

Relationship between post-traumatic growth and symptoms of post-traumatic stress disorder a long time after a volcanic disaster

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Background: Mt. Unzen-Fugendake, located in southwestern Japan, began erupting in November 1990. Forty-three people were killed in the 1991 pyroclastic flow. The eruption lasted for 6 years, and approximately 11,000 people, or about 25% of the population, were forced to live in shelters, some for up to 10 years. **Aim:** This study was conducted 25 years later to investigate the relationship between post-traumatic stress disorder (PTSD) symptoms a long time after a disaster and the evacuation period. **Methods:** In 2015, a questionnaire survey was conducted. The 12-item General Health Questionnaire (GHQ-12), Impact of Event Scale-Revised (IES-R), and Post-Traumatic Growth Inventory-Short Form (PTGI-SF) were distributed to residents affected by the disaster and collected by mail. **Results:** In total, 300 responded to the survey, and 278 of whom provided complete answers and were included in the analysis. The mean evacuation period was 35.8±27.9 months. The percentage of those with a high score on the IES-R was 11.5%, which is higher than the general population, and the mean PTGI-SF score was 18.09. Injury to family members and the need to evacuate were related to PTSD and post-traumatic growth (PTG). **Conclusion:** PTSD symptoms were still apparent 25 years after the disaster. The length of the evacuation period at the time of the disaster was significantly related to the appearance of PTSD symptoms. PTG was similarly affected by the length of the evacuation period. These findings suggest the need to continue measures and support with a longer perspective to support residents after a disaster.

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Introduction

Mt. Unzen-Fugendake in Nagasaki Prefecture, Japan, resumed eruptive activity in November 1990, after about 200 years of dormancy. A large-scale pyroclastic flow occurred in June 1991, resulting in a catastrophe that killed 43 people. The disaster continued until 1996, with up to 11,000 people, or about 25% of the population, being forced to evacuate their homes to live in shelters over the long term. The Department of Neuropsychiatry in the School of Medicine at

Nagasaki University cooperated with a community health center, the local government, and the Nagasaki Prefectural government to provide mental health support activities to for people affected by this disaster, and since that time, we have been conducting follow-up surveys.¹⁻³

In our previous studies, we clarified the impact of the volcanic disaster on residents.

For example, in November 1990, we examined the secular change in scores on the 30-item General Health Questionnaire (GHQ-30).⁴ In a comparison of the first survey in

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November 1991 with the fifth survey in November 1999, Ohta et al. showed that the percentage of residents who scored >8 points on the GHQ-30 (the high score group) decreased from 75% to 29%, indicating that almost one-third of the residents were still experiencing negative effects from the disaster. Thus, it appeared that psychological and mental factors remain even 8 years after a large disaster. Mean scores on the GHQ-30 for “anxiety, tension, and insomnia” significantly improved over 8 years.³ However, the score for “interpersonal relationship impairment” had significantly worsened. These findings clearly suggested that a continuous regional survey would be meaningful, even long after a disaster, and that the use of mental health measures needs to be continued. The purpose of this study was to examine how various situations at the time of disaster have affected the mental state of victims after 25 years. In particular, we investigated the relationship between the length of the evacuation period after the disaster and symptoms of post-traumatic stress disorder (PTSD) at the time of this survey. People who had to evacuate for >12 months were classified as “yes” in regard to the need to evacuate. In addition, we examined post-traumatic growth (PTG). To the best of our knowledge, this is the first paper to examine PTG scores in association with the evacuation period.

Methods

The target sample involved residents of Shimabara city and Minami-Shimabara city, the former evacuation area, who were forced to evacuate at the time of the disaster. The target age was at least 31 years at the time of the survey. The reason for setting a target age is because it assumes a person who is at least in the first grade of elementary school at the start of the eruption would have a memory of the disaster. We conducted a questionnaire survey that included the following scales: the General Health Questionnaire 12-item version (GHQ-12)⁴ to evaluate general mental health; the Impact of Event Scale-Revised (IES-R)^{5,6} to screen for symptoms of PTSD; and the Japanese version of the Post-Traumatic Growth Inventory-Short Form (PTGI-SF)⁷ to assess elements of PTG. The PTGI-SF consists of 10 items and the following five subscales: 1) Relationship with others (two items); 2) New possibilities (two items); 3) Human strength (two items); 4) Spiritual transformation (two items); and 5) Appreciation for life (two items). In addition to these three major scales, the questionnaire included the situation at the time of the disaster and subjective health level, the degree of subjective stress at the time of the disaster, and a simple depression scale with two items at the time of the survey.

