

表2. 質問紙の回収状況

		0-2歳	3-6歳	小学生	中学生	16歳以上	保護者	合計
山田町	配布	241	399	728	465	848	465	3146
	回収	92	168	297	130	247	127	1061
	回収率	38%	42%	41%	28%	29%	27%	34%
大槌町	配布	214	297	508	328	612	328	2287
	回収	80	107	177	86	158	89	697
	回収率	37%	36%	35%	26%	26%	27%	30%
釜石市	配布	19	28	51	30	68	30	226
	回収	4	13	29	14	32	14	106
	回収率	21%	46%	57%	47%	47%	47%	47%
陸前高田市	配布	277	446	895	577	949	577	3721
	回収	175	279	562	309	474	307	2106
	回収率	63%	63%	63%	54%	50%	53%	57%
合計	配布	751	1170	2182	1400	2477	1400	9380
	回収	351	567	1065	539	911	537	3970
	回収率	47%	48%	49%	39%	37%	38%	42%

### Ⅲ. 研究成果の刊行に関する一覧

研究成果の刊行に関する一覧表

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# Mental Health and Related Factors after the Great East Japan Earthquake and Tsunami

Yukari Yokoyama<sup>1,2\*</sup>, Kotaro Otsuka<sup>3</sup>, Norito Kawakami<sup>4</sup>, Seiichiro Kobayashi<sup>5</sup>, Akira Ogawa<sup>6</sup>, Koza Tanno<sup>1</sup>, Toshiyuki Onoda<sup>1</sup>, Yumi Yaegashi<sup>1</sup>, Kiyomi Sakata<sup>1</sup>

**1** Department of Hygiene and Preventive Medicine, School of Medicine, Iwate Medical University, Iwate, Japan, **2** Department of Social Welfare, Nihon Fukushi University, Aichi, Japan, **3** Department of Psychiatry and Disaster Medicine, School of Medicine, Iwate Medical University, Iwate, Japan, **4** Department of Mental Health, Graduate School of Medicine, The University of Tokyo, Tokyo, Japan, **5** Department of Plastic and Reconstructive Surgery, School of Medicine, Iwate Medical University, Iwate, Japan, **6** Iwate Medical University, Iwate, Japan

## Abstract

Mental health is one of the most important issues facing disaster survivors. The purpose of this study is to determine the prevalence and correlates of mental health problems in survivors of the Great East Japan Earthquake and Tsunami at 6–11 months after the disaster. The questionnaire and notification were sent to the survivors in three municipalities in the Tohoku area of the Northern part of Honshu, Japan's largest island, between September 2011 and February 2012. Questionnaires were sent to 12,772, 11,411, and 18,648 residents in the Yamada, Otsuchi, and Rikuzentakata municipalities, respectively. Residents were asked to bring the completed questionnaires to their health check-ups. A total of 11,124 or (26.0%) of them underwent health check-ups, and 10,198 were enrolled. We excluded 179 for whom a K6 score was missing and two who were both 17 years of age, which left 10,025 study participants (3,934 male and 6,091 female, mean age 61.0 years). K6 was used to measure mental health problems. The respondents were classified into moderate (5–12 of K6) and serious mental health problems (13+). A total of 42.6% of the respondents had moderate or serious mental health problems. Multivariate analysis showed that women were significantly associated with mental health problems. Other variables associated with mental health problems were: younger male, health complaints, severe economic status, relocations, and lack of a social network. An interaction effect of sex and economic status on severe mental health problems was statistically significant. Our findings suggest that mental health problems were prevalent in survivors of the Great East Japan Earthquake and Tsunami. For men and women, health complaints, severe economic status, relocations, and lack of social network may be important risk factors of poor mental health. For men, interventions focusing on economic support may be particularly useful in reducing mental health problems after the disaster.

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\* Email: yyukari-ky@umin.ac.jp

## Introduction

On March 11, 2011, Japan was rocked by a magnitude 9.0 earthquake that caused serious damages to the Tohoku area in the northern part of the main island of Japan. The tsunami that followed the earthquake devastated the coastal areas, and as of November 2012, 15,873 people have been confirmed dead, and 2,768 are still missing [1]. The widespread, costly damage has been referred to as the worst natural disaster in the recorded history of Japan.

