Table 13. Association rules related to volunteer activity participation and mental and physical distress.

Time	Affiliation	Consequent	Antecedent (Combination of Conditional Parts)	Support	Confidence	Lift
1st Survey	Department of Medicine	Volunteer	Building damage, No physical distress	20.81%	52.24%	1.237
		Volunteer	Building damage, No physical distress, No mental distress	17.39%	50.00%	1.184
		Volunteer	Building damage, No finacial problems, No physical distress	19.26%	51.61%	1.222
		Volunteer	Building damage, No personal harm, No physical distress	20.50%	51.52%	1.22
		Volunteer	Building damage, No finacial problems, No physical distress, No mental distress	16.77%	50.00%	1.184
		Volunteer	Building damage, No personal harm, No physical distress, No mental distress	17.39%	50.00%	1.184
		Volunteer	Building damage, No personal harm, No finacial problems, No physical distress	18.94%	50.82%	1.203
		Volunteer	Building damage, No personal harm, No finacial problems, No physical distress, No mental distress	16.77%	50.00%	1.184
	Department of Health Sciences	Volunteer	Building damage	13.56%	50.00%	2.107
	Graduate School	Volunteer	Building damage, No personal harm, Mental distress	5.95%	40.00%	1.244
		Volunteer	Building damage, No personal harm, No finacial problems, Mental distress	5.95%	40.00%	1.244
2nd Survey	Department of Medicine	Volunteer	Financial problems	6.09%	50.00%	1.279
		Volunteer	Building damage	21.83%	46.51%	1.19
		Volunteer	Building damage, No mental distress	17.77%	45.71%	1.17
		Volunteer	Building damage, No physical distress	19.80%	46.15%	1.181
		Volunteer	Building damage, No personal harm	19.80%	46.15%	1.181
		Volunteer	Building damage, No personal harm, No mental distress	16.75%	45.46%	1.163
	Department of Health Sciences	Volunteer	Building damage	24.14%	30.00%	1.225
		Volunteer	Building damage, No mental distress	18.28%	35.85%	1.464
		Volunteer	Building damage, No physical distress, No mental distress	17.24%	34.00%	1.389
	Graduate School	Volunteer	Mental distress	5.88%	62.50%	1.518
		Volunteer	Financial problems	10.29%	57.14%	1.388
		Volunteer	No physical distress, Mental distress	5.15%	57.14%	1.388
		Volunteer	Building damage, Mental distress	5.88%	50.00%	1.124
		Volunteer	Building damage, Financial problems	5.15%	57.14%	1.388
		Volunteer	Financial problems, No physical distress	8.82%	50.00%	1.124
		Volunteer	Building damage, Mental distress	7.35%	50.00%	1.124
		Volunteer	Building damage, No physical distress, Mental distress	6.62%	55.56%	1.349

areas. It is also likely that 27-40% of the homes and workplaces of the families responsible for the students' tuition and living expenses were located in these areas, and it was highly likely that the graduate students paying their own living expenses and tuition fees would have lost their place of employment. In fact, in these surveys, the proportion of students for whom the continuation of their studies became financially difficult was highest among graduate students, at around 10%, relative to 5-6% of undergraduates. These frequencies were relatively low considering the enormity of the disaster; however, should this type of widespread disaster occur in the future, the following particularly important points should be considered: such students require assistance quickly in order to continue their studies, and the frequency of the problem may differ according to department.

The results suggested that the disaster affected the students in a large variety of ways. In this disaster, many students from the affected areas were exposed to life-threatening experiences as the long, strong tremors demolished furniture and buildings; in addition, they were forced into evacuation, as the entire infrastructure that supports daily living was lost for an extended period of time following the earthquake. Because transportation and communications were paralyzed, students who had been traveling had no means of returning home and could only worry about the safety of their families and friends. Foreign students who experienced difficulty communicating in Japanese were forced to evacuate without being able to obtain sufficient information. Students working in hospitals were forced into action on the front lines of post-disaster treatment with-

out power or other infrastructure while also required to keep patients safe. Individuals in areas impacted by tsunamis were likely to have found themselves in crisis situations in which they witnessed people and homes being swept away. According to a report by Kin and Onuma (2012), events that can traumatize victims include the following: encountering events involving certain death; actual physical experiences of harm, such as pain or being burned; witnessing death and injury; loss of family members or friends; loss of identity related to the loss of bodily functions, community, financial income, or occupation; inability to live life as usual; and exposure to various kinds of information due to evacuation or relocation. In addition, it has been reported that the feeling of the earth shaking beneath one's feet increases the likelihood of psychological trauma (National Center of Neurology and Psychology 2012). Research has also shown that survivors may suffer "survivor's guilt"; that is, they may feel guilty about surviving, being uninjured, or having lost little relative to others. Furthermore, when the acute phase of a disaster is over, survivors may look back on their behavior and feel guilty about what they did or did not do (Underwood 2005). Considering the disaster experiences of students described above, this research suggests that all of the students in this study may have experienced psychological trauma to a greater or lesser degree, regardless of whether they were victims, because the areas affected were fundamental parts of their lives. The results of every survey conducted during the approximate 25-month study period showed high proportions of individuals complaining of physical or mental distress. The frequency of physical or mental distress was highest in Survey 2 (four months after the disaster), followed by Survey 1 (one month after the disaster), suggesting that interventions are urgently required soon after a disaster occurs. It is notable that incidence of students with mental distress after the Great East Japan Earthquake was 20% and that observed in the Vietnam and Iraq war veterans with PTSD was 30% (Weiss et al. 1992; Hoge et al. 2006). Incidence was similar but slightly small in the present case than veterans; repetitive stress in the latter may be the main reason for such difference. While comparisons of the incidence of harm and physical or mental distress clearly showed that disaster victims were more likely to exhibit distress, every survey also showed that students who did not directly damaged also suffered from distress, suggesting that they were strongly affected by traumatic factors other than suffering disaster-related harm.

The association rules generated during data mining showed that experiencing building damage was a possible motivation for participation in voluntary activities, as it was the most frequently generated of all harm conditions in the rule antecedents across all academic departments. In Survey 2, in addition to building damage, experiencing financial problems was also generated as a rule antecedent. In contrast, experiencing personal harm was not generated as a condition related to participation in voluntary activities. In addition, of the two types of distress, mental distress was generated as a possible motivation for participating in voluntary activities, but physical distress was not. The explanation for these results could be that there are two different ways in which mental attitudes are affected, according to the nature of the harm: property loss or damage can be understood as a temporary problem, enabling expectations of resolution over time; however, there may be no resolution of personal loss or injury, even with the passage of time. Personal harm exerted the strongest effect on impediments to daily living in the results of the covariance structure analysis; an example of this effect may be that domestic financial problems could stem from loss of family income or parents or guardians, and for graduate students, the workplace. Similar to the phenomena in the association analysis, these were serious problems that the students were powerless to resolve, which may have affected interest in participating in voluntary activities. The reason that physical distress was not generated as a condition for participating in voluntary activities may have been that it would have been difficult to do so while experiencing headaches and nausea. However, the cluster analysis showed that some of the 13% of students who were in Cluster 2 participated in voluntary activities, even while suffering personal harm and physical distress, conditions that were not generated in relation to voluntary activity participation in the association analysis. Other possible reasons for motivation for participating in voluntary activities may have been that students were encouraged to do so by the people around them; they wanted to see the affected areas (Gakusei Borantia Kenkyukai 2012 (in Japanese)); or they had experienced a sense of mission as students affiliated with a school of medicine. However, students exhibiting physical and mental distress and behaving in this way should be observed particularly closely, because they could be tormented by the sight of casualties or feelings of loss while participating in voluntary activities in tsunami-damaged areas. In contrast, any intervention to restrict participation in voluntary activities should be undertaken cautiously because of the possibility that the individual may suffer survivor's guilt at a later date. Therefore, cluster analysis of continuously collected data to identify students belonging to the group most at risk (Cluster 2) may improve intervention effectiveness.

The survey performed two years after the earthquake demonstrated that problems involving harm and mental and physical distress were, relatively speaking, progressing toward resolution; however, it also showed that some students were exhibiting a six-month delay in onset of symptoms resulting from stress factors listed in the post-traumatic stress disorder diagnostic criteria (American Psychiatric Association 2000). This suggests a need to continue surveying this population in the longer term.

While considering how long we should continue these surveys, we thought that we should initiated this kind of survey shortly after the occurrence of the disaster to help the mental health care for our students. We think that this

attempt gave benefits for medical students. Thanks to this early implementation, funding was received from many institutions, and scholarships could be offered to students in need, pre-empting the formation of barriers to their continued study. We included spaces for free responses in the surveys, and in response to feedback from foreign students indicating that they did not know how to secure disaster counseling services or evacuation shelters, we created maps in English showing the relevant locations near the university. Therefore, by capturing the needs of students early and being able to progress toward the resolution of their problems, it was possible to alleviate their anxiety. Furthermore, the various analyses of factors in this study, which investigated the possibility of future problems occurring as a result of harm, distress, and behavior patterns, facilitated the preparation of appropriate interventions, even when students had not asked for assistance. This may have contributed to the prevention of the exacerbation of problems in the long term. Finally, because we were able to contact students who were interested in counseling swiftly and formulate plans to address their problems, we may have been able to prevent a secondary disaster resulting from the mental and physical challenges and various other problems caused by the first disaster.

Study limitations

The questions in this study included items regarding trauma, which could be considered invasive; therefore, students who did not wish to remember the disaster were able to choose to not participate. In addition, we were unable to distribute the surveys to some of the graduate students directly, due to their absence from the campus, and they may have been unable to respond to the survey if they were busy providing medical treatment or conducting around-the-clock research. Further, in the first survey, because second-, third-, and fourth-year students in the health sciences were excluded, we only received responses from the first-year students, and this may have affected our present study. It was not possible to further analyze on differences by gender because we did not collect such data. The survey questionnaires included items regarding participation in voluntary activities; however, some of the graduate students were providing treatment in the affected areas as medical staff, which was neither considered a voluntary activity nor included in the survey questions. Studies have been conducted to examine the effects of the disaster on the mental and physical health of veteran medical practitioners who were engaged in treatment activities in affected areas (Yamazaki and Tanno 2009) however, they were unable to determine how graduate students were affected. Future surveys should include the question "Did you perform any treatment in disaster areas as a member of a medical team?" and a survey of psychological factors related to survivor's guilt, such as whether the respondents participated in voluntary activities and, if not, whether they had wanted to but had been unable to do so.

