[Environmental Health and Preventive Medicine 6, 165–169, October 2001]

Original Article

Seismic Intensity and Mental Stress after the Great Hanshin-Awaji Earthquake

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Abstract

Objective: For 1,361 victims of the Great Hanshin-Awaji Earthquake, to evaluate the usefulness of seismic intensity information for mental health activities, we examined the quantitative relationship between experienced seismic intensity and earthquake-related life events or mental health.

Methods: Questionnaires were administered concerning seismic intensity, life events and mental health to the victims.

Results: The incidence of serious life events, such as death of a close family member and mental disorders were higher in areas of high seismic intensity than in low-intensity areas. Victims who experienced intensity 7 (Japan Meteorological Agency) scored 11 or more on the Modified Mercalli (MM) scale, perceived more depressive symptoms [odds ratio (OR) 2.11, 95% confidence interval (95% CI), 1.49–2.98)] and lower mental health status (OR 1.87, 95% CI 1.34–2.61) than those who suffered intensity 4 or less, who scored 7 or less on MM scale after controlling for various sociodemographic factors.

Conclusions: Higher seismic intensity was associated with each severe life event and ill mental health among earthquake victims.

Key words: earthquake, stress, life event, depression, mental health

Introduction

In Japan, much attention is paid to Japanese Meteorological Agency (JMA) seismic intensity data, which is scaled according to the likelihood of earthquake damage. At present, minutes after the occurrence of an earthquake, its magnitude, epicenter, and seismic intensity in each area are reported by the disaster prevention administration in municipalities or broadcast by the national media such as television or radio via the Automated Data Editing and Switching System (ADESS) at the JMA[1)]. Seismic intensity information has been used for formulating initial plans to cope with disasters such as determination of the advice to give survivors of victims and rapid organization of rescue and relief activities as well as for a rough estimation of the state of damage to and the safety of structures. This immediately available intensity information may be useful for organizing more effective deployment and use of mental health resources immediately following a disaster and may be useful for preventing mental disorders associated with the disaster and promoting mental health care. Seismic intensity information, however, has not been directly used in the formulating of mental health activities even in Japan where most victims know the seismic intensity of the earthquake in the area in which they experienced it.

Pathological mental states due to exposure to destruction and death caused by earthquakes have long been known to be a by-product of both the material and spiritual losses that people suffer along with the abrupt changes in personal and social lifestyles[2,3)]. A gradient in the incidence of mental disorders corresponding to quantitative differences in earthquake damage, with the incidence rising towards the epicenter, has been reported[4–6)]. Previous studies have shown that people who have a higher number of earthquake-related life events and greater degree of loss experience more frequently develop mental disorders and show severer symptoms[7–20)]. The introduction of psychotherapy or mental recovery programs after a disaster has been reported to reduce the development of posttraumatic stress disorder (PTSD) and depression[21,22)]. In catastrophic disasters, victims are often alienated because their direct fear of the disaster cannot be understood by others. Therefore, it is better to take measures as soon as possible after the occurrence of an earthquake to prevent fear and pain from leading to despair. To evaluate whether the immediately available seismic intensity information available in Japan is useful for formulating a rapid mental-health response, we evaluated the quantitative relationship between seismic intensity and earthquake-related life events or

Received Dec. 19 2000/Accepted Apr. 12 2001
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earthquake stress for victims of the Great Hanshin-Awaji Earthquake.

Materials and Methods

The Great Hanshin-Awaji Earthquake

The Great Hanshin-Awaji Earthquake occurred at 5:46 a.m. on 17 January, 1995. The extensive damage caused across a wide urban area was comparable to the 1923 Great Kanto Earthquake that devastated Tokyo. The readily countable human toll was 6,430 deaths, 3 missing persons, 8,763 persons required hospitalization, and 35,010 persons received first aid. Residential damage included 104,900 houses completely destroyed, 144,256 houses partially destroyed, and 263,690 houses partially damaged. In addition, damage to buildings including public facilities and essential infrastructures were great. The area of severe damage was extensive, including a broken, roughly 5 km long, 1 to 2 km wide band of damage parallel to the coast, mainly in Kobe city, and patches of damage in Awaji Island and further inland. Intensity 7 is the highest on the JMA seismic intensity scale and corresponds to 11 or more on both the Modified Mercalli (MM) scale that is frequently used in Western countries and the Medvedev, Sponheuer and Karnik (MSK) scale that is used internationally (Fig. 1).