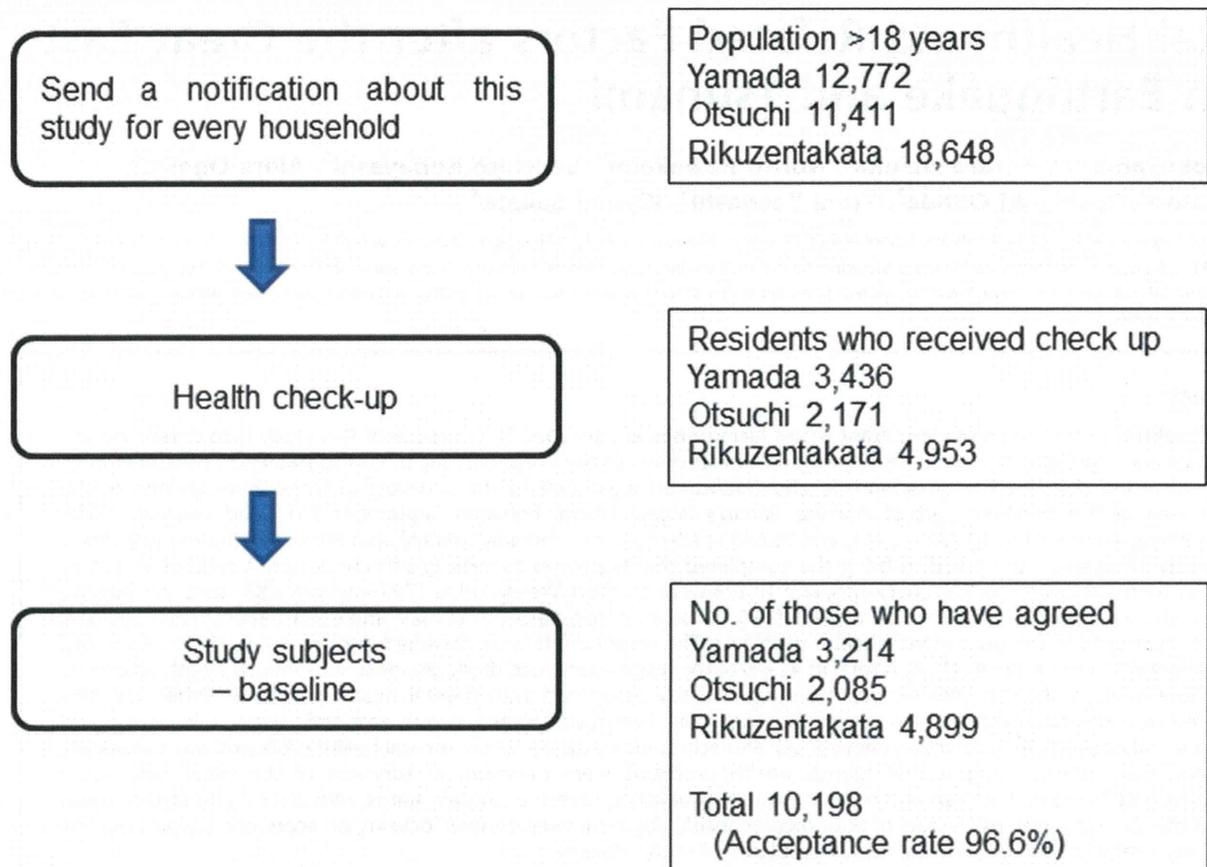
Mental health is one of the most important issues for disaster survivors, and many studies have reported higher rates of mental health problems after disasters (e.g., hurricanes and tsunamis) [2–5]. In Japan, mental health problems have been a matter of great concern after disasters, such as the Hanshin Awaji Earthquake in 1995 that killed more than 5,500 people [6] and the Niigata-Chuetsu Earthquake in 2004 that forced the evacuation of 103,000 residents [7]. However, the Great East Japan Earthquake wreaked enormous damage, surpassing that of previous disasters.

Previous research led us to expect a high prevalence of mental health problem among the victims of the Great East Japan Earthquake.

