Areas Affected by the Great East Japan Earthquake: Empirical Studies on the Impact of Horticultural Therapy. J Trauma Treat 3: 187. doi:10.4172/2167-1222.1000187

Kotozaki, J Trauma Treat 2013, 3.1
http://dx.doi.org/10.4172/2167-1222.1000184

Trauma & Treatment

Research Article Open Access

The Psychological Changes of Horticultural Therapy Intervention for Elderly Women of Earthquake-Related Areas

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Abstract

Despite the passage of time, some people who experienced the Great East Japan Earthquake are still living with the emotional trauma and stress. We provided horticultural therapy as an intervention to 39 elderly women with earthquake stress living in the affected areas of the coastal areas of the Great East Japan Earthquake. The participants were divided into two groups, an intervention group (n=20) and a control group (n=19). The intervention group underwent eight weeks of horticultural intervention. On the other hands, the control group underwent eight weeks of stress control education. After two months of horticultural therapy intervention, the Clinician-Administered PTSD Scale (CAPS) total score, Geriatric Depression Scale (GDS) score, the Posttraumatic Growth Inventory (PTGI-J) score, and the WHO Quality of Life 26 (WHO-QOL26) score in the intervention group improved significantly, and salivary cortisol level in the intervention group also improved significantly. After follow up, CAPS score, GDS score, PTGI-J score, and WHO-QOL26 score (psychological QOL score, social QOL score, environmental QOL score, and global QOL score), and salivary cortisol level in the intervention group was improved or almost the same as the post-intervention scores in the intervention group. These findings suggest that horticultural therapy has an effect on the symptoms of earthquake stress in elderly women, and that this effect may sustain.

Keywords: Earthquake; Earthquake-related stress; Horticultural therapy; Intervention; Elderly women

Introduction

The Great East Japan Earthquake that occurred on March 11, 2011 was the earthquake and tsunami of the largest in the earthquake that occurred in Japan. Despite the passage of time, some people living of the Pacific coast of Tohoku have complained about the mental and physical condition such as insomnia and anxiety. This means that some people who experienced the Great East Japan Earthquake are still living with the emotional trauma and stress. Previous studies report that prevalence of Posttraumatic Stress Disorder (PTSD) ranging from approximately 5 percent to 60 percent is seen in the first 1-2 years after a disaster [1,2]. It suggest that mental health problems of survivors are most evident a certain amount of time after a disasters [3]. Additionally, previous studies reported about mental health problems of survivors after a disaster such as a temporary increase in cortisol level [4-7]. The recovery is progressing little by little in the disaster area of Tohoku and it may be said that it is important to medium- to long-term psychological care for the people who live in the disaster area. In this study, as a method of medium- to long-term psychological care for them, we focused on the horticultural therapy.

Horticultural Therapy (HT) is a psychological care method for Post-Traumatic Stress Disorder (PTSD) that was developed in the United States for the psychological care and social rehabilitation of disabled soldiers and war veterans with PTSD symptoms after World War II [8]. HT interventions are led by professionals trained to incorporate the use of plants and horticultural education into rehabilitation therapies [8]. The therapy in a group setting improves the participant's communication skills through collaborative horticultural activities [8]. It has been reported that participants begin to identify with plant growth, regain health and motivation. Through such experiences and their association with nature, participants are thought to experience improvemen [9]. It has mainly been developed for elderly adults and people with disabilities [10,11].

Previous studies suggested that HT and exposure to nature can have cognitive [12,13], psychological [13-17], social [18,19], and physical [20] benefits. It also suggested that HT has a positive effect on physiological factors, such as heart rate and salivary cortisol levels [20]. Previous HT studies have utilized psychological measures and observational data. Recently, the study on the effects of HT for earthquake stress reported by our group [21]. However, the person targeted for the study was an adult woman and was not able to examine the elderly woman. Previous study suggest that women are easy to feel anxiety of post-disaster than men [21] and Women are more likely than men to have PTSD after natural disasters [22-25], and low social support is associated with a higher likelihood of PTSD [26,27]. Other studies reported that the elderly people were more likely to develop PTSD and general psychiatric morbidity compared with the young people [25,28-30]. We performed an experimental study aimed at elderly woman from 60 to 75 years old because there was no study of effect verification of horticultural therapy for elderly woman who live in disaster area. We hypothesize that HT may help elderly women with earthquake-related stress improve their mental and physical functioning affected due to the traumatic experience.