Subjects

The subjects were 2,500 (2,300 males and 200 females) randomly chosen workers at 5 businesses and 2 public corporations that cooperated in this survey among the 20 organizations that were addressed by the Osaka Scientific and Technology Center. All subjects were struck by the earthquake in the northern part of Awaji Island, Kobe City, cities in the Hanshin area, and Osaka City. We conducted a questionnaire survey between February and April, 1996, with respondents returning the anonymously completed questionnaire by mail directly to the Osaka Scientific Center. Replies were obtained from 1,767 victims (1,610 males, 151 females, with 6 not answering) for a response rate of 70.7%. The 1,361 males who property responded as requested to all items were evaluated in this study. Females were not analyzed in this study because of the uneven distribution of their places of residence.

Measurements

Each subject reported the JMA seismic intensity in the place where he experienced the earthquake. We assigned the subjects to 3 groups according to seismic intensity: Group A (intensity, 1–4), Group B (5–6), and Group C (7). All subjects were at home when the earthquake struck in the early morning. No subject was in an area with a seismic intensity of less than 1. We asked the subjects to report earthquake-related life events in 5 categories with 12 items in total: separation by death including death of a close family member, death of a close friend; injury or illness including injury or illness of self and injury or illness of a family member; financial change including decrease in income and increase in mortgage or loan, and loss of employment; living environment including life in a shelter, change in residence, separate residence from family or partner; damage or legal problems with residence including destruction of residence and legal problems with reconstruction. Stress from the earthquake disaster was assessed using the Zung self-rating depression scale (SDS) and the GHQ-28 to provide four scores: somatic symptoms; anxiety and insomnia; social dysfunction; and severe depression.

Statistical analysis

Findings for earthquake-related life events and earthquake stress for each category based on JMA seismic intensity were evaluated. The relationship between JMA seismic intensity and life events was analyzed by chi-square test, and an incidence corrected for age was obtained. Subjects with a score of mean +1 SD or more were considered to be depressed or in poor mental health. The relationship between the JMA seismic intensity and the SDS and GHQ-28 ratings were evaluated using multiple logistic analysis taking into consideration age, marital status, Type A behavior, social support and living standard as confounding factors. These analyses were effected with the use of the Statistical Package for Social Sciences (SPSS) computer program[23].

Results

Relationship between the seismic intensity and earthquake-related life events

The incidence of each life event item significantly differed among the 3 groups (Table 1). The incidence of each item was significantly lower in Group A than in Groups B or C, reflecting the slight damage experienced in Group A. In Group B, the incidence of each item except death of a close family member and loss of employment was more than twice as high as in Group A. In particular, in Group B, 21.6% reported a decrease in income and 13.4% destruction of residence.

In Group C, indicative of serious life events, 5.3% reported death of a close family member and 6.6% death of a close friend. Most of these deaths were due to suffocation or crushing after buildings collapsed. One in six of respondents reported personal injury or illness and one in four, injury or illness of family members. In the financial change category, 2.7% reported loss of employment but 59.5% reported a decrease in income and 40.0% reported an increase in mortgage or loan payments. In the living environment category, 46% of Group C experienced life in a shelter and 18.3% separate residence from their family or partner.