It is essential to identify vulnerable populations and give them effective assistance. Available evidence shows that risk factors for mental health include age [8], female sex [9–11], low socioeconomic status [9], relocation [12], and lack of social network [8,9].

However, no previous studies allowed us to clarify the factors associated with mental health in the large population of the disaster-stricken area after the 2011 Great East Japan Earthquake.

In addition, despite the consistent sex differences observed in the prevalence of mental health problems after disasters [9–11], previous studies have not sufficiently established specific risk factors by sex. Females are more likely to have mental health problems, regardless of whether assessments occurred in the aftermath of a disaster [13,14]. However, risk factors, such as unemployment are known to have more serious repercussions on mental health among males [15]. Previous studies conducted in Japan have revealed that increasing opportunities for social



**Figure 1. Study Design, Sample Selection, and Description of the Study Population.**

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participation improves mental health, especially for females [16]. Therefore, determining sex specific stressors could provide important insights into the appropriate interventions needed for facilitating coping, healing, and recovery from loss and catastrophe. The primary objective of the present study was to report the prevalence of mental health problems among survivors of the 2011 Great East Japan Earthquake and Tsunami. The secondary objective was to examine the factors associated with mental health according to sex.

## Materials and Methods

### Study populations

We analyzed part of data from the RIAS (RIAS; Research project for prospective Investigation of health problems Among Survivors of the Great East Japan Earthquake and Tsunami Disaster). It was launched with the purpose of screening the physical, mental, and social health of residents in the devastated area, and determining the long-term health impact of the disaster. The survey was carried out between September 2011 and February 2012 in 3 municipalities in Iwate Prefecture located in the Tohoku area in the northern part of Honshu, Japan's largest island. The municipalities were Yamada Town, Otsuchi Town and Rikuzentakata City, which were heavily damaged by the earthquake, and broad areas were washed away by the tsunami. Seven hundred and ninety-nine people died or were missing in Yamada, 1,811 in Rikuzentakata, and 1,311 in Otsuchi [17], which accounted for 4.3%, 7.8%, and 8.6% of the total population in each municipality respectively. Otsuchi sustained the second

highest ratio of dead and missing in Japan, Rikuzentakata the third, and Yamada the fifth.

Although at that time we could not know for certain the population remaining after the disaster (owing to various factors such as residents dying, going missing, or relocating), we sent out notifications of the health survey and questionnaires to all residents aged 18 years or older based on provisional figures compiled by municipalities: 12,772 people in Yamada, 11,411 in Otsuchi, and 18,648 in Rikuzentakata. Many survivors had informed their municipal government of their addresses when filing their claims for accident compensation. As some residents did not live at the addresses captured by the government's system, we announced our health check-ups on a community bulletin board located at the temporary housing complexes in addition to mailing notifications and questionnaires to residents whose addresses were registered with their municipal government. Most of the relocated survivors lived in the same areas compensation filing system where their temporary housing complexes were situated, and had received information about the check-ups from the municipality. Thus, there is a high possibility that residents of the devastated areas were well aware of the health checks. We asked residents to complete the questionnaire and bring it to their municipal check-up site. When the residents received a health check-up, we explained the study in detail. If the answers in the questionnaires were insufficient, a trained interviewer asked the respondent to answer as fully as possible.

Figure 1 shows the selection of the participants in this study. A total of 11,124 people underwent health check-ups, and 10,198 people gave written informed consent for participation in this

study (acceptance rate: 91.7%). Participants comprised about 25% of the area population in the same age group in the 3 municipalities (See Appendix S1, S2, S3 and S4 for more information). Of these 10,198 participants, we excluded 179 for whom the mental health score was missing and 2 who were 17 years old. Consequently, 10,025 participants (3,934 male and 6,091 female) took part in the present study. Mean age (SD) was 62.3 (14.5) years and 60.1 (14.7) years respectively.

The study protocol was reviewed and approved by the Ethics Committee of Iwate Medical University.

## Measurements

**Mental health.** Mental health was assessed using the K6 scale [18,19], which consisted of 6 items measuring mental health on a 5-point Likert scale. Each question was scored from 0 to 4, and the total points score therefore ranged from 0 to 24. In this study, Cronbach's  $\alpha$