The purpose of this study was to verify the reduction in the symptoms of earthquake-related stress in elderly women who live in disaster areas of the Pacific coast through HT intervention using psychological measures and salivary cortisol level. Additionally, we investigated the effect of HT on the symptoms of earthquake-related

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Received November 30, 2013; **Accepted** December 23, 2013; **Published** December 26, 2013

Citation: Kotozaki Y (2013) The Psychological Changes of Horticultural Therapy Intervention for Elderly Women of Earthquake-Related Areas. J Trauma Treat 3: 184. doi:10.4172/2167-1222.1000184

stress and the maintenance of its effect after a two-month Follow-Up (FU) period using psychological measures and salivary cortisol level.

Methods

Participants

The participants were women aged 60-75 years old who were residents of the coastal areas of Miyagi Prefecture and had experienced the Great East Japan Earthquake of March 11, 2011. They were recruited through newspaper advertisements distributed in the earthquake-affected areas, to which 100 residents of the coastal areas (from Kesennuma City to Watari town) responded. These 100 applicants were screened for PTSD using a combination of the Mini-International Neuropsychiatric Interview (M.I.N.I.) [31,32] and the Clinician-Administered PTSD Scale (CAPS) [33-35]. In the CAPS, the F1/2 method was used for evaluation, with applicants regarded as symptomatic if they scored ≥ 1 on frequency and ≥ 2 on intensity. After the exclusion of 61 applicants who had no PTSD symptoms and a CAPS score of ≥ 40, 39 healthy, right-handed elderly women participated in this study as part of our ongoing project to investigate the associations between brain structure and mental health. All participants who took part in this study also participated in our interventional studies and underwent psychological measures and MRI scans that are not described in this study but were performed together with those described in this study. All participants were diagnosed with a symptom of PTSD on the M.I.N.I., and they had one to two 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 the intervention and FU. This study was approved by the Research Ethics Committee of Tohoku University Graduate School of Medicine after an ethical screening. Informed consent in writing was obtained from the experimental participants before the start of the experiment. The intervention period was from October 2012 to May 2013.

The study was a randomized, open -label assessors are blinded, crossover trial (RCT), and it was registered in the University Hospital Medical Information Network Clinical Trials Registry (UMIN 000008936). Testers are blind to the study's hypothesis and the group membership of participants. The participants were divided into two groups, an intervention group (n=20) and a control group (n=19), by the permuted block method, and the intervention group underwent eight weeks of horticultural intervention followed by an eight-week FU period. The control group underwent eight weeks of stress control education, followed by eight weeks of horticultural intervention (Figure 1). Although the intervention group had a follow-up period after the intervention period, participants were allowed to keep growing plants during the follow-up period because it could have been stressful or created negative emotions, if we required participants to stop their horticultural activities. In addition, this study design used a design same as our previous study [21].

Description of interventions

Horticultural intervention (Intervention group): The HT intervention was designed in collaboration with a horticultural therapist and clinical psychologists. This intervention comprised a total of eight weekly sessions (60 min each) at a university lab and 15 minutes per day at participants' homes. The sessions at a university lab were comprised of interactive lectures and practical horticultural training. 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.

Stress control education intervention (Control group): The SE intervention session was a 60-minute session consisting of a lecture regarding stress education, and it was managed by psychological tester studied psychology in college as a whole-time teacher of this intervention. 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 taught participants about the human body, such as stress mechanisms, psychology, and 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.

Follow-up (Intervention group): At the end of the two-month horticultural intervention, the participants allocated to the intervention group entered a two-month FU period. During this period, they did not receive any specific instructions from the investigators and were asked to lead their normal lives.