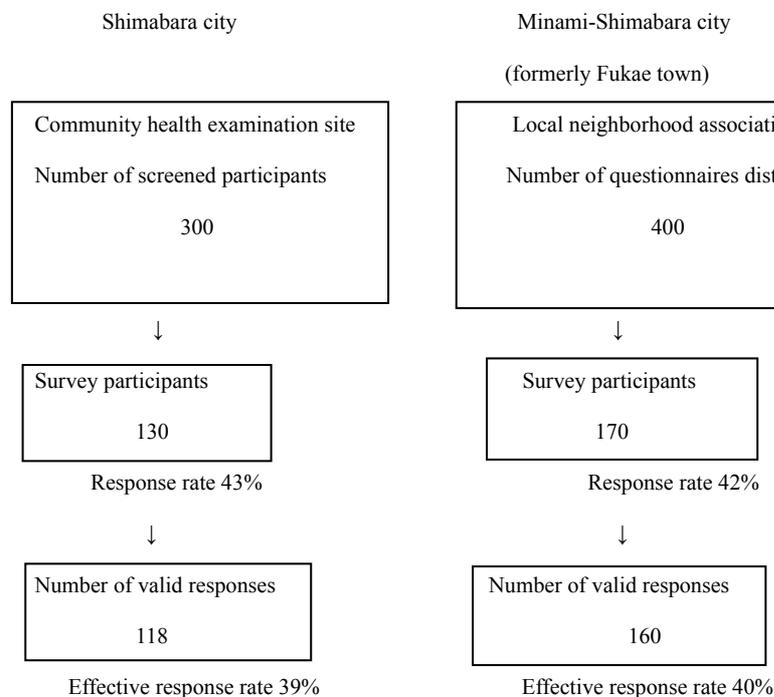


Figure 1. Flowchart of the selection process

In Shimabara City, participants were gathered at venues for health check-up in the former disaster area. In Minami-Shimabara city, participants were gathered through a neighborhood association. Both have a recovery rate of 42-43%, the effective response rate was 39-40%, which was not a significant difference.

The questionnaires were distributed at the local health examination site in Shimabara city and each house through the town association in Minami-Shimabara city. (Fig.1).

The questionnaires and consent forms were collected by hand or by mail. It is assumed that this questionnaire was usually completed over a period of about 20 min. All items, such as the length of the evacuation period and the degree of stress during the disaster, were described subjectively based on the memory of the respondent. This study was approved by the Nagasaki University Medical Ethics Committee (approval No.15062650). We did our best to give due consideration to the privacy and psychosocial impact of the study on the participants. The questionnaires and consent forms were kept separate, and the anonymity of the respondents was protected.

Data analysis

We conducted a series of Mann-Whitney U tests between personal situations at the time of the disaster and psychiatric conditions 25 years later. Then, we conducted a series of Mann-Whitney U tests between PTGI subscale scores and related mental evaluation items. The Mann-Whitney U test is used to compare groups of subjects with a non-normal distribution. We conducted this test to compare the situation at the time of the disaster, e.g., whether there is a significant difference in the distribution of psychological tests, such as the IES-R and GHQ, between the group with and without housing damage. We also compared whether there was a significant difference in the average scores on psychological tests, such as the IES-R and GHQ, in regard to the situation at the time of the disaster, between the two groups with and without housing damage. The evacuation period (in months) was calculated based on the subjective memory of the respondent and entered in units of months and years. All statistical analyses were conducted using SPSS (version 25; IBM, Tokyo, Japan). In the main analysis, $P < 0.05$ by the Mann-Whitney U test, which is a nonparametric test, was considered to indicate statistical significance.

Results

Responses were received from 300 residents during the survey period from June to the end of November 2015. A flowchart of the participant selection process is shown in Fig.1.

Of these responses, 278 contained complete answers to all

questionnaire items and were included in the analysis (133 men, 145 women; mean age, 65.3 ± 11.35 years). Table 1 shows the demographic characteristics of the participants. Table 2 shows the experience of the participants at the time of the disaster and the relationship between each of the findings and the participants' situation at the time of the disaster.

The homes of 141 (51%) participants sustained some type of damage. The degree of subjective stress that participants felt at the time of the disaster was classified as follows: 66 (23%) felt quite serious stress, 91 (33%) felt serious stress, 77 (28%) felt a little stress, and 44 (16%) felt no stress. Therefore, 56% of the participants were under strong stress conditions at the time of the disaster. People who had to evacuate for >12 months were classified as "yes" in regard to the need to evacuate. The mean evacuation duration was 35.8 ± 1.67 months (median: 39 months, range: 0-120 months). The mean IES-R score was 10.86 points, with 32 (11.5%) respondents having a high score (>25 points). The mean value of the total score on the GHQ-12 was 11.7 points, with 26 (9.4%) respondents being classified into the high score group (>4 points). The mean PTGI-SF score was 18.09 points (median: 17.05 points, range: 0-50 points).