Acknowledgments

We would like to thank the following people for their guidance, without which we would not have completed this research: Associate Professor Seiichi Ishii and Associate Professor Junichi Kameoka of the Tohoku University Graduate School of Medicine, Office of Medical Education; Professor Naoto Ishii of the Department of Microbiology and Immunology; Associate Professor Seiichi Saitoh of the Kobe University Graduate School of Human Development and Environment; Instructor Yoshimi Suzukamo of the Tohoku University Department of Physical Medicine and Rehabilitation for her guidance on the analysis methodology. In addition, we would like to express our sincere appreciation to the Tohoku University School of Medicine's Medical Student Welfare Committee, the school affairs office, and the students for the support we received in conducting the surveys.

Conflict of Interest

The authors declare no conflict of interest.

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ORIGINAL RESEARCH

Correlation Between the Great East Japan Earthquake and Postpartum Depression: A Study in Miyako, Iwate, Japan

Hidekazu Nishigori, MD, PhD; Michiho Sasaki, BSN; Taku Obara, PhD; Toshie Nishigori, PhD; Mami Ishikuro, PhD; Hirohito Metoki, MD, PhD; Junichi Sugawara, MD, PhD; Shinichi Kuriyama, MD, PhD; Akira Hosoyachi, MD; Nobuo Yaegashi, MD, PhD; Takashi Kobayashi, MD; Noboru Yoshizumi, MD, PhD

ABSTRACT

Objective: This study aimed to explore the correlation between the 2011 Great East Japan Earthquake and postpartum depression among perinatal subjects in the Miyako region of Iwate, an area damaged by earthquakes and tsunamis.

Methods: We retrospectively compared the percentages of women with scores ≥9 on the Japanese version of the Edinburgh Postnatal Depression Scale (EPDS) among 3 groups of women who gave birth prior to the disaster (before-disaster group: n = 141), within 3 months after the disaster (within-3-months group: n = 70), and 4-6 months after the disaster (4-6-months group: n = 89) at the Iwate Prefectural Miyako Hospital. The risk factors for EPDS scores ≥9 were estimated with multivariate logistic regression analyses.

Results: Compared with the before-disaster group, a significantly greater number of women in the within-3-months group had EPDS scores ≥9 at hospital discharge (31.4% versus 9.9%, $P < .0001$), whereas women in the 4-6-months group did not (10.1% versus 9.9%, $P = .96$). In both the after-disaster groups, the destruction of their home (adjusted odds ratio [AOR], 3.68; 95% confidence interval [CI], 1.46-9.26) and dissatisfaction with their living conditions (AOR, 3.02; 95% CI, 1.20-7.59) were significantly associated with EPDS scores ≥9.

Conclusions: An increase in postpartum depression was observed after the Great East Japan Earthquake among perinatal women. (*Disaster Med Public Health Preparedness.* 2015;9:307-312)

Key Words: tsunamis, mental disorders, medical records

On March 11, 2011, an undersea earthquake (the Great East Japan Earthquake) measuring 9.0 on the Richter scale hit the northeast coast of Honshu Island, Japan. Its epicenter was located approximately 130 km east of the Pacific coast (Figure 1). The earthquake generated devastating tsunamis with waves that reached heights of 40 m. The tsunamis destroyed the towns and villages in the coastal areas of a number of prefectures, including the Iwate, Miyagi, and Fukushima prefectures. Approximately 18 400 people died or went missing, and more than 400 000 houses and buildings were completely or partially destroyed.[1]

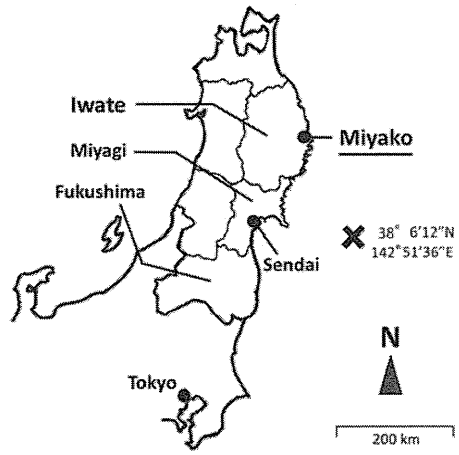
Previous studies have suggested that maternal mental health disorders, including perinatal depression, can be influenced by the devastation caused by a natural disaster.[2-5] Perinatal depression can affect the mental health of postnatal women[6] and may impact the quality of care given to the newborn.[7] Maternal psychosocial health can affect the mother-infant relationship,[8-10] the nutritional status of the infants, illness,[11,12] and children's emotional or cognitive problems.[13,14] Therefore, perinatal women should be considered to be a vulnerable population, and methods to prevent perinatal depression must be established in preparation of future devastating disasters.

The Iwate Prefectural Miyako Hospital is located on the northeastern coast of Japan (Figure 1), and its medical service area includes Miyako, Iwaizumi, Yamada, and Tanohata. According to 2010 census data, this area has a population of approximately 92 000, and approximately 550 births occur annually. Approximately 390 births annually occur at the Iwate Prefectural Miyako Hospital. Following the Great East Japan Earthquake and tsunamis, approximately 1500 people died or went missing and more than 12 600

 DOI: 0.1017/dmp.2015.51

FIGURE 1

Location of Miyako, Iwate Prefecture



The epicenter of the Great East Japan Earthquake is schematically (cross mark) indicated.

houses and buildings were completely or partially destroyed in the service area. Following this disaster, the Iwate Prefectural Miyako Hospital served as a disaster base hospital, and it provided intensive maternal mental health care to prevent perinatal depression.

In the present study, we retrospectively examined scores on the Japanese version of the Edinburgh Postnatal Depression Scale (EPDS)[15,16] of perinatal women who were treated at the Iwate Prefectural Miyako Hospital to assess the influence of the Great East Japan Earthquake on their mental health.

METHODS

Study Design

This retrospective study was conducted using a medical chart–based survey and a questionnaire that was completed by perinatal women who gave birth at the Iwate Prefectural Miyako Hospital. Existing medical records were reviewed in this observational study. Because this was a retrospective study, informed consent was omitted according to the Ethical Guidelines for Clinical Studies issued by the Japanese Ministry of Health, Labour, and Welfare.[17] The study protocol was approved by the ethics committee of the Iwate Prefectural Miyako Hospital on January 17, 2012, and conformed to the provisions of the Declaration of Helsinki (revised in Tokyo 2004).[18]

Study Subjects

The study subjects included perinatal women who had delivered at the Iwate Prefectural Miyako Hospital between October 1, 2010, and September 10, 2011. The hospital had been assessing these patients with the Japanese version of EPDS[15,16] at the time of postdelivery hospital discharge and their regular 1-month postdelivery checkup. Perinatal women who gave birth between February 10, 2011, and March 10, 2011, were excluded because they had undergone the hospital discharge EPDS test prior to the earthquake and the 1-month EPDS test after the earthquake.

Data Collection

We collected the following data from medical charts: age, marital status, parity, employment, mental disorder history, obstetric complications during pregnancy (ie, threatened premature labor, preterm delivery, pregnancy-induced hypertension, fetal growth restriction, hemolysis, elevated liver enzymes, low platelet count syndrome, placenta previa, placental abruption, placenta accreta, gestational diabetes, or intrauterine fetal death), type of delivery, abnormal delivery (emergency cesarean section, vacuum extraction, obstructed labor, or uterine atony), postpartum obstetric complications (vulvar hematoma, problematic surgical scaring, or breast abnormalities), and scores on the Japanese version of the EPDS at hospital discharge and at the regular checkup 1 month after delivery.

Women with vaginal deliveries took the EPDS test 4-5 days later at the time of hospital discharge, whereas those who delivered by cesarean section took the test 6-7 days later at the time of hospital discharge. At the Iwate Miyako Prefectural Hospital, women are routinely admitted for 4-5 days after uncomplicated vaginal deliveries and for 6-7 days after cesarean deliveries.

The Japanese version of EPDS is a self-reported scale that contains 10 items, each of which is graded with a 4-point Likert scale, with the total score ranging from 0 to 30. The cutoff score in the Japanese population is 9, which is considered to indicate a significant risk for postpartum depression.[16,19] The self-administered questionnaire administered at hospital discharge after delivery included questions about whether perinatal women could consult their families when they had problems, anxiety over household finances, dissatisfaction with living conditions, the death of loved ones, and worries about baby care.

We collected information on the feelings of the women who gave birth after March 11, 2011, about being a disaster victim, the destruction of their homes, residence issues, and family members who had lost their jobs. The definition of a destroyed home was in accordance with the guidelines authorized by the Cabinet Office of the Japanese Government in 2011.[20]

Analysis

The percentages of women with EPDS scores ≥9 at hospital discharge and 1 month after delivery were compared among

the following 3 groups: the before-disaster group, which consisted of women who gave birth before the disaster (October 1, 2010-February 9, 2011); the within-3-months group, which consisted of women who gave birth within 3 months after the disaster (March 11, 2011-June 10, 2011); and the 4-6-months group, which consisted of women who gave birth 4-6 months after the disaster (June 11, 2011-September 10, 2011). Student's t tests, χ^2 tests, and Fisher's tests were used when appropriate for statistical analyses.

Multivariate logistic regression analyses were performed after adjusting for the variables that were significantly associated with EPDS scores ≥9 at hospital discharge among the after-disaster group in univariate analysis. The after-disaster group included both the within-3-months group and the 4-6-months group. The adjusted odds ratios (AORs) and 95% confidence intervals (CIs) were calculated to estimate the risk of EPDS scores ≥9 at hospital discharge after the disaster. All statistical analyses were performed with SAS version 9.3 statistical software (SAS Institute, Inc, Cary, NC).

RESULTS

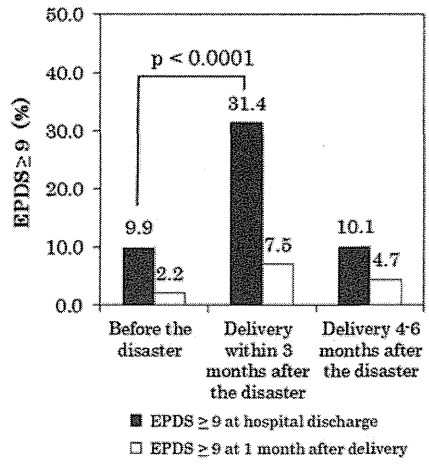
Of the 141 women in the before-disaster group, 141 and 134 underwent the EPDS test at the time of discharge and 1 month after delivery, respectively. Of the 73 women in the within-3-months group, 70 and 67 underwent the EPDS test at hospital discharge and 1 month after delivery, respectively. Of the 90 women in the 4-6-months group, 89 and 86 underwent the EPDS test at hospital discharge and 1 month after delivery, respectively.