PTSD screening: M.I.N.I. and CAPS

In this study, structured interviews, M.I.N.I. and CAPS, were performed by three psychologists who underwent training before carrying out the actual interviews.

Psychological measures: The following questionnaires were administered three times (pre-intervention, post-intervention, and FU): (a) short version of the Geriatric Depression Scale (GDS) [36,37], (b) the Posttraumatic Growth Inventory (PTGI) [38,39], (c) the World Health Organization Quality of Life 26 instrument questionnaire (WHO-QOL26) [40]. We used the Japanese version of these psychological measures.

Saliva sampling

We collected saliva samples from participants to measure the salivary cortisol levels. Distressing psychological stimuli are associated with an increased cortisol level [7,41]. In consideration of the participants' circadian cortisol rhythms, we collected all saliva samples

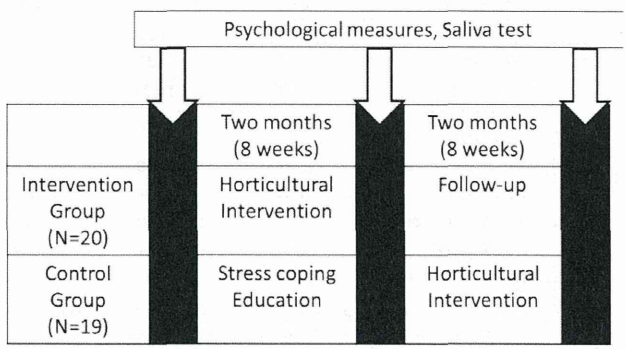

Figure 1: Intervention design.

at 4:00 p.m. on weekdays both before and after the intervention. We selected 4:00 p.m. because humans are less affected by circadian cortisol rhythms at this time of day [42]. Participants were asked to refrain from drinking, eating, and exercising [43] for two hours before saliva sampling. This method was same method as our previous studies [7,21].

Measure of salivary cortisol: To assess physiological stress, we used the same technique to measure salivary cortisol as described in a previous study [7,21]. Saliva samples were collected using the salivette apparatus (Sarstedt, Nümbrecht, Germany). We stored the supernatant solutions in airtight containers at -80°C and measured salivary cortisol using the solutions. We measured salivary cortisol with a semi-microcolumn high-performance liquid chromatography (HPLC) system (Shiseido, Tokyo).

Analytical methods

The 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 the one-way analyses of variance. The one-way analyses of covariance (ANOVA) were conducted with the differences between the 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 intervention and control groups using one-tailed tests ($p<0.05$), in the same manner as in previous studies [7,21].

Moreover, changes in the intervention group were confirmed by the analysis of variance of psychological measure scores and salivary cortisol level at three points (pre-intervention, post-intervention, and FU) using repeated-measures ANOVA. A post hoc analysis was carried out by using the Bonferroni's multiple comparison. The significance was established at a level of $p<0.05$.

Results

Comparison of an intervention group with a control group (Pre vs. Post)

Psychological measures: The demographic and clinical data for the study participants are given in Table 1. The age and Clinician-Administered PTSD Scale (CAPS) scores did not differ significantly between the intervention group and control group. Comparisons of the psychological changes before and after the intervention between the two groups are shown in Table 2. The intervention group was a significant decrease in the post-intervention CAPS score [1,37] ($F= 4.47$, $p<0.05$), and the GDS score ($F[1,37]=5.12$, $p<0.05$) compared with the control group. The intervention group also showed a significantly improve in the post-intervention Posttraumatic Growth Inventory (PTGI)-J total scores ($F[1,37]=6.36$, $p<0.01$), WHO-QOL26 Psychological score ($F[1,37]=5.95$ $p<0.01$), WHO-QOL26 Social score ($F[1,37]=8.96$, $p<0.01$), WHO-QOL26 Environmental score ($F[1,37]=4.46$, $p<0.05$) , and WHO-QOL26 Global score ($F[1,37]=10.98$, $p<0.001$) compared with the control group.

Salivary cortisol level: The results of comparisons of salivary cortisol levels measured pre- and post-intervention are shown in Table 2. The intervention group was a significant decrease in salivary cortisol [1,37] ($F= 4.83$, $p<0.05$), indicating a reduction of stress in this group compared with the control group.