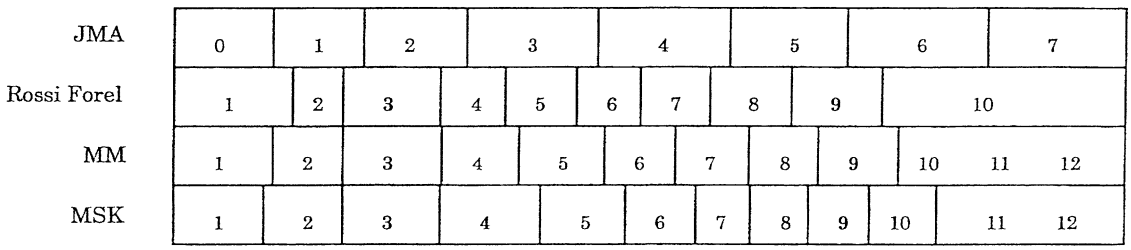

Fig. 1 Equivalent index values on the Japanese Meteorological Agency (JMA) seismic scale, Rossi-Forel scale, Modified Mercalli (MM) scale, and Medvedev, Sponheuer, Karnik (MSK) scale (Ref. (1)).

Table 1 Frequency distribution of earthquake-related life events occurring during 1 year after the Great Hanshin-Awaji earthquake reported by the victims in Japanese Meteorological Agency (JMA) intensity 1–4, 5–6 and 7 areas

	The Japanese Meteorological Agency (JMA) seismic intensity							
	A: Intensity 1–4 (n=783[a])		B: Intensity 5–6 (n=283[a])		C: Intensity 7 (n=295[a])			
Life event categories and items	N	% (Age adjusted %)	N	% (Age adjusted %)	N	% (Age adjusted %)	Chi-square value[b]	Significance
Separation by death								
Death of a close family member	9	1.1 (1.2)	4	1.4 (1.5)	16	5.4 (5.3)	19.65	p<0.0001
Death of a close friend	10	1.3 (1.3)	17	6.0 (6.1)	20	6.8 (6.6)	26.45	p<0.0001
Injury or illness						6.8 (6.6)		
Injury or illness of self	10	1.3 (1.4)	19	6.7 (6.8)	49	16.6 (16.4)	93.88	p<0.0001
Injury or illness of a family member	18	2.3 (2.3)	24	8.5 (8.5)	69	23.4 (23.3)	127.29	p<0.0001
Financial change								
Decrease in income	16	2.0 (2.4)	61	21.6 (22.0)	175	59.5 (58.7)	469.48	p<0.0001
Increase in mortgage or loan	10	1.3 (1.5)	26	9.2 (9.5)	118	40.0 (39.5)	321.78	p<0.0001
Loss of employment	2	0.3 (0.3)	1	0.4 (0.4)	8	2.7 (2.7)	17.05	p<0.0005
Living environment								
Life of a shelter	2	0.3 (0.3)	28	9.9 (9.9)	136	46.1 (46.1)	422.32	p<0.0001
Change in residence	7	0.9 (0.9)	14	4.9 (5.0)	89	30.2 (30.3)	251.92	p<0.0001
Separate residence from family or partner	7	0.9 (0.9)	17	6.0 (6.0)	54	18.3 (18.3)	120.28	p<0.0001
Damage or legal problems of house								
Destruction of house	3	0.4 (0.5)	38	13.4 (13.5)	176	59.7 (59.4)	563.49	p<0.0001
Legal problems of reconstruction	2	0.3 (0.3)	7	2.5 (2.6)	27	9.2 (9.0)	65.91	p<0.0001

[a] The subjects were classified according to reported experience of intensity 1–4, 5–6, and 7.