Comparisons of the percentages of women with EPDS scores ≥9 at hospital discharge and 1 month after delivery are shown in Figure 2. The percentage of women with EPDS scores ≥9 at hospital discharge was significantly greater in the within-3-months group (31.4%, $P < .0001$) than in the before-disaster group (9.9%); this difference was not significant 1 month after delivery (7.5% versus 2.2%, $P = .12$). There was no significant difference in the percentages of women with EPDS scores ≥9 between the 4-6-months group and before-disaster group at hospital discharge (10.1% versus 9.9%, $P = .96$) or 1 month after delivery (4.7% versus 2.2%, $P = .44$).

The background characteristics of the perinatal women who took the EPDS test at hospital discharge in the before-disaster group and in the after-disaster group are shown in Table 1. In the after-disaster group, univariate analysis showed that the percentages of women with obstetric complications during pregnancy ($P = .03$), dissatisfaction with living conditions ($P = .0001$), the death of loved ones ($P = .048$), the destruction of their home ($P < .0001$), and a change in residence after the disaster ($P = .0001$) were significantly different between the group with EPDS scores ≥9 and the group with scores <9 (Table 1). Because the correlation between the destruction of their home and a change in residence after the disaster was multicollinear, we chose the former variable for multivariate logistic regression analysis. Multivariate logistic regression analysis was adjusted for obstetric complications during pregnancy, the death of loved ones, dissatisfaction with living conditions, and the destruction of their home. This analysis showed that the destruction of their home (AOR, 3.02; 95% CI, 1.20-7.59) and dissatisfaction with living conditions (AOR, 3.68; 95% CI, 1.46-9.26) were significantly and independently associated with EPDS scores ≥9 at hospital discharge after the disaster (Table 2).

FIGURE 2

Percentages of Women With Scores ≥9 on the Japanese Version of the Edinburgh Postnatal Depression Scale (EPDS) at Hospital Discharge and 1 Month After Delivery



DISCUSSION

The percentage of women with EPDS scores ≥9 at hospital discharge was significantly greater in the within-3-months group than in the before-disaster group ($P < .0001$). This difference was not significant ($P = .12$) 1 month after delivery. Several explanations for this finding have been proposed. First, an increase in the number of patients with perinatal depression after the disaster was predicted; therefore, the hospital conducted a recollection of birth (birth review)[21,22] earlier and introduced touch[23,24] to encourage patients to express their emotions. Second, because damage to parenting environments such as housing without essential

TABLE 1

Background Characteristics of Perinatal Women Who Underwent the Japanese Version of the Edinburgh Postnatal Depression Scale (EPDS) at Hospital Discharge

		Before-Disaster Group				After-Disaster Group[a]			
		Total	EPDS < 9	EPDS ≥ 9		Total	EPDS < 9	EPDS ≥ 9	
	n	141	127	14	*P*	159	128	31	*P*
Age	Mean ± SD	30.1 ± 5.6	30.1 ± 5.5	29.8 ± 6.1	.83	30.3 ± 5.6	30.3 ± 5.7	30.0 ± 5.2	.74
	≤24 y, n (%)	21 (14.9)	18 (14.2)	3 (21.4)	.40	26 (16.4)	20 (15.6)	6 (19.4)	.56
	25–29 y, n (%)	46 (32.6)	42 (33.1)	4 (28.6)		45 (28.3)	36 (28.1)	9 (29.0)	
	30–34 y, n (%)	42 (29.8)	40 (31.5)	2 (14.3)		47 (29.6)	36 (28.1)	11 (35.5)	
	≥35 y, n (%)	32 (22.7)	27 (21.3)	5 (35.7)		41 (25.8)	36 (28.1)	5 (16.1)	
Marital status	Married, n (%)	140 (99.3)	126 (99.2)	14 (100.0)	1.00	152 (95.6)	122 (95.3)	30 (96.8)	1.00
Parity	Primipara, n (%)	60 (42.6)	53 (41.7)	7 (50.0)	.55	66 (41.5)	51 (39.8)	15 (48.4)	.39
	Multipara, n (%)	81 (57.5)	74 (58.3)	7 (50.0)		93 (58.5)	77 (60.2)	16 (51.6)	
Employment	Yes, n (%)	65 (46.1)	58 (45.7)	7 (50.0)	.76	61 (38.4)	49 (38.3)	12 (38.7)	.96
Mental disorder history	Yes, n (%)	11 (7.8)	11 (8.7)	0 (0.0)	.60	3 (1.9)	1 (0.8)	2 (6.5)	.10
Complication during pregnancy	Yes, n (%)	35 (24.8)	27 (21.3)	8 (57.1)	.01	26 (16.4)	17 (13.3)	9 (29.0)	.03
Type of delivery	Spontaneous vaginal delivery, n (%)	92 (65.3)	84 (66.1)	8 (57.1)	.56	96 (60.4)	74 (57.8)	22 (71.0)	.08
	Vacuum extraction, n (%)	0 (0.0)	0 (0.0)	0 (.0)		8 (5.0)	5 (3.9)	3 (9.7)	
	Cesarean section, n (%)	49 (34.8)	43 (33.9)	6 (42.9)		55 (34.6)	49 (38.3)	6 (19.4)	
Abnormal delivery	Yes, n (%)	17 (12.1)	14 (11.0)	3 (21.4)	.38	28 (17.6)	21 (16.4)	7 (22.6)	.42
Complication at postpartum	Yes, n (%)	1 (0.7)	1 (0.8)	0 (0.0)	1.00	5 (3.1)	4 (3.1)	1 (3.2)	1.00
Family who can consult	No, n (%)	7 (5.0)	4 (3.2)	3 (21.4)	.02	4 (2.5)	2 (1.6)	2 (6.5)	.17
Anxiety over household finances	Yes, n (%)	28 (19.9)	24 (18.9)	4 (28.6)	.48	23 (14.5)	18 (14.1)	5 (16.1)	.78
Satisfaction with living conditions	No, n (%)	28 (19.9)	23 (18.1)	5 (35.7)	.12	47 (29.6)	29 (22.7)	18 (58.1)	.0001
Death of loved ones	Yes, n (%)	24 (17.0)	21 (16.5)	3 (21.4)	.71	53 (33.3)	38 (29.7)	15 (48.4)	.048
Worries about baby care	Yes, n (%)	51 (36.2)	20 (24.7)	31 (51.7)	.001	55 (34.6)	28 (30.1)	27 (40.9)	.16
Destruction of home	Complete (carried away), n (%)					15 (9.4)	7 (5.5)	8 (25.8)	.001
	Complete, n (%)					9 (5.7)	6 (4.7)	3 (9.7)	
	Half, n (%)					8 (5.0)	5 (3.9)	3 (9.7)	
	Partial, n (%)					2 (1.3)	1 (0.8)	1 (3.2)	
	No damage, (%)					125 (78.6)	109 (85.2)	16 (51.6)	
	Total destroyed, n (%)					34 (21.4)	19 (14.8)	15 (48.4)	<.0001
Residence	Refuge, n (%)					2 (1.3)	0 (0.0)	2 (6.5)	<.0001
	Temporary dwelling, n (%)					8 (5.0)	7 (5.5)	1 (3.2)	
	Parent's house, n (%)					9 (5.7)	7 (5.5)	2 (6.5)	
	Relative's house, n (%)					6 (3.8)	2 (1.6)	4 (12.9)	
	House or apartment for rent, n (%)					4 (2.5)	1 (0.8)	3 (9.7)	
	Damaged/destroyed own house, n (%)					7 (4.4)	4 (3.1)	3 (9.7)	
	Own house, n (%)					123 (77.4)	107 (83.6)	16 (51.6)	
	Change of residence by disaster, n (%)					36 (22.6)	21 (16.4)	15 (48.4)	.0001
Family who lost job	Partner, n (%)					11 (6.9)	8 (6.3)	3 (9.7)	.82
	Subject, n (%)					1 (0.6)	1 (0.8)	0 (0.0)	
	Other, n (%)					1 (0.6)	1 (0.8)	0 (0.0)	
	None, n (%)					146 (91.8)	118 (92.2)	28 (90.3)	
	Total who lost job, n (%)					13 (8.2)	10 (7.8)	3 (9.7)	.72

[a]The after-disaster group included both the within-3-months group and the 4-6-months group.

TABLE 2

Multivariate Logistic Regression Analysis of the Data for Perinatal Women With Scores ≥9 on the Japanese Version of the EPDS Score at Hospital Discharge in the After-Disaster Group

Variables	β	SE	AOR (95% CI)[a]	P
Obstetric complications during pregnancy (no = 0)	0.71	0.525	2.03 (0.73–5.67)	.18
Death of loved ones (no = 0)	0.19	0.469	1.21 (0.48–3.04)	.68
Dissatisfaction with living conditions (satisfaction = 0)	1.10	0.470	3.02 (1.20–7.59)	.02
Destruction of their home (no = 0)	1.30	0.471	3.68 (1.46–9.26)	.006
Change in residence after the disaster (no = 0)[b]			—	

Abbreviations: EPDS, Edinburgh Postnatal Depression Scale; SE, standard error; AOR, adjusted odds ratio; CI, confidence interval.
[a]Adjusted for "obstetric complications during pregnancy," "death of loved ones," "dissatisfaction with living conditions," and "destruction of their home."
[b]The correlation between "destruction of their home" and "change in residence after the disaster" was multicollinear.

utilities was expected, the hospital provided support to promote breastfeeding and advised new mothers about the level of damage at the time of discharge, and they received parenting support at hospital discharge and at checkups performed 2 weeks and 1 month after delivery. Although the difference of 1 month after delivery was not significant (5 of 67 versus 3 of 134, $P = .12$), the study was statistically limited because the number of clinical cases was small. Therefore, the results must be interpreted with caution.

There were no significant differences between the 4-6-months group and the before-disaster group at hospital discharge (10.1% versus 9.9%, $P = .96$) and 1 month after delivery (4.7% versus 2.2%, $P = .44$). The prevalence of EPDS scores ≥9 at the Iwate Prefectural Miyako Hospital differed from the findings of a study that was conducted in the coastal area of Miyagi Prefecture after the disaster.[2] Miyagi Prefecture is located to the south of Iwate Prefecture (Figure 1). In the coastal area of Miyagi Prefecture, which was also affected by the disaster,[25,26] the percentage of postpartum women with EPDS scores ≥9 was 21.3% around 6 months after the disaster.[2] Further investigations are required to clarify the factors correlated with this difference.