The degree of individual subjective stress influenced the scores on all three scales, but the length of the evacuation period only influenced scores on the IES-R and PTGI-SF. The degree of housing damage was associated with higher IES-R and lower PTGI-SF scores.

We also examined the relationship between the PTGI-SF subscales and the IES-R and GHQ-12. The mean and median scores for the subscales of the PTGI-SF were as follows: Relationship with others, mean 4.36 points, median 4.0 points; New possibilities, mean 3.48 points, median 3 points; Human strength, mean 3.60 points, median 3 points; Spiritual transformation, mean 2.23 points, median 2 points; and Appreciation for life, mean 4.41 points, median 4 points. Here, the mean refers to the arithmetic mean, and the range for all medians was 0-10.

Relatively high scores were observed for Relationship with others and Appreciation for life, whereas a relatively low score was observed for Spiritual transformation.

Table 3 shows the correlation results between the ratio of participants with high IES-R scores, high GHQ-12 scores, and high scores on the PTGI-SF subscales. In terms of IES-R scores, four of five subscales showed significant results; the only subscale with non-significant findings was New possibilities. None of the results regarding the GHQ-12 subscale scores were significant. PTGI-SF scores at 25 years after the disaster indicated the participants' current mental health, and were significantly related to IES-R scores, which

indicate the degree of PTSD. PTGI-SF scores were not related to GHQ-12 scores.

Depressive mood, one of the current criteria for depression as assessed on a simple depression scale with two items, was significantly associated with four items other than new possibilities. Spiritual transformation and appreciation for

life were associated with loss of interest as assessed using a simple depression scale with two items. Statistically, when the evacuation period was longer than 12 months, the Mann-Whitney rank sum test showed a significant correlation with the IES-R total score ($P = 0.01$).

Table 1. Demographic characteristics of the participants (November 2015)

	N (%)	Age mean (SD)	Male N (%)	Mean length of evacuation (SD)	IES-R mean (SD)	GHQ-12 mean (SD)	PTGI-SF mean (SD)
Shimabara	118 (42.4)	69.95 (8.88)	51 (43.2)	17.7 (23.2) month	7.65 (7.6)	0.63 (1.2)	16.97 (11.8)
Minami-shimabara	160 (57.6)	61.96 (11.8)	82 (51.2)	49.1 (23.2)	13.23 (13.9)	1.56 (3.2)	18.9 (12.7)
Total	278 (100%)	63.35 (11.3)	133 (47.8)	35.8 (27.9)	10.86 (12)	1.17 (2.6)	18.1 (12.4)

Footnotes

IES-R: Impact of Event Scale-Revised

GHQ-12: The 12-item General Health Questionnaire

PTGI-SF: Post-Traumatic Growth Inventory-Short Form

SD: Standard deviation

Table 2. Relationship between psychological rating scales and situation at the time of the disaster

	Yes	No	Total IES-R score 10.86 (11.9) Mean (SD)	Total GHQ-12 score 1.17 (2.57)	Total PTGI-SF score 18.09 (12.37)
Medical Treatment	28 (10%)	250 (90%)	$P=0.01$ *	0.02 *	0.07
Death of family members	11 (4)	267 (96)	0.98	0.83	0.53
Injury of family members	14 (5)	264 (95)	0.02 *	0.61	0.14
Death of friends and acquaintances	49 (18)	229 (82)	0.13	0.47	0.01 *
Injury of and friends acquaintances	15 (5)	263 (95)	0.01 *	0.01 *	0.61
Damage to home	137 (49)	141 (51)	0.01 *	0.31	0.04 *
Degree of stress	156 (56)	121 (44)	0.01 *	0.01 *	0.04 *
Evacuation period ※ 1	Long 228 (82)	Short 50 (18)	0.01 *	0.57	0.09

Data are expressed as N (%)

IES-R: Impact of Event Scale Revised, GHQ-12:12-item General Health Questionnaire, PTGI-SF: Post-Traumatic Growth Inventory-Short Form

※ 1 Long evacuation period : Long as over 12 months. * $P<0.05$ (Mann-Whitney U test).