Table 2 Association of the Japan Meteorological Agency (JMA) seismic intensity and the evaluated mental health status of victims in the intensity 1–4, 5—6 and 7 areas

	The Japan Meteorological Agency (JMA) seismic intensity							
	A: Intensity 1–4 (reference) (n=783[a])		B: Intensity 5–6 (n=283[a])			C: Intensity 7 (n=295[a])		
Ill mental health	N (%)	OR[β]	N (%)	OR[b]	95% CI[c]	N (%)	OR[b]	95% CI[c]
SDS score (≥45)	123 (15.7)	1.00	58 (20.5)	1.44	1.01–2.07*	82 (27.8)	2.11	1.49–2.98***
GHQ-28								
Total score (≥8)	141 (18.0)	1.00	65 (23.0)	1.43	1.01–2.02*	83 (28.1)	1.87	1.34–2.61***
Somatic symptoms (≥2)	127 (16.2)	1.00	72 (25.4)	1.78	1.28–2.49***	91 (30.8)	2.44	1.76–3.38***
Anxiety and insomnia (≥1)	136 (17.4)	1.00	77 (27.2)	1.77	1.27–2.45***	95 (32.2)	2.19	1.59–3.01***
Social dysfunction (≥6)	150 (19.2)	1.00	57 (20.1)	1.02	0.70–1.47	72 (24.4)	1.35	0.96–1.91
Severe depression (≥1)	36 (4.6)	1.00	17 (6.0)	1.34	0.72–2.47	20 (6.8)	1.68	0.92–3.06

[a] The subjects were classified according to reported experience of intensity 1–4, 5–6, and 7.
[b] OR, odds ratio; logistic regression of ill mental health on the JMA seismic intensity with adjustment for age, marital status, Type A behavior pattern, social support and living standard.
[c] 95% CI, 95% confidence interval.
*P<0.05, ***P<0.001.

Complete or partial destruction of their house was reported by 59.7%, and 9.2% were involved in legal problems of reconstruction.

Relationship between the seismic intensity and mental health status

JMA seismic intensity correlated strongly with depression. Even after taking confounding factors into consideration, the incidence of depression in Group B was 1.44 times, and that in Group C was 2.11 times higher than the incidence in Group A. Significant differences in the correlation between JMA seismic intensity and poor mental health were also found: the percentage of victims with a high score in Group B was 1.43 times and in Group C 1.87 times higher than the incidence in Group A (Table 2). Among the GHQ-28 subscales, significant differences were observed in somatic symptoms and anxiety and insomnia. The percentage of victims with such physical symptoms as headache and weariness in Group B was 1.78 times, and in Group C 2.44 times, higher than the incidence in Group A; while the incidence of anxiety and insomnia in Group B was 1.77 times, and in Group C 2.19 times, higher than the incidence in Group A; all these differences were significant.

Discussion

An ounce of prevention is better than a pound of cure: obviously it is better for victims and a more efficient use of resources if we can rapidly initiate primary prevention measures immediately after the occurrence of an earthquake in areas in which victims are at the highest risk of mental disorder[24]. Some victims with

psychological trauma present no symptoms soon after disasters but develop PTSD or other mental disorders much later[25]. Earthquakes are still the most unpredictable of natural disasters. In the confusion following an earthquake, evaluation of the extent of damage and assessment of victims usually takes time; preventive mental health measures that fit the needs of victims have not always been taken quickly enough[26]. Since the Great Hanshin-Awaji Earthquake in 1995, the government has been even more greatly concerned to rapidly evaluate earthquake damage with greater precision. In 1995, the number of nationwide JMA seismographic monitoring locations was increased to 600. In 1996, intensities 5 and 6 on the JMA seismic intensity scale were subclassified into 2 categories each (strong and weak), effectively making it a ten-intensity scale. Until now, however, in Japan there has been no analysis relating mental effects to seismic intensity and this valuable data has been used to guide preventive. Elsewhere, researchers have compared the incidence of mental disorder depending on the degree of stress suffered[4–6], but no study has presented quantitative findings on the relationship between the seismic intensity and life events and earthquake stress. To evaluate the usefulness of immediately available seismic intensity information for guiding initial postdisaster mental health activities, we carried out a survey one year after the Great Hanshin-Awaji Earthquake.