Psychological changes of an intervention group (The effectiveness of HT intervention)

Psychological measures: Changes in the various psychological measures of the intervention group are shown in Table 3. CAPS scores showed that the main effect of time (pre-intervention, post-intervention, and FU) was significant [$F(2,38)=78.73$, $p<0.001$]. The Bonferroni's multiple comparison showed a significant decrease in the post-intervention score compared with the pre-intervention score ($p<0.001$), with the FU score also significantly lower than the pre-

	Intervention group		Control group		
Factor	Mean	SD	Mean	SD	p^a
Age (years)	65.15	3.65	67.21	5.18	0.158
CAPS score	23.50	6.03	21.84	4.83	0.351

[a]One-way analysis of variance.
HT: Horticultural Therapy; SE: Stress Education; SD: Standard Deviation; CAPS: Clinician-Administered Post-Traumatic Stress Disorder Scale

Table 1: Baseline demographic and clinical data of the participants.

	Intervention group				Control group				p^a
	Pre		Post		Pre		Post		
Measures	Mean	SD	Mean	SD	Mean	SD	Mean	SD	
CAPS score	23.50	6.03	6.60	5.25	21.84	4.83	10.63	8.90	0.05
GDS score	3.25	3.37	1.85	2.06	3.11	2.64	3.42	2.67	0.016
PTGI total score	66.35	16.17	75.95	8.06	66.37	14.86	64.26	6.38	0.008
WHO-QOL26 Physical QOL score	3.34	0.44	3.21	0.46	3.23	0.47	3.17	0.39	0.334
Psychological score	3.11	0.30	3.46	0.53	3.04	0.49	2.99	0.62	0.010
Social score	3.37	0.36	3.73	0.55	3.23	0.68	3.02	0.59	0.003
Environmental score	2.92	0.48	3.31	0.48	2.80	0.56	2.72	0.68	0.021
Global score	3.19	0.24	3.43	0.30	3.07	0.39	2.98	0.36	0.001
Salivary cortisol level	2.29	2.45	1.53	1.63	2.49	1.94	3.49	2.28	0.025

[a]One-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; GDS: Geriatric Depression Scale; PTGI: Posttraumatic Growth Inventory; WHO-QOL26: World Health Organization Quality Of Life 26

Table 2: Psychological measures pre- and post-intervention.

	Pre		Post		FU	
Measures	Mean	SD	Mean	SD	Mean	SD
CAPS score	23.50	6.03	6.60	5.25	3.05	4.26
GDS score	3.25	3.37	1.85	2.06	2.10	2.02
PTGI total score	66.35	16.17	75.95	8.06	80.65	7.67
WHO-QOL26 Physical QOL score	3.34	0.44	3.21	0.46	3.20	0.46
Psychological score	3.11	0.30	3.46	0.53	3.59	0.41
Social score	3.37	0.36	3.73	0.55	3.75	0.47
Environmental score	2.92	0.48	3.31	0.48	3.36	0.48
Global score	3.19	0.24	3.43	0.30	3.42	0.30
Salivary cortisol level	2.29	2.45	1.53	1.63	1.66	1.62

HT: Horticultural Therapy; SE: Stress Education; SD: Standard Deviation; CAPS: Clinician-Administered Post-Traumatic Stress Disorder Scale; GDS: Geriatric Depression Scale; PTGI: Posttraumatic Growth Inventory; WHO-QOL26: World Health Organization Quality Of Life 26

Table 3: Psychological changes of Intervention group (Pre, Post, and FU).