Multivariate logistic regression analyses were performed in the after-disaster group with EPDS scores ≥9 at hospital discharge. Because the number of clinical cases was small in multivariate logistic regression analyses in the within-3-months group and in the 4-6-months group separately, the after-disaster group included both the within-3-months group and the 4-6-months group for multivariate logistic regression analyses. For the risk factors for perinatal depression that were related to the disaster, previous studies have found that exposure to storm,[27] loss of resources,[28] earthquake experience,[29,30] anxiety about earthquakes,[31,32] and exposure to tsunami[2] were more likely to cause depression in pregnant and postnatal women who were affected by natural disasters. In the present study, we found that the destruction of their home and dissatisfaction with their living conditions were significant risk factors for postpartum depression among women in the after-disaster group.

Limitations

This study had some limitations. First, this study was based on a single institution, which decreases the generalizability of the results. There were 2 obstetric clinics other than the Iwate Miyako Prefectural Hospital in the region, and this study did not include all perinatal women in the Miyako medical service area. Second, this study did not investigate the impact of "maternity blues" on the results. Third, the study also had statistical and epidemiological limitations because the number of clinical cases was small.

CONCLUSIONS

In conclusion, the percentage of women with EPDS scores ≥9 at hospital discharge was significantly greater in the group that delivered within 3 months after the Great East Japan Earthquake than in the group that delivered before the disaster. The destruction of their home and dissatisfaction with living conditions were more likely to cause perinatal depression in women who delivered after the disaster. An increase in postpartum depression is predicted after a large-scale disaster, and interventions focused on pregnant women should be actively initiated after the disaster.

About the Authors

Department of Obstetrics and Gynecology, Tohoku University Graduate School of Medicine, Miyagi, Japan (Drs H. Nishigori, Sugawara, and Yaegashi); Department of Obstetrics and Gynecology, Iwate Prefectural Miyako Hospital, Iwate, Japan (Ms Sasaki and Drs Hosoyachi and Yoshizumi); Tohoku Medical Megabank Organization (Drs Obara, T. Nishigori, Ishikuro, Metoki, Sugawara, Kuriyama, and Yaegashi)and International Research Institute of Disaster Science, (Dr Kuriyama), Tohoku University, Miyagi, Japan; and Kobayshi Clinic of Obstetrics and Gynecology, Iwate, Japan (Dr Kobayashi).

Correspondence and reprint requests to Hidekazu Nishigori, MD, PhD, Department of Obstetrics and Gynecology, Tohoku University Graduate School of Medicine, 1-1 Seiryo Aoba, Sendai, Miyagi, Japan, 020-8505 (e-mail: nishigori@med.tohoku.ac.jp).

Acknowledgments

We thank Dr Hideyuki Chida, Dr Hideo Kodama, Dr Takeshi Obara, Mrs Toshiko Kurabe, and Dr Yoshihiro Akimoto for their expertise and guidance. This work was supported by JSPS KAKENHI (C) Grant Number 24592457

Published online: April 21, 2015.

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Journal of Affective Disorders 190 (2016) 341–348

Contents lists available at ScienceDirect

Journal of Affective Disorders

journal homepage: www.elsevier.com/locate/jad

Research report

Psychological distress during pregnancy in Miyagi after the Great East Japan Earthquake: The Japan Environment and Children's Study

Zen Watanabe [a], Noriyuki Iwama [a], Hidekazu Nishigori [a,b], Toshie Nishigori [b,c], Satoshi Mizuno [b], Kasumi Sakurai [b], Mami Ishikuro [b,c], Taku Obara [b,c,d], Nozomi Tatsuta [b], Ichiko Nishijima [c], Ikuma Fujiwara [b], Kunihiko Nakai [b], Takahiro Arima [b], Takashi Takeda [a,e], Junichi Sugawara [a,c], Shinichi Kuriyama [b,c,f], Hirohito Metoki [a,b,c,*], Nobuo Yaegashi [a,b,c], Japan Environment & Children's Study Group

[a] Department of Obstetrics and Gynecology, Tohoku University Graduate School of Medicine, 1-1, Seiryo-machi, Aoba-ku, Sendai, Miyagi 980-8574, Japan
[b] Environment and Genome Research Center, Tohoku University Graduate School of Medicine, 2-1, Seiryo-machi, Aoba-ku, Sendai, Miyagi 980-8573, Japan
[c] Tohoku Medical Megabank Organization, Tohoku University, 2-1, Seiryo-machi, Aoba-ku, Sendai, Miyagi 980-8573, Japan
[d] Department of Pharmacy, Tohoku University Hospital, 1-1, Seiryo-machi, Aoba-ku, Sendai, Miyagi 980-8574, Japan
[e] Division of Women's Health, Research Institute of Traditional Asian Medicine, Kinki University School of Medicine, 377-2, Ohnohigashi, Osakasayama, Osaka 589-8511, Japan
[f] Division of Disaster Public Health, International Research Institute for Disaster Science, Tohoku University Graduate School of Medicine, 2-1, Seiryo-machi, Aoba-ku, Sendai, Miyagi 980-8573, Japan

ARTICLE INFO

Article history:
Received 17 August 2015
Received in revised form
11 October 2015
Accepted 15 October 2015
Available online 28 October 2015

Keywords:
Psychological distress
Negative life events
Earthquake
Tsunami

ABSTRACT

Objective: To examine psychological distress among pregnant women in Miyagi prefecture which was directly affected by the Great East Japan Earthquake and tsunami and compare other areas of Japan that were less damaged.
Methods: This study was conducted in conjunction with the Japan Environment and Children's Study (JECS). We examined 10,129 Japanese women using the primary fixed data of the JECS. The Kessler 6-item psychological distress scale (K6) was administered to 7473 eligible women including 998 in Miyagi unit center ('Miyagi UC') and 6475 in the other unit centers ('13UCs'). We compared the prevalence and the risk of distress (K6 $\geq$ 13) during pregnancy in 'Miyagi UC' and '13UCs'.
Results: More women in 'Miyagi UC' (4.9%) suffered psychological distress, compared with '13UCs' (3.1%) ($p < 0.001$). A significantly higher prevalence of women in 'Miyagi UC' (55.5%) had experienced negative life events, whereas '13UCs' showed 42.7% ($p < 0.0001$). In multivariable logistic analyses adjusted for baseline characteristics, there was a significant regional difference of psychological distress (adjusted odds ratio; aOR in Miyagi UC=1.488; 95%CI, 1.059–2.090). After further adjusting for negative life events, the association was diminished (aOR=1.338; 95%CI, 0.949–1.884).
Limitations: The JECS had no data before the earthquake and the extent of damage was not investigated. Possible regional representativeness is also a limitation.
Conclusion: After the Great East Japan Earthquake, the prevalence of pregnant women with psychological distress (K6 $\geq$ 13) were high in Miyagi prefecture. Especially in the coastal area directly affected by tsunami, it is high with or without negative life events experienced.

1. Introduction

On March 11, 2011, a massive earthquake measuring 9.0 on the Richter scale, struck northeast Japan. An earthquake of this magnitude is thought to occur only once in 1000, years. The Great East Japan Earthquake and subsequent tsunami resulted in 19,000 dead or missing, and approximately 400,000 houses collapsed (Fire and Disaster Management Agency of the Ministry of Internal Affairs and Communications, 2015). Miyagi prefecture, located on the pacific coast of Japan, was one of the most seriously damaged areas by tsunami. It was reported that 10,521 people died and 1258 were missing, and 238,119 houses were completely or partially destroyed in Miyagi prefecture (Miyagi Prefecture Government, 2015).

Previous studies have shown that natural disasters affect

* Corresponding author at: Department of Obstetrics and Gynecology, Tohoku University Graduate School of Medicine, 1-1, Seiryo-machi, Aoba-ku, Sendai, Miyagi 980-8574, Japan. Fax: +81 22 717 7258.
E-mail address: hmetoki@med.tohoku.ac.jp (H. Metoki).

http://dx.doi.org/10.1016/j.jad.2015.10.024
0165-0327/

perinatal women's mental health and lead to mental disorders such as perinatal depression (Chang et al., 2002; Dong et al., 2013; Harville et al., 2009; Hibino et al., 2009; Ren et al., 2014; Xiong et al., 2010). Depression or anxiety disorders during pregnancy have negative effects, such as preterm delivery, low birth weight, and hypertensive disorders during pregnancy (Fransson et al., 2011; Lederman et al., 2004; Meng et al., 2012; Mulder et al., 2002; Rahman et al., 2007; Straub et al., 2012). In addition, a depressive or anxious mood during pregnancy can affect the long-term behavioral and emotional development of children according to the prenatal programing hypotheses (Field, 2011; O'Connor et al., 2005, 2003; Sharp et al., 2015). Mental illness during pregnancy may extend to the puerperal period (Dietz et al., 2007; Kitamura et al., 2006; Leigh and Milgrom, 2008; Robertson et al., 2004) and cause postpartum problems such as bonding failure (Kitamura et al., 2013; Kokubu et al., 2012). Early detection and rapid intervention for psychological distress during the perinatal period are important (Choate and Gintner, 2011; Dennis and Dowswell, 2013). Therefore, it is likely that natural disasters will have considerable psychological impact on pregnant women.

There is some genetic vulnerability in susceptibility to perinatal depression (Caspi et al., 2003; Duman and Monteggia, 2006; Krishnan and Nestler, 2008; McEwen, 2007), but demographic and socio-economic factors are strongly associated with a risk of mental imbalance that manifests as perinatal depression (Beck, 2001; Kitamura et al., 2006; O'Hara et al., 1991; Pope, 2000; Robertson et al., 2004). Stressful life events during pregnancy are associated with maternal mental disorders in both human studies and animal experiments (Brummelte and Galea, 2010; Burke et al., 2005; Otte et al., 2005). Stressful life events may interact with vulnerability factors to create psychological distress. However, there is no large-scale population-based study comparing the differences between earthquake disaster-affected areas and non-damaged areas.

The Japan Environment and Children's Study (JECS) was already underway when the Great East Japan Earthquake occurred (Kawamoto et al., 2014). In this study, we used the Kessler 6-item psychological distress scale (K6) from the JECS to assess the influence of the massive earthquake on antenatal psychological distress. And we examined psychological distress among pregnant women in Miyagi prefecture which was directly affected by the Great East Japan Earthquake and tsunami and compare other areas of Japan that were less damaged.