First, we analyzed the association between seismic intensity and earthquake-related life events that happened during the 1-year period immediately following the earthquake. As expected, more victims experienced health problems such as death or injury or health disorders in the intensity 7 areas than in the lower intensity areas. The experience of such serious life events increased the risk of mental disorders such as PTSD and depression[2,15–19], and long-term prevention and therapeutic mental health measures should be initiated from immediately after the occurrence of disastrous earthquakes. Small-scale factory owners and shopkeepers, in particular, suffered a serious decrease in income and increase in debt. Moreover, they were faced with the expense and uncertainty of reconstructing damaged factories and shops. In addition, many houses in this area were completely or partially destroyed, adding the burden of a reconstruction loan to the previous mortgage, resulting in a double home loan for many owner-occupier victims. Such increases in financial burdens resulting from earthquakes may cause long-term stress in victims.

In the intensity 7 areas, 46% of the victims experienced life in shelters, and 30% moved. Previous studies have suggested the importance of social support because evacuation and transfer of residence following an earthquake disrupts the social networks[3,16]. In addition to helping victims who require protection, better producers to make it easier for people to seek out and find their friends and family members should have been implemented. It is relatively easy to gather and provide such information while protecting the right to privacy. In areas of high seismic intensity where there were many deaths, even after the houses have been rebuilt, it is difficult to rebuild a community similar to that which existed before the destruction. Long-term mental health activities are also necessary to support victims who have suffered various types of loss[10]. Counseling or intervention to support victims as they cope with and try to overcome the mental strain of their experience has been shown to be effective for reducing stress[27].

The percentage of victims who showed depression or poor mental health was significantly higher in the intensity 7 or 5–6 areas than in areas of intensity 4 or less. Kawakami and Koizumi[28] reported that the mean SDS score (±SD) was 31.3 (±6.4) in the normal male population. In the present study, we demonstrated that the mean SDS scores (±SD) were 37.7 (±6.6) in the A group, 38.7 (±7.0) in the B group and 40.0 (±7.7) in the C group. Similarly, Ezoe and Morimoto[29] reported that the mean GHQ-28 total score was 3.98 (±3.5) in 2,332 Japanese male workers. We also demonstrated that the mean GHQ-28 scores (±SD) were 4.30 (±3.5) in the A group, 4.86 (±3.9) in the B group and 5.35 (±4.4) in the C group. We found that earthquake victims had experienced greater damage had more depressive symptoms and lower mental health status. Other studies have suggested that various life events associated with earthquakes are involved in the development of mental disorders[2,15,17]. These previous surveys of life events, however, have usually been undertaken a considerable time after the occurrence of the earthquake[15,18], and mental health attention has normally been given only to some of the victims who have already developed obvious mental disorders[22]. The results of the present study suggest that the type and incidence of earthquake-related life events and the incidence of mental disorders can be predicted using seismic intensity information. If PTSD and depression are allowed to develop they often persist and are difficult to treat[19,20]. To prevent mental disorders after earthquakes, intervention studies suggest that it is better to carry out stress debriefing as early as possible[18,30,31]. If stress debriefing is used not only for rescue members but also for general victims, seismic intensity information would be useful for identifying which victims most urgently require it. The evidence of this study suggests that seismic intensity findings are useful for the formulation of rapid response planning. In areas of high seismic intensity, mental health activities should include not only general education and guidance concerning earthquake stress, elective consultation, and emergency treatment, but also extensive preventive counseling.

In conclusion, we found higher incidence of serious life events and mental disorder in areas of higher seismic intensity than in low-intensity areas. To help victims recover and return to their daily lives, various types of individual support are necessary. In terms of primary prevention, comprehensive measures in localities showing marked damage is important. To clarify in more detail the quantitative relationships between seismic intensity and life events or mental disorders, access to comparative findings from other sites of disasters is necessary.

In Japan, mental health activities have been rapidly but rather sporadically performed. Clarification of the association between seismic intensity information and life events or earthquake stress, however, may allow the planning of measures with objective criteria to justify the assigning of priority of need.

Acknowledgement

This study was performed with Special Coordination Funds provided by the Science and Technology Agency of the Japanese Government.

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