intervention score ($p<0.001$) and post-intervention score ($p<0.01$), confirming that this effect was sustained. GDS scores showed that the main effect of time (pre-intervention, post-intervention, and FU) was significant [$F(2,38)=4.65$, $p<0.05$]. The Bonferroni's multiple comparison showed a significant lower in the post-intervention score compared with the pre-intervention score ($p<0.05$), with the FU score also significantly lower than the pre-intervention score ($p<0.05$), confirming that this effect was sustained. PTGI-J scores showed that the main effect of time (pre-intervention, post-intervention, and FU) was significant [$F(2,38)=13.20$, $p<0.001$]. The Bonferroni's multiple comparison showed a significant higher in the post-intervention score compared with the pre-intervention score ($p<0.01$), with the FU score also significantly higher than the pre-intervention score ($p<0.001$) and post-intervention score ($p<0.01$), confirming that this effect was sustained. WHO-QOL26 psychological QOL scores showed that the main effect of time (pre-intervention, post-intervention, and FU) was significant [$F(2,38)=16.10$, $p<0.001$]. The Bonferroni's multiple comparison showed a significant higher in the post-intervention score compared with the pre-intervention score ($p<0.01$), with the FU score also significantly higher than the pre-intervention score ($p<0.001$) and post-intervention score ($p<0.05$), confirming that this effect was sustained. WHO-QOL26 social QOL scores showed that the main effect of time (pre-intervention, post-intervention, and FU) was significant [$F(2,38)=8.70$, $p<0.001$]. The Bonferroni's multiple comparison showed a significant higher in the post-intervention score compared with the pre-intervention score ($p<0.01$), with the FU score also significantly higher than the pre-intervention score ($p<0.01$). WHO-QOL26 environmental QOL scores showed that the main effect of time (pre-intervention, post-intervention, and FU) was significant [$F(2,38)=8.27$, $p<0.001$]. The Bonferroni's multiple comparison showed a significant higher in the post-intervention score compared with the pre-intervention score ($p<0.01$), with the FU score also significantly higher than the pre-intervention score ($p<0.01$). WHO-QOL26 global QOL scores showed that the main effect of time (pre-intervention, post-intervention, and FU) was significant [$F(2,38)=11.43$, $p<0.001$]. The Bonferroni's multiple comparison showed a significant higher in the post-intervention score compared with the pre-intervention score ($p<0.01$), with the FU score also significantly higher than the pre-intervention score ($p<0.01$).

Salivary cortisol level: Changes in salivary cortisol level in the intervention group are shown in Table 3. The main effects was significant [$F(2,38)=3.31$; $p<0.05$]. The Bonferroni's multiple comparison showed that the post-intervention cortisol level was significantly lower than the pre-intervention cortisol level ($p<0.05$).

Discussion

The purpose of this study was to verify the reduction in the symptoms of earthquake-related stress in elderly women who live in disaster areas of the Pacific coast through HT intervention using psychological measures and salivary cortisol level, and to investigate the effect of HT on the symptoms of earthquake-related stress and the maintenance of its effect after a two-month follow-up period. The present study revealed that HT intervention affected the psychological changes and salivary cortisol level in elderly women with earthquake-related stress and psychological effects remain effective over a period. These results are consistent with our hypothesis that HT may help elderly women with earthquake-related stress improve their mental and physical functioning affected due to the traumatic experience.

The intervention group showed improved CAPS scores, indicating that HT reduced PTSD symptoms. Also, this effect is sustained for a certain period. This finding was similar results to a previous study [21] and will extend the previous findings of the effect of HT on severe PTSD, by showing its efficacy with elderly women with earthquake-related stress.

In the results of other psychological measures, the intervention group was improved GDS score, PTGI-J total scores, WHO-QOL26 score (psychological score, social score, environmental score, and global score), and salivary cortisol levels after HT intervention, indicating that HT reduced stress levels. This finding was related to salivary stress level are consistent with previous studies [20,21,44]. The intervention group showed improved GDS scores, indicating that HT decrease elderly depression. There are several HT studies for the elderly depression [45-47] and these studies reported that HT may reduce depression and stress. By our result, GDS score of intervention group decreased after HT intervention and GDS score almost sustained after FU. In other words, it is believed that HT is a method to improve a depression.