2. Methods

2.1. Study design

This study was a part of the JECS, which was initiated by the Ministry of the Environment in Japan as a nationwide population-based prospective birth cohort to investigate the association between environmental factors and children's health and development. Fifteen units in Japan assented to the JECS (Fig. 1), and women and their families entered between January 2011 and March 2014. Periodical questionnaires and biochemical examinations were conducted during and after pregnancy. The assessment will be continued until the participating children become thirteen years old. Written informed consent was obtained from all participants. The design of JECS has been described previously in detail (Kawamoto et al., 2014).

The national center of JECS provides several data sets for research groups in series. Each research group uses released data sets to investigate its own research subject. In October 2013, the JECS released "jecs-ag-ai-20131008" as the primary fixed data set. We analyzed this primary fixed data from 10,129 women who gave written informed consent to participate in the JECS study, and who had confirmed obstetric outcomes by December 31, 2011. Recruitment for the JECS began in January 2011. However, the Great East Japan Earthquake on March 11, 2011 interrupted enrollment in the coastal area of Miyagi unit center until May 2011. Therefore, we limited our investigation to women who had delivered between June 1, 2011 and December 31, 2011, and who completed the K6, which is described in detail below.

There were fifteen unit centers included in the JECS. Location of each unit center is shown in Fig. 1. Fukushima unit center was excluded because the nuclear power plant accident was considered to create a huge confounding influence. Miyagi unit center ('Miyagi UC') was selected as the disaster area and the other thirteen units ('13 UCs') which suffered no or little direct effects were selected as control areas because this study was intended to assess the impact of the disaster, especially the tsunami. Furthermore, 'Miyagi UC' was divided into two groups: the 'Coast' area which suffered from extensive damage from tsunami, and the 'Inland' area which had massive earthquake damage, but no direct tsunami damage. Seven municipalities were included in each area: Kesennuma, Minami-Sanriku, Ishinomaki, Onagawa, Iwanuma, Watari and Yamamoto in the 'Coast' area, and Osaki, Wakuya,

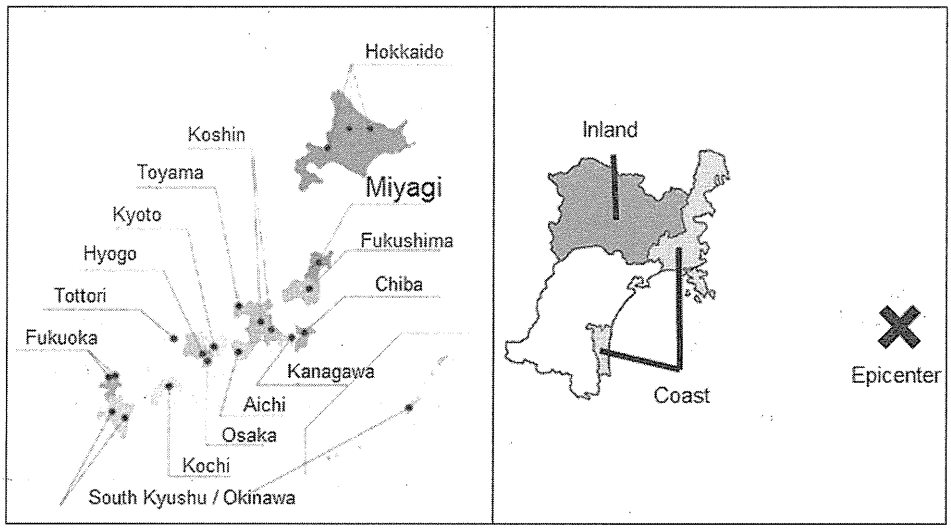

Fig. 1. Fifteen unit centers in the Japan Environment and Children's Study (JECS), and two subgroups in 'Miyagi' unit center, 'Inland' area and 'Coast' area. Left map is an excerpt from the study design of the JECS. Cross on the right map indicates the epicenter of the Great East Japan Earthquake (38°1′N, 142°9′ E).

Misato, Kami, Shikama, Kurihara and Tome in the 'Inland' area.

All data were obtained from two self-reported questionnaires; the "T1" questionnaire was performed upon enrollment and during the maternal first trimester, and the "T2" questionnaire was performed during the second or third trimester.

2.2. Main outcome measurement

The K6 has been widely used as a screening scale for psychological distress in the general population (Kessler et al., 2002, 2003). The Japanese version of the K6 was recently developed using the standard back-translation method (Furukawa et al.,

Table 1
Baseline characteristics by region of The Japan Environment and Children Study.

	13 UCs (n=6475)	Miyagi UC (n=998)	p Value[a]	Inland (n=670)	Coast (n=328)	p Value[b]
Age						
Mean (S.D)	31.2 (4.9)	29.8 (5.2)	<0.0001	29.6 (5.2)	30.0 (5.3)	<0.0001
≤ 24 years	9.2	16.5	<0.0001	17.2	15.3	<0.0001
25–29 years	27.3	32.5		32.8	31.7	
30–34 years	36.2	31.8		31.3	32.6	
≤ 35 years	27.0	19.0		18.5	20.1	
Missing	0.3	0.2		0.2	0.3	
Parity						
Primipara	35.6	37.2	<0.0001	35.4	40.9	<0.0001
Multipara	58.4	62.4		64.3	58.5	
Missing	6.0	0.4		0.3	0.6	
Marital status						
Married	95.7	93.9	0.001	93.3	95.1	0.005
Other	3.8	6.0		6.6	4.9	
Missing	0.5	0.1		0.1	0.0	
Famiry income						
≤ 199 × 10^4 JPY	5.6	9.2	<0.0001	8.7	10.3	<0.0001
200 –399 × 10^4 JPY	32.3	35.2		34.6	36.3	
400–599 × 10^4 JPY	31.6	27.3		25.5	30.8	
≤ 600 × 10^4 JPY	24.7	19.1		20.2	17.1	
Missing	5.8	9.2		11.0	5.5	
Educational level						
Maternal						
Junior high school	5.0	6.1	<0.0001	6.3	5.8	<0.0001
High school	29.0	47.8		48.5	46.3	
College	65.5	45.8		44.9	47.9	
Missing	0.5	0.2		0.3	0.0	
Paternal						
Junior high school	7.7	10.7	<0.0001	10.3	11.6	<0.0001
High school	34.8	51.5		50.4	53.7	
College	56.7	36.3		37.5	33.8	
Missing	0.8	1.5		1.8	0.9	
Body mass index						
< 18.5 kg/m^2	16.7	14.0	<0.0001	13.4	15.2	<0.0001
18.5–24.9 kg/m^2	70.8	71.2		71.1	71.4	
≤ 25 kg/m^2	9.6	14.4		15.2	12.8	
Missing	2.9	0.4		0.3	0.6	
Smoking						
Maternal						
Yes	5.0	8.3	<0.0001	7.6	9.8	0.0003
No	94.2	91.2		91.9	89.6	
Missing	0.8	0.5		0.5	0.6	
Paternal						
Yes	44.7	60.0	<0.0001	58.8	62.5	<0.0001
No	53.4	38.3		39.4	36.0	
Missing	1.9	1.7		1.8	1.5	
Alcohol intake						
Yes	3.8	3.7	0.99	3.3	4.6	0.39
No	95.6	95.7		96.4	94.2	
Missing	0.6	0.6		0.3	1.2	
Feeling toward this pregnancy						
Bemused	7.9	11.5	0.0003	9.9	14.9	<0.0001
Others	91.8	88.4		90.0	85.1	
Missing	0.3	0.1		0.1	0.0	
Past history of mental illness						
Yes	7.5	5.4	0.02	5.5	5.2	0.06
No	92.5	94.6		94.5	94.8	
Fetal number						
Singleton	99.1	98.9	0.53	99.1	98.5	0.58
Multiple	0.9	1.1		0.9	1.5	

Values except for mean of age are percentages.
Miyagi UC' (n=1010) was combined with 'Inland' (n=677) and 'Coast' (n=333).
13 UCs': the thirteen units centers without Miyagi unit center and Fukushima unit center.

[a] Calculated between 'Miyagi UC' and '13 UCs' by χ^2 tests for categorical variables or student t test for continuous normally distributed variables.
[b] Calculated among 'Inland', 'Coast' and '13 UCs' by $\chi 2$ tests for categorical variables or one-way ANOVA for continuous normally distributed variables.

2008). The K6 consists of six questions with five possible responses (0–4) for each question; "none of the time" (0 points), "a little of the time" (1 point), "some of the time" (2 points), "most of the time" (3 points), and "all of the time" (4 points). The six questions were as follows; "During the last 30 days, how often have you felt the followings, (1) nervous, (2) hopeless, (3) restless or fidgety, (4) so depressed that nothing could cheer you up, (5) that everything was an effort, and (6) worthless?" The range of total scores is from 0 to 24. As Kessler et al. (2003) suggested, we classified women with K6 scores ≥ 13 as having psychological distress. In previous studies (Hayasaka et al., 2013; Hozawa et al., 2009; Nakaya et al., 2014), the Japanese version of K6 has been used with the same cutoff point. The K6 was measured two times during pregnancy. The mean and standard deviation of gestational ages for questionnaire response were 22.5 ± 6.0, 27.4 ± 7.0, 19.1 ± 6.4 weeks in 'Inland', 'Coast' and '13UCs', at the time of the first (T1), respectively, and 32.7 ± 2.7, 33.3 ± 3.6, 30.0 ± 4.2 at the time of the second (T2), respectively. In this study, mental distress in the second or third trimester of pregnancy was assessed using the K6 score of the T2 questionnaire because interruption of recruiting just after the earthquake altered the timing of our questionnaire sending.

2.3. Baseline characteristics and negative life events

Based on previous literature (Kitamura et al., 2006; Leigh and Milgrom, 2008; Robertson et al., 2004), we set the baseline characteristics described in Table 1. Information about age, parity, marital status, body mass index (BMI) before pregnancy, family structure, feelings toward this pregnancy and past history of mental illness was obtained by using the T1 questionnaire upon enrollment. Information about family income, education level of couple, smoking history of couple, and maternal alcohol intake was gained from the T2 questionnaire in addition to the K6 scale. Age was divided into four categories: ≤ 24 years, 25–29 years, 30–34 years, and ≥ 35 years. Parity was assorted into 'primipara' and 'multipara' with regard to this pregnancy. Marital status was classified into two groups as 'married' including de facto marriage and 'the others'. Family income, defined by the annual revenue of the household, was categorized as: < 2 million Japanese yen (JPY), 2–4 million JPY, 4–6 million JPY, and > 6 million JPY with reference to the average Japanese household income. Education level of the couple was defined by the highest academic achievement and categorized as follows: junior high school, high school, and college or advanced education. BMI was categorized as: < 18.5 kg/m^2, 18.5–24.9 kg/m^2, and ≥ 25.0 kg/m^2. The information about the smoking history of couple and maternal alcohol intake reflected the situation at the time of T2 questionnaire. Regarding the feelings toward this pregnancy, 'bemused' was defined in the case where subjects felt unsure and embarrassed about the pregnancy. Past history of mental illness included reports of depression, anxiety disorders, schizophrenia and dysautonomia which women had experienced before pregnancy. Fetal number in this pregnancy was classified by singleton, and multiple including twin and triplet.