Table 3. Relationship between PTGI subscale scores and related mental evaluation items

Item	High IES-R score	High GHQ-12 score	Depressive mood +	Loss of interest +	
	group	group	group	group	
	Mean (SD)	N (%),P)			
1.Relationship with others	4.36 (3.05)	32 (11.5, 0.04 *)	26 (9.4, 0.69)	55 (19.8, 0.01 *)	46 (16.5, 0.58)
2.New possibilities	3.48 (2.93)	32 (11.5, 0.23)	26 (9.4, 0.76)	55 (19.8, 0.8)	46 (16.5, 0.52)
3.Human strength	3.6 (2.88)	32 (11.5, 0.02 *)	26 (9.4, 0.79)	55 (19.8, 0.01 *)	46 (16.5, 0.73)
4.Spiritual transformation	2.23 (2.37)	32 (11.5, 0.04 *)	26 (9.4, 0.06)	55 (19.8, 0 *)	46 (16.5, 0.01 *)
5.Appreciation for life	4.41 (2.96)	32 (11.5, 0.01 *)	26 (9.4, 0.25)	55 (19.8, 0 *)	46 (16.5, 0.05 *)

Data are expressed as N (% , P)

PTGI: Post-Traumatic Growth Inventory

IES-R: Impact of Event Scale Revised

GHQ-12: 12-item General Health Questionnaire.

Depressive mood and loss of interest are each based on answers to two-choice questions.

*P<0.05 (Mann-Whitney U test).

Discussion

To our knowledge, this study is one of only a few that have assessed PTG in the community at >20 years after the occurrence of a natural disaster.^{8,9} In addition, this is the first paper aiming to examine the relationship between duration of the evacuation period and the occurrence of PTG. It is easy to assume that stress will be alleviated and mental symptoms will gradually improve with the passage of time after a disaster. However, as reported Ota et al.,³ mental symptoms can remain for years after a disaster, and mental health measures used by local administrations are needed to help residents deal with these symptoms. PTG in this survey was based on the results of collecting and aggregating positive movements in mental health after going through a difficult period. A previous study noted the relationship between PTG and resilience.⁸ The PTGI assesses PTG, which is a previous study noted a relationship between PTG and resilience.⁸ The PTGI assesses PTG, which involves positive psychological changes reported by people who have experienced a traumatic event. Nishi et al.¹⁰ examined the correlation between PTGI and PTSD in 118 victims in Japan at 18 months after experiencing a traffic accident, and found that PTGI was correlated with all items of the IES-R, and especially with avoidance symptoms. In this study, PTGI scores were also significantly correlated with IES-R scores. Although Jin et al.¹¹ reported that PTGI scores tended to be higher in women, no sex-related effects were observed in this study.

Cann et al.¹² reported that the PTGI-SF accurately reflects the five factors of PTG based on only 10 items. In a questionnaire survey targeting medical students who experienced

the Great East Japan Earthquake, Taku et al.⁷ compared PTSD and PTG and stated that confusion, anger, and sadness after the disaster helped to predict the PTG score over time. Kaye et al.¹³ examined the effects of medical student's volunteer activities during that disaster on their lives 8 years later using the PTGI and Connor-Davidson Resilience Scale. Volunteers continued to show greater PTG as well as greater overall resilience. Based on our findings, the PTGI-SF, like the IES-R and GHQ-12, appears to be useful for assessing stress a long time after a disaster.

Limitations

This study had several limitations. First, there was no control group because we only surveyed residents in the evacuation area and compared findings based on length of the evacuation period. This research was based on the assumption that the longer the evacuation period, the stronger the mental distress and economic impact. Second, after 25 years, the respondents' memories of the situation at the time of the disaster may not be accurate.

Although deaths and transfers have occurred during the last 25 years, it is difficult to measure population migration accurately for those in the targeted age cohort. For reference, the change in population in the target area was as follows: the population of Shimabara city decreased by 21% between 1990 and 2015, from 56,903 to 44,928, respectively. The population of the affected area, Minami-Shimabara city (formerly known as Fukae town), decreased by 11% between 1990 and 2015, from 8,422 to 7,456, respectively, and in both areas, the population continues to decrease. For this study,

the survey for residents of Shimabara city was conducted at a health check-up site, and that for residents of Minami-Shimabara city at a neighborhood association. For this reason, the exact difference in recovery rates between the two regions cannot be compared.

Therefore, our assessment of stress may have underestimated the actual amount experienced. Finally, it is possible that the participants had been affected by other disasters in the area, such as heavy rains and earthquakes. However, the experiences of these events would have been similar for almost all residents, as most of them were living in the same area.

Conclusion

We examined the possibility of increased PTSD and PTG if the evacuation period after a natural disaster is prolonged. Both PTSD and PTG appear to last a long time after a disaster. PTSD symptoms and PTG still exist even 25 years after a disaster. Therefore, to support residents who experience a disaster, it is necessary to develop measures and types of support with a long-term perspective.

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Disclosure statement

The authors declare no conflicts of interest.

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