The intervention group showed improved PTGI-J scores, indicating that HT increased Posttraumatic Growth (PTG). The result of our previous horticultural intervention study reported PTGI total score in intervention group was improved and there is persistence of the effects for a certain period [21]. Previous study of PTG process suggests that people suffer emotional pain due to disruptions of their personal growth resulting from traumatic experiences[51]. However, people use PTG to cope 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 [48,49]. Previous study suggests that horticulture activity involves instinctive and creative action and leads to improvement of humanity [50]. Taking into consideration the factors mentioned above, it may be said that PTG and horticulture share a key feature. We think that participants of this intervention felt their own growth overlap with the growth process of the plant while cultivating the plants during two months. Additionally, this effect is sustained after FU periods. We also think that the result of PTG was reflected a psychological effect because horticulture work in our HT intervention was included fulfillment, pleasure, challenges, and a sense of accomplishment using plants such as flower and seedlings.

The intervention group showed improved WHO-QOL26 scores (psychological QOL score, social QOL score, environmental QOL score, and global QOL score) indicating that HT increased QOL.

Previous studies suggest that HT improve QOL [51-53]. In our study, WHO-QOL26 physical QOL score did not have the change by the HT intervention. However, psychological QOL score, social QOL score, environmental QOL score, and global QOL score was significantly improve by HT intervention and these effects was sustained after FU periods. We think that the raising of the plant make challenging in everyday life and communication with the people around one. Additionally, we think the raising of the plant produces different changes life and the synergy that imposed by a plant improved the QOL.

The intervention group showed improved salivary cortisol levels, indicating that HT reduced stress. This finding was similar results to a previous study [20]. Cortisol is popular as indicator of psychological and physiological stress and salivary cortisol levels increase in people with PTSD symptoms. By this result, salivary cortisol levels in intervention group was significantly decreased after HT intervention, and salivary cortisol levels did not change after a follow-up compared to the post-intervention. We think that the reduction of salivary cortisol level reflects that HT improve stress condition because the score of CAPS and GDS that used to measure stress-related psychological changes was improved after HT intervention and these effects is sustained after FU. For all of these reasons, the results of our present study suggest the possibility of HT as an effective intervention against the earthquake-related stress.

The major limitation of this study was the small sample size. In the results of analysis of variance (ANOVA) for sensitivity, the effect size of this study was 0.45 and power was 0.8, and α err prob was 0.05. Therefore, a possible future direction would be to replicate and extend the results of current study with larger sample and a lighter (more casually controlled) trial design.

In conclusion, this study suggests that HT improve earthquake-related stress such as depression of elderly women who live in disaster area of the Great East Japan earthquake and the psychological effects of HT was sustained. We believe HT may be able to suggest the possibility is one of the effective interventions for earthquake-related stress. We hope that it spread HT as a psychological support over the medium to long term in the natural disaster areas.

Acknowledgements

We thank study participants and all of our colleagues in Institute of Development, Ageing, and Cancer and in Tohoku University for their support. In addition, the authors thank Ms. Satomi Nishiyama, Ms. Ayaka Sato, Ms. Mio Sato, Ms. Kana Ohkiri, Ms. Ayumi Goto, Ms. Rei Takamatsu, Ms. Mayu Fujita, and Mr. Misaki Chiba for assisting with psychological testing. We also appreciate the contribution of Mrs. Taeko Shishido, a horticultural therapist who provided advice during the preparation of the intervention program. This study was supported by a Grant-in-Aid for Young Scientists (B) (KAKENHI 24730566) from the Ministry of Education, Culture, Sports, and Science to Dr. Y.K.

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Citation: Kotozaki Y (2013) The Psychological Changes of Horticultural Therapy Intervention for Elderly Women of Earthquake-Related Areas. J Trauma Treat 3: 184. doi:10.4172/2167-1222.1000184

Psychological Effects of the Great East Japan Earthquake: Posttraumatic Stress, Psychological Effects and the Cortisol Levels in Women Who Live in the Coastal Disaster Areas