Past life events affect the psychological condition during pregnancy and after delivery (Beck, 2001; Kitamura et al., 2006; Leigh and Milgrom, 2008; Robertson et al., 2004). Negative life events were defined as the experience of any of the following events: bereavement of close blood relatives and friends, injury and illness of close blood relatives, unemployment of self and husband with large debts, change of family structure, change of residence, marital problems and divorce. In this study, the data of negative life events was obtained from the T2 questionnaire which was administered in the aftermath of the Great East Japan Earthquake.

2.4. Statistical analyses

The distribution of the K6 score was not normal. Therefore we evaluated the difference among the areas for psychological distress during pregnancy using Wilcoxon rank-sum test or Kruskal–Wallis, and calculated odds ratios (ORs) for regional differences using multivariable logistic regression analysis.

Chi-square tests were used to describe regional differences of baseline characteristics between 'Miyagi UC' and '13 UCs'; or 'Inland', 'Coast' and '13 UCs'. Mean maternal age was compared by Student's *t*-test or one-way ANOVA.

In two models of multivariable logistic regression analyses, we calculated ORs of each area in Miyagi for psychological distress. Model 1 was the logistic regression analyses adjusted for all baseline characteristics shown in Table 1: age, parity, marital status, family income, education level of couple, BMI, smoking history of couple, alcohol intake, feelings toward this pregnancy, past history of mental illness, and fetal number. In *Model 2*, we further adjusted for all selected covariates including negative life events. In this study, missing covariates were included in multivariable logistic regression analyses as dummy variables.

We performed stratified analyses to confirm the interaction between regionality and negative life events.

All analyses were performed using SAS version 9.4 (SAS Inc., Cary, NC). A two-sided $p < 0.05$ was regarded as statistically significant.

3. Results

A participants flow diagram is shown in Fig. 2. The primary fixed data of the JECS included 10,129 women from all unit centers. Participants in Fukushima unit center ($n=650$) were excluded due to the huge impact of the nuclear power plant accident. In the other study regions, 9206 women had given birth, and the other 273 women had miscarriages or stillbirths during the period. For those in the second or third trimester, 7645 women responded to the T2 questionnaire. Women who did not provide information on the enrollment questionnaire ($n=122$) and women with missing data on the K6 in the T2 questionnaire ($n=50$) were excluded. Data from 7473 women including 998 women from 'Miyagi UC' were included in these analyses. 'Miyagi UC' had 670 women from the 'Inland' area and 328 women from the 'Coast' area.

As shown in Table 1, the baseline characteristics of pregnant women were significantly different among regions except for alcohol intake and fetal number.

The prevalence of pregnant women with scores of K6 ≥ 13 were 4.9% in 'Miyagi UC', with 3.1% in '13 UCs'. Scores of K6 ≥ 13 for pregnant women in 'Miyagi UC', were 4.6% for 'Inland' and 5.5% for 'Coast'. In the rank sum test, the K6 scores of pregnant women in 'Miyagi UC' ($p < 0.0001$) and 'Inland'/'Coast' ($p=0.0002$) were significantly higher than '13 UCs' (Table 2).

In the heavily damaged 'Miyagi UC', a significantly higher prevalence of pregnant women experienced negative life events compared to '13 UCs', especially bereavement, unemployment, change of family structure, and change of residence (Table 2). In the 'Coast' area, where there was extensive damage particularly from tsunami, there were many pregnant women who experienced bereavement, unemployment of husband, and change of residence.

In univariable logistic regression analyses, 'Miyagi UC' had significantly more pregnant women with psychological distress (K6 ≥ 13) compared with '13 UCs' (Table 3), (OR=1.637; 95%CI, 1.189–2.254). The 'Coast' area had significantly higher prevalence of psychological distress compared with '13 UCs' (OR=1.841; 95% CI, 1.121–3.022).

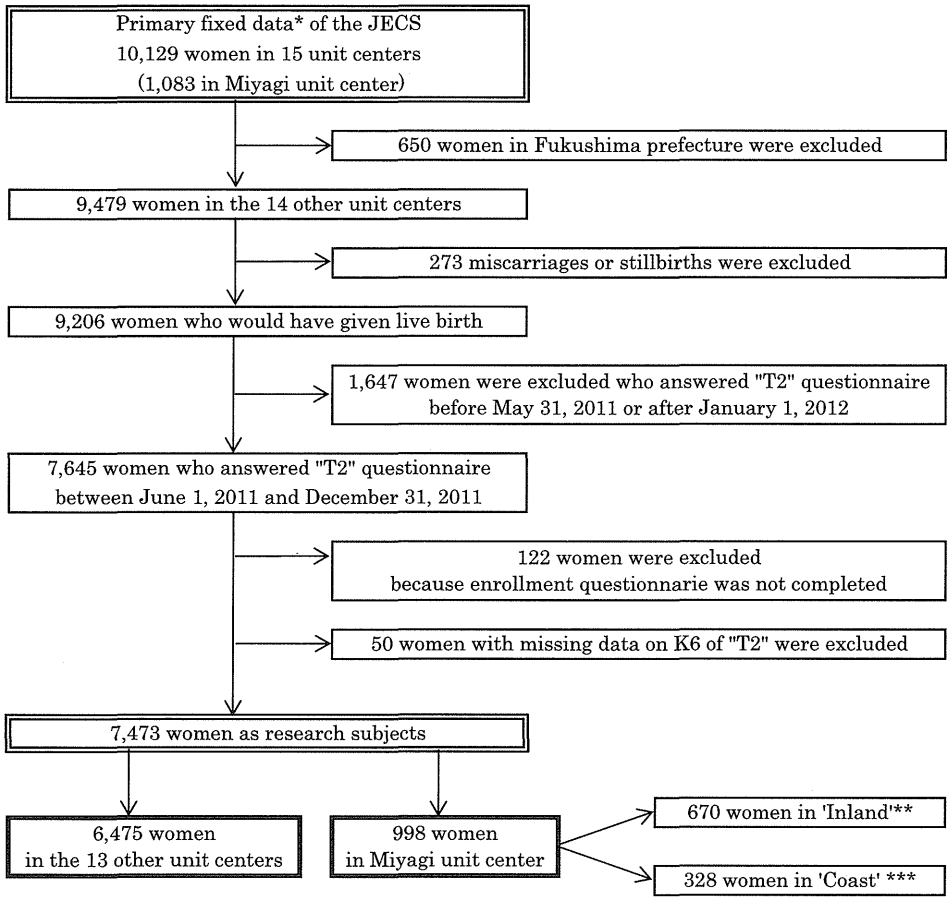

Fig. 2. Participants flow diagram * The primary fixed data was from women who had given informed consent to the JECS, and had obstetric outcome (live birth, miscarriage and stillbirth) by December 31, 2011, ** 'Inland' was the inland area in Miyagi prefecture including Osaki, Wakuya, Misato, Kami, Shikama, Kurihara and Tome, *** 'Coast' was the coastal area in Miyagi prefecture including Kesennuma, Minami-Sanriku, Ishinomaki, Onagawa, Iwanuma, Watari and Yamamoto

Table 2
Total scoring of K6 points and negative life events by region.

	13 UCs $n=6475$	Miyagi UC $n=998$	p *Value*	Inland $n=670$	Coast $n=328$	p *Value*
Total scoring of K6 points						
≤4	71.6	65.7	<0.001**	66.7	63.7	0.0002*
5–9	20.5	23.6		23.1	24.4	
10–12	4.9	5.8		5.5	6.4	
≥13	3.1	4.9		4.6	5.5	
Negative life events[a]						
Yes	42.7	55.5	<0.0001	49.8	67.1	<0.0001
No	56.5	44.1		49.6	32.9	
Missing	0.8	0.4		0.6	0.0	
Fine classification of negative life events[a]						
Bereavement						
Close blood relatives	2.2	3.9	0.001	2.7	6.4	<0.0001
Close friends	1.0	4.4	<0.0001	2.1	9.2	<0.0001
Injury and illness						
Close blood relatives	14.3	11.4	0.01	12.4	9.5	0.02
Disemployment						
Self	1.2	3.1	<0.0001	3.0	3.4	<0.0001
Husband	1.2	2.8	<0.0001	1.8	4.9	<0.0001
Huge debt	1.0	0.7	0.41	0.5	1.2	0.35
Change of family structure	4.0	9.8	<0.0001	9.9	9.8	<0.0001
Change of residence	9.2	12.2	0.002	10.8	15.2	0.0007
Marital problem	10.1	9.9	0.85	8.7	12.5	0.16
Divorce	0.3	0.4	0.38	0.5	0.3	0.63

Values are percentage.
13 UCs': the thirteen units centers without Miyagi unit center and Fukushima unit center.
Miyagi UC' was the group combined with 'Coast' and 'Inland'.

* $p<0.001$.
** $p=0.001$ versus '13 UCs' with the rank sum tests.
[a] Calculated among 'Inland', 'Coast' and '13 UCs' or between 'Miyagi UC' and '13 UCs' by χ^2 tests.

Table 3
Logistic regression analyses for pregnant women with a K6 score ≥13 among areas.

	13 UCs (n=6475) OR (95% CI)	Miyagi UC (n=998) OR (95% CI)	Inland (n=670) OR (95% CI)	Coast (n=328) OR (95% CI)
Crude	1 (ref)	1.637 (1.189–2.254)	1.538 (1.044–2.265)	1.841 (1.121–3.022)
Model 1[a]	1 (ref)	1.488 (1.059–2.090)	1.394 (0.928–2.095)	1.680 (1.002–2.819)
Model 2[b]	1 (ref)	1.338 (0.949–1.884)	1.322 (0.876–1.994)	1.366 (0.812–2.298)

13 UCs' the thirteen units centers without Miyagi unit center and Fukushima unit center.
Miyagi UC' was the group combined with 'Coast' and 'Inland'.

[a] *Model 1*: Adjusted for age, parity, marital status, family income, education level of couple, body mass index, smoking of couple, alcohol intake, feeling toward this pregnancy, past history of mental illness, and fetal number.

[b] *Model 2*: Adjusted for negative life events in addition to *Model 1*.