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Abstract— **The Pacific side of northeast Japan was devastated by the seismic activity and resulting tsunami generated from the Great East Japan Earthquake in 2011. People living in the coastal disaster areas witnessed firsthand the danger of the tsunami and subsequent horrible sights and were more shocked than people living inland of the disaster area. This study attempts to reveal the psychological effects of these experiences on women living in the coastal areas, using psychological measures and salivary cortisol levels, 6 months after the earthquake. We anticipate that this study will provide a better understanding of posttraumatic responses to the earthquake and tsunami in the early stages of adaptation and to effectively expand prevention strategies and countermeasures for posttraumatic stress disorder (PTSD). Fifty-four right-handed women with mild PTSD who were living in the disaster area participated in this study. Six months after the earthquake, all subjects completed PTSD screening using the Clinician-Administered PTSD Scale (CAPS), then they completed psychological measures and collected saliva samples. We used the following psychological measures to investigate psychological effects: the quality of life, psychological distress, physical symptoms and depressive symptoms. The results showed that the loss group had significantly lower lifestyle evaluations after the earthquake than the non-loss group. They had significantly lower scores of psychological health, social relationships and the environment subscale of the WHO-QOL26 than the non-loss group. In addition, the loss group had significantly higher salivary cortisol levels than the non-loss group. Moreover, in the loss group, the physical health scores of the WHO-QOL26 were significant negative correlations with salivary cortisol levels. Also, the psychological scores of the WHO-QOL26 were significant negative correlations with the salivary cortisol levels. The novelty of this study is that there are identified the psychological effects on women with mild PTSD derived from natural disasters such as earthquakes. Our results demonstrate that several psychological stressors related to the survivors' QOL induced by the disaster are associated with increased salivary cortisol levels. The findings that the physical health scores and the psychological health scores of the WHO-QOL26 in the loss group were low indicate that the conditions of the components of these domains are worst. Based on these results, we propose strongly that the immediate psychological and social support for women with loss experience is necessary.**

Keywords: Earthquake, Disaster area, Women, Loss experience, Psychological effect

I. Introduction

The Pacific Coast regions of the Tohoku area suffered significantly from the Great East Japan Earthquake that occurred on March 11, 2011. Particularly, the coastal areas of Miyagi, including Kesennuma, Ishinomaki and Minamisanriku, were destructive damage by the earthquake and tsunami. In the aftermath of the earthquake, the affected people were damaged both physically and psychologically. Two years have passed since the earthquake, the region continues to fight intermittent aftershocks. Many researchers have studied the mental health and physical changes that occur in survivors after serious events [1–5]. Previous studies have suggested that survivors' mental health problems are most evident after a certain amount of time following a disaster [6], and have also suggested that prevalence rates of posttraumatic stress disorder (PTSD) ranging from approximately 5% to 60% are seen in the first one to two years after a disaster [7–8]. Other previous studies have reported that depending on individual differences and the type of disaster, the rate of psychiatric disorders among survivors either decreases after

Manuscript received February 18, 2013; revised and accepted March X, 2013.

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the second year or is prolonged and becomes chronic [5,6,9–10]. In the case of the Great Hanshin-Awaji Earthquake of 1995, many survivors damaged mentally and physically by the earthquake and many of they had the problem of some mental health. [11]. Some survivors of the Great East Japan Earthquake is still suffering from trauma by this disaster.