When comparing '13UCs' and 'Miyagi UC' in multivariable analysis after adjusting for possible confounding factors (*Model 1*), the statistically significant association between areas and K6 ≥ 13 remained (OR=1.488; 95%CI, 1.059–2.090); furthermore, when we adjusted for negative life events (*Model 2*), the association between areas and K6 ≥ 13 was diminished (OR=1.338; 95%CI, 0.949–1.884). When 'Miyagi UC' was subdivided into 'Inland' and 'Coast' in the multivariate logistic analysis, the 'Coast' area had the same association as 'Miyagi UC' in *Model 1* and *Model 2*; OR=1.680 (95%CI, 1.002–2.819), OR=1.366 (95%CI, 0.812–2.298), respectively. On the other hand, the association between 'Inland' and K6 ≥ 13 was also diminished in both *Model 1* and *Model 2*; OR=1.394 (95% CI, 0.928–2.095), OR=1.322 (95%CI, 0.876–1.994), respectively.

We also examined the combination of areas and negative life events for psychological distress (Fig. 3). When we compared women in '13UCs' without negative life events, ORs for psychological distress among women in the 'Coast' area and women in the 'Inland' area were 4.025 (95%CI, 1.651–9.811) and 1.605 (95%CI, 0.743–3.465), respectively. Although women in '13UCs' with negative life events had significantly high OR for psychological distress (OR=3.567; 95%CI, 2.543–5.004), ORs for psychological distress among the 'Inland' and 'Coast' areas were similar, 4.428 (95% CI, 2.601–7.540), and 3.553 (95%CI, 1.823–6.925), respectively. The negative interaction between 'Coast' and 'negative life events' was significant (p=0.01).

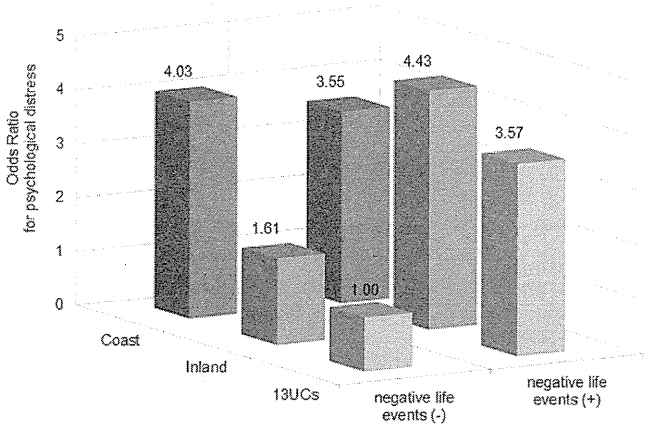

Fig. 3. Combined analyses for interaction between areas and negative life events. '13 UCs': the thirteen units centers did not include Miyagi unit center and Fukushima unit center. Adjusted for age, parity, marital status, family income, education level of couple, body mass index, smoking history of couple, alcohol intake, feelings toward this pregnancy, past history of mental illness, and fetal number.

4. Discussion

Several research studies have reported that natural disasters affected the maternal psychological condition and contributed to increased depressive symptoms during and after pregnancy (Chang et al., 2002; Dong et al., 2013; Harville et al., 2009; Hibino et al., 2009; Ren et al., 2014; Xiong et al., 2010). In Miyagi prefecture, where tsunami caused serious damage in the coastal area, it is likely that victimized pregnant women faced immeasurable psychological suffering. Actually the prevalence of postnatal depression assessed by the Edinburgh Postnatal Depression Scale was higher (21.3%) in Miyagi prefecture after the Great East Japan Earthquake, compared with Japanese women who did not experience an earthquake (13.9%) (Nishigori et al., 2014). Women who experience depressive disorders during pregnancy are more vulnerable to postpartum depression (Dietz et al., 2007), thus it is likely that there were many depressive postpartum women in Miyagi prefecture after the earthquake.

In the present study, the prevalence of pregnant women with psychological distress (K6 ≥ 13) was 4.9% in 'Miyagi UC', while '13UCs' showed only 3.1% (Table 2). In the previous data from a Japanese nationwide survey in 2007 (Kawakami and Furukawa, 2007), the total distribution of K6 points of Japanese people showed; 72.0% had K6 ≤ 4, 20.0% had 5–9, 5.0% had 10–12, and 3.0% had ≥ 13. K6 score in '13UCs' might reflect the typical pattern of the normal Japanese population who were not affected by disasters.

According to an investigation of negative life events, there were many people in the 'Coast' who experienced bereavement of parents or close friends, their own or partner's unemployment, change of family structure or change of residence; whereas in the 'Inland' area people experienced bereavement of close friends, their own unemployment or a change of family structure. These results suggested the enormous influence of the tsunami on the 'Coast'.

It is reasonable to consider that bereavement of close relatives or friends would have a strong correlation with psychological distress; thus many more pregnant women could have K6 scores ≥ 13; however only 4.9% of women in 'Miyagi UC', and 5.5% in the 'Coast' area, actually had psychological distress. Other factors such as 'huge disaster scale beyond the reach of imagination' and 'personality of Japanese' might work as suppressors, or other influences could have a closer relationship and a large enough impact to cancel the effects of negative life events.

Postpartum depression in Japan was reported to be lower compared to other countries (Kumar, 1994). In addition, in a study of global burden of disease, Japan had the lowest prevalence of depressive disorders in the world (Ferrari et al., 2013). It may be said that Japanese women are apt to restrain their emotions. Therefore the mental condition might be less reflected in the psychological scale. Because the prevalence of psychological distress was not exceptionally high considering the scale of the Great East Japan Earthquake and the extensive damage, differences among the areas might not be significant.

In multivariable analyses adjusted for the baseline characteristics including age, parity, marital status, family income, education level of couple, smoking history of couple, alcohol intake, feelings toward this pregnancy, past history of mental illness, and fetal number, the significant differences of psychological distress among the regions remained; 'Miyagi UC' (OR=1.488; 95%CI, 1.059–2.090). After 'Miyagi UC' was divided into two groups, there was a distinction between 'Inland' and 'Coast'. The pregnant women in the 'Coast' area (OR=1.680; 95%CI, 1.002–2.819) became vulnerable to psychological distress, whereas there was no statistical association in the 'Inland' area (OR=1.394; 95%CI, 0.928–2.095). When we further adjusted for negative life events, the

association was completely diminished in both areas. This means that negative life events had a great impact. Actually the OR of negative life events for psychological distress was very strong (OR=3.822; 95%CI, 2.855–5.115). The frequency of negative life events, which pregnant women had experienced, was very different between Miyagi unit center and the other 13 unit centers, and was notably higher in the 'Coast' area (Table 2). The difference of negative life events might affect the difference of psychological distress.

In the combined analyses, when pregnant women experienced negative life events, their risk of psychological distress was almost equal regardless of location. In pregnant women who did not experience negative life events, the more they were affected by the disaster especially tsunami, the greater the risk of psychological distress was. Paradoxically, just in the 'Coast' area, the risk of psychological distress did not change through the experience of stressful events. There was a statistically significant negative-interaction between the 'Coast' area and 'negative life events' ($p=0.01$). In contrast, there was little interaction between the 'Inland' area and 'negative life events'. Though both the 'Coast' area and the 'Inland' area were areas of devastation in the same prefecture, the interactions were different.

Miyagi prefecture sustained the most serious damage from the earthquake and tsunami, such as collapse of homes, electric power failure, and disruption of the water supply. The coastal area suffered the most damage from the tsunami. In this huge disaster, 11,779 people approximately 0.5% of the entire population of Miyagi prefecture were dead or missing, and 238,119 houses were destroyed across Miyagi prefecture. However damage situations depended a lot on whether tsunami directly hit. Actually in the 'Coast' area, which was directly affected by tsunami, 7148 people died and 2299 were missing that were equal to 2.6% of the population of the area, and 59,912 houses were completely or partially destroyed, whereas 23 dead or missing people (0.006%) and 7155 destroyed houses in the 'Inland' area (Miyagi Prefecture Government, 2015). The damage and revival situations right after the Great East Japan Earthquake were much different between the 'Inland' area and the 'Coast' area. The direct damage from tsunami might make the difference of interactions.

Higher prevalence of women with high scoring points of K6 in the tsunami-affected areas (Table 2) reflected the combined effect that there were more women who experienced negative life events in the tsunami-affected areas than the others, as well as the effect that higher prevalence of psychological distress was observed in the group without negative life events. This result in the combined analyses could indicate that pregnant women who survived were less affected by the negative life events included in the questionnaire of this study. There might be the other certain factors which could not be gleaned from survey data of JECS.

Survivors in Miyagi prefecture, especially in the coastal area directly affected by tsunami, had more long-term restrictions than other people. Most of them probably encountered miserable circumstances and were apart from their ordinary lives. In the 'Coast' area, the prevalence of psychological distress (K6 ≥ 13) was almost equal without (5.5%) or with (5.4%) negative life events, whereas it changed in the others; 1.3%, 5,5% in '13 UCs' and 2.4%, 6.8% in the 'Inland' area, respectively. In the 'Coast' area, pregnant women under such a catastrophic situation probably reached a certain level of stressful conditions, even if they had not experienced negative life events included in the questionnaire. It appears that the impact on psychological distress of living in disaster areas during the reconstruction period was so great that the additional influence of negative life events was reduced. After the huge earthquake and tsunami, regardless of whether or not survivors experienced negative life events, all needed total support including mental health care to prevent psychological distress.

The previous literatures said that multiple pregnancy increased the risk of maternal mental disorder (Leonard, 1998; Thorpe et al., 1991). In 7,473 women as research subjects, 69 women (0.92%) of multiple pregnancy participated in this study. After we analyzed 7404 women in the only singleton pregnancy, the results did not change in both *Model 1* and *Model 2*.

There are some limitations of this study. First, there was no data before the Great East Japan Earthquake and we did not conduct an investigation about the extent of damage. We could not directly know if the earthquake and the tsunami affected the women's psychological condition during pregnancy. The second limitation is that, participation in JECS was not compulsory, thus there is a limitation regarding regional representativeness. JECS have made contact with as many expecting mothers as possible, who reside in study areas, and the recruitment rate is targeted to be more than 50% of all eligible mothers (Kawamoto et al., 2014). However sample coverage rates estimated from the circulation of Maternal and Child Health Handbooks during the study period was 63.4% in the coastal area and 70.3% in the inland area; therefore some level of representativeness is ensured.

5. Conclusion

Three to nine months after the Great East Japan Earthquake, the prevalence of pregnant women with psychological distress (K6 ≥ 13) were high in Miyagi prefecture, especially in the coastal area. The pregnant women, in the coastal area directly affected by tsunami, had the high risk of psychological distress regardless of whether they had actually experienced negative life events.

Authorship disclosure

All authors declare that they have no conflicts of interest. All authors have contributed to this scientific work and approved the final version of the manuscript. ZW performed the data analyses and wrote the manuscript. HM was involved in the design of the paper, supervised the data analyses, and co-wrote the manuscript. NI, HN, TN, SM, KS, MI, TO and TT helped to analyze data and supervise the manuscript. SM, KS, MI and TO were responsible for data gathering and cleansing. NT, IN, IF, KN, TA, JS, SK and NY were involved in the conception of the JECS and helped to improve the manuscript.

Acknowledgements

The Japan Environment and Children's Study was funded by the Ministry of the Environment, the Government of Japan. The conclusions of this article do not reflect the administration's views.

Members of the JECS as of 2015 (principal investigator, Toshihiro Kawamoto): Hirohisa Saito (National Center for Child Health and Development, Tokyo, Japan), Reiko Kishi (Hokkaido University, Sapporo, Japan), Nobuo Yaegashi (Tohoku University, Sendai, Japan), Koichi Hashimoto (Fukushima Medical University, Fukushima, Japan), Chisato Mori (Chiba University, Chiba, Japan), Fumiki Hirahara (Yokohama City University, Yokohama, Japan), Zentaro Yamagata (University of Yamanashi, Chuo, Japan), Hidekuni Inadera (University of Toyama, Toyama, Japan), Michihiro Kamijima (Nagoya City University, Nagoya, Japan), Ikuo Konishi (Kyoto University, Kyoto, Japan), Hiroyasu Iso (Osaka University, Suita, Japan), Masayuki Shima (Hyogo College of Medicine, Nishinomiya, Japan), Toshihide Ogawa (Tottori University, Yonago, Japan), Narufumi Suganuma (Kochi University, Nankoku, Japan), Koichi Kusuhara (University of Occupational and Environmental Health, Kitakyushu, Japan), Takahiko Katoh (Kumamoto University, Kumamoto, Japan).

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体力科学 第64巻 第3号 323-332 (2015)
DOI：10.7600/jspfsm.64.323

原　著

スクリーン時間ならびに勉強時間と体力の関連
－震災後における東北太平洋側地域の高校2年生を対象とした横断研究－

中條 雅彦[1]，門間 陽樹[2]，黄 聡[2]，永富 良一[1,2]

Association between screen viewing time and study time of physical fitness: A cross-sectional study among second-year high school students of the Pacific side in the Tohoku region after The Great East Japan Earthquake disaster

Masahiko Chujo[1], Haruki Momma[2], Cong Huang[2] and Ryoichi Nagatomi[1,2]

[1] 東北大学大学院医学系研究科運動学分野，〒980-8575 宮城県仙台市青葉区星陵町2-1 *(Department of Medicine and Science in Sports and Exercise, Graduate School of Medicine, Tohoku University, 2-1 Seiryo-machi, Aoba-ku, Sendai, Miyagi 980-8575, Japan)*

[2] 東北大学大学院医工学研究科健康維持増進医工学分野，〒980-8575 宮城県仙台市青葉区星陵町2-1 *(Division of Biomedical Engineering for Health and Welfare, Graduate School of Biomedical Engineering, Tohoku University, 2-1 Seiryo-machi, Aoba-ku, Sendai, Miyagi 980-8575, Japan)*

Received: January 27, 2015 / Accepted: April 22, 2015

Abstract The purpose of this study was to examine the association of screen viewing time (SVT) and study time (ST) with physical fitness among second-year high school students. This cross-sectional study was carried out including 678 (boys: n = 322) students enrolled from 2011 to 2013. Physical fitness measurements included muscular fitness, explosive power and endurance performance. Muscular fitness and explosive power were evaluated by grip strength and standing broad jump test, respectively. Endurance performance was evaluated by endurance running speed of 1500 meters (in boys) or 1000 meters (in girls) running. SVT, ST and other lifestyle behaviors were obtained by a self-reported questionnaire. Analysis of covariance was used to examine the association of SVT and ST with grip strength, standing broad jump distance and endurance running speed. After adjustment for potential confounders, longer SVT was associated with poorer endurance running speed in both boys and girls, (p for trend < 0.01). Longer SVT was also associated with lower standing broad jump distance in boys (p for trend = 0.007) and grip strength in girls (p for trend = 0.005). In boys, longer ST was also associated with lower grip strength after adjustment for potential confounders (p for trend = 0.007). In conclusion, these results suggest that differences between SVT and ST may have different effects on physical fitness data 3-year after the earthquake disaster. Further studies are necessary to confirm the findings of this study.

Jpn J Phys Fitness Sports Med, 64(3): 323-332 (2015)

Keywords : screen viewing time, study time, physical fitness, high school students, cross-sectional study

緒　言

近年，子どもの体力低下[1-3]が大きな問題となっていることはよく知られている．毎年，文部科学省が実施している新体力テストの報告によると，平成25年の高校生の持久走（男子1500 m，女子1000 m）と握力は，昭和60年頃と比較すると1500 mで約4％，1000 mで約6％，握力で男女いずれも約6％，各々の種目で低い値を示している[4]．高校生の体力は成人期以降の生活習慣病の発症と関連すること[5,6]，さらに青年期の体力が高ければ成人期以降の体力も高い値を示すこと[7]を考慮すると，青年期の体力を高いレベルに向上し，それを維持することが将来の健康にとって重要であるといえる．

子どもの体力低下の原因として，学外の学習活動や室内での遊び時間の増加，いわゆる，学習時間や座位行動の増加が影響力の強い原因の一つとして挙げられている[1,3]．実際に，青年期を対象にした先行研究において，テレビ（TV）視聴時間は心肺体力と負の関連を示し[8]，

また，TV視聴時間と筋力についても負の関連が認められている[9]．生活環境の変化や価値観の多様化により，特に最近の高校生は，通学や部活動，放課後の行動，勉強に費やす時間は様々であり，座位行動や勉強時間などに関わる時間は，個々人の生活様式に強く影響を受けると考えられる．学内での生活は基本的に一様であることを考えると，放課後の過ごし方が体力に強い影響を与えている可能性が高い．日本の高校生は，放課後に勉強およびTVの視聴，パソコン，TVゲームに費やす時間（スクリーン時間）はそれぞれ約1時間[10]および約2時間[11]と報告されており，先行研究で注目されているスクリーン時間に加えて，学外での勉強時間が体力に与える影響も無視することはできない．しかしながら，その一方で，学業成績と体力テストの成績は正の関連を示し[12]，勉強時間と学業成績は正の関連を示すことから[13]，学外での勉強時間と体力は正の関連を示す可能性も考えられる．しかし，学外での勉強時間が体力に対し，どのような影響を与えるかについて検討した研究は，現在のところ報告されていない．

そこで，本研究は，日本の高校生を対象に，学外のスクリーン時間および勉強時間と体力との関連について検討することを目的とした．本研究においては，スクリーン時間および勉強時間が長ければ，体力指標は低い値を示すと仮説を立て検証を行った．

方　法

対象者　対象者は，2011年～2013年の間，東北太平洋側地域の中都市に位置し，2011年3月に東日本大震災で被災したN高校に在籍した2年生857人である．このうち身長，体重の欠損値のある者140人，体力データの欠損値のある者9人，生活習慣のデータの欠損値のある者30人をそれぞれ除外し，最終的な分析対象者は，678人（男子322人，女子356人）とした（Fig. 1）．

体力測定は，2011年～2013年の各年6月上旬に市営陸上競技場で当該校の保健体育科教員が実施した．ただし，2011年は東日本大震災の影響により，同年9月上旬に校庭と同校体育館で実施した．1年生は受験後のため体力を正確に把握しにくく，また，3年生はこの時期進路実現に向けた準備に取り掛かることから，対象を2年生に限定した．測定は，本研究を行うにあたり，事前に生徒とその保護者に調査の内容を説明したうえで，書面で同意を得た．本研究は，東北大学大学院医学系研究科倫理委員会の承認を得て実施した（承認番号2014- 1-549）．

体力評価　体力評価を行うため，新体力テスト実施要項[14]に基づき，新体力テストを行った．本研究においては，新体力テストの項目のうち国際的な子供期・青年期の健康関連体力テストであるThe ALPHA（Assessing Levels of Physical Activity）Fitness tests battery[15]で妥当性・信頼性・安全性が認められている握力，立幅跳，20 mシャトルラン（SR）を体力指標として採用した．ALPHAと新体力テストの評価の解釈，実施方法は同じである．さらに心肺体力の評価は，先行研究[16]で採用され，一度に多くの人数を少ない用具（たとえばストップウォッチ）で測定可能な[17]持久走（男子1500 m，女子1000 m）を本研究で採用した（ただし，新体力テストは，20 mSRか持久走のどちらかを選択することとなってい

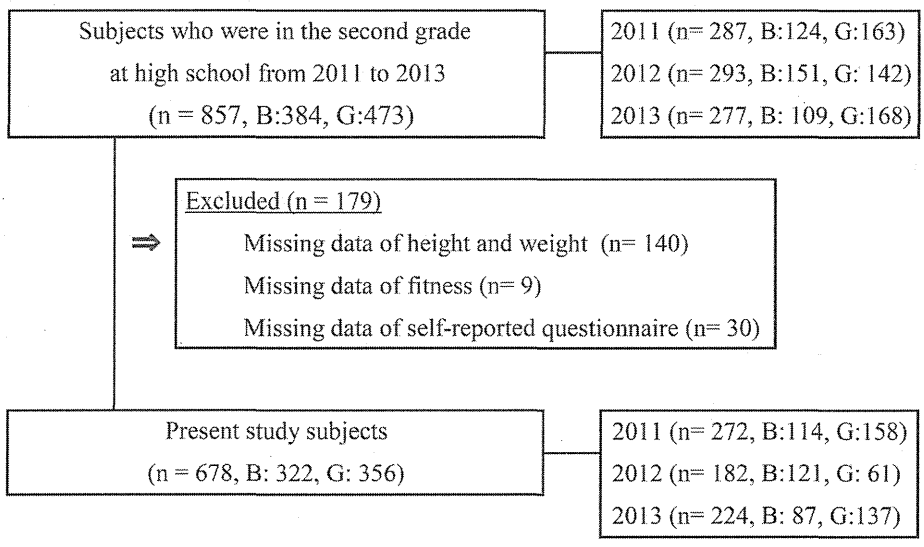

Fig. 1　Flowchart of subjects in this study.
Boys: B, Girls: G