Chronic stress responses involve actual physiological changes to body systems and organs, also there are been paid to acute physiological stress responses. It has been suggested that such physiological changes may subsequently lead to chronic stress responses [12]. PTSD, which develops under intense stress conditions, is associated with behavioral and physiological pathologies, including disruption of the hypothalamic–pituitary–adrenal (HPA) axis [13]. The HPA axis mediates physiological stress responses and the secretion of the stress hormone cortisol [14]. Cortisol is an indicator of psychological and physiological stress and can be used to examine PTSD pathophysiology [15]. Previous studies have shown that the cortisol levels are high when people feel heavily stressed; this symptom of PTSD can result from events including but not limited to earthquakes, war, accidents, abuse and radioactive damage [16–18]. During the Hanshin-Awaji Earthquake, for example, people with severe PTSD were found to have significantly higher cortisol levels than those without PTSD [2]. Cortisol can be extracted from blood, urine and saliva. The use of sampling via saliva collection has attracted attention as a less stressful and invasive method of estimating the cortisol levels compared to other methods of extraction [19–22]. In particular, the salivary cortisol levels have been reported to reflect unbound blood cortisol, and a very high correlation has been reported between the plasma and salivary cortisol levels [21–23]. Also, cortisol production has a circadian rhythm [24]. The cortisol levels peak in the early morning and drop to their lowest concentration at night [25]. In addition, the cortisol levels increase independently of the circadian rhythm in response to stress [26]. Several studies of the psychological effects on survivors induced by natural disaster have been performed thus far [27]. The subjects of these studies included both men and women [28–31], only men [1, 32–33] and children [34–37]. However, there is very little study focusing only women by natural disaster. Previous studies between men and women suggest that women are more likely than men to have PTSD in addition to high levels of anxiety and anxiety disorders after natural disasters [27, 31, 37–41]. However, there have been few reports on psychological effects of women induced by the East Japan Great Earthquake. We therefore focused on this point. We believe that the information obtained in this study will be useful for providing support at the time of disasters in Japan, especially for women. The purpose of this study was to investigate psychological effects in women who live in the disaster area through the use of psychological and biochemical data collected six months after the earthquake, particularly comparing women who lost a member of their household and/or a relative and those who did not. We hypothesized that the psychological conditions of the women who lost a relative would be poor compared with those of women who did not.

II. Materials and Methods

A. Subjects

Fifty-four healthy, right-handed women participated in this study as part of our ongoing project to investigate the associations between brain structure and mental health. All subjects who took part in this study also participated in our interventional studies and underwent psychological tests and MRI scans that are not described in this study but were performed together with those described in this study. The subjects were recruited using a newspaper advertisement. With regard to the ability of subjects to make judgments, one of the criteria applied during open recruitment was that candidate was to have no past medical history, including treatment or hospitalization for mental illness. The mean subject age was 43.4 years (standard deviation [SD], 8.8). All subjects were survivors of the Great East Japan Earthquake of March 11, 2011 and were living in the disaster area at the time of study. The subjects lived in cities that were devastated by the disaster, including Ishinomaki, Onagawa and Higashi-Matsushima in Miyagi Prefecture. The majority of the subjects were married (96.3%). Only eight people (14.8%) lived alone, while 46 (85.2%) lived with their spouse or relatives. In terms of damage from the earthquake, 17 people (31.5%) lost their homes (completely destroyed), 19 people (35.2%) sustained damage to their homes (semi-destroyed) and 20 people sustained slight damage to their homes. People with completely destroyed or semi-destroyed homes lived in rental houses in other areas, relatives' homes or temporary houses. Furthermore, 22 people (40.7%) lost members of their households and/or relatives.

During the PTSD screening, a clinical psychologist reviewed the candidate's condition using an interview. When any candidate showed even the slightest sign of an abnormal condition, the clinical psychologist consulted a doctor of psychosomatic medicine who was a member of the research project to decide whether to exclude the subject from participation. Having taken such measures, the subjects of this study were considered to be subjects with the capacity to give consent and render judgment. The subjects were verified as having no neuropsychiatric disorders via the Mini-International Neuropsychiatric Interview (MINI) [42, 43] as a check of their competence to give consent. We used the CAPS to assess whether the volunteers had PTSD [44-46]. The CAPS scores were divided into the following categories: 0–19 (asymptomatic/ few symptoms), 20–39 (mild PTSD/sub-threshold), 40–59 (moderate PTSD/above threshold), 60–79 (severe PTSD symptoms) and ≥80 (extreme PTSD symptoms). Trained psychologists (A.O., N.A., M.S., N.S., S.T. and Y.W.) administered the Japanese version of the CAPS [46] to all subjects in structured psychiatric diagnostic interviews to screen for posttraumatic stress symptoms. Consequently, all subjects were diagnosed with mild PTSD via the M.I.N.I and the CAPS. The M.I.N.I. and CAPS were administered before examination. Subjects answered to the face sheets a household member and/or relative perished in the earthquake and those who did not. After that, they were assigned to the loss group and the non-loss group. The number of subjects in the loss group was 22 (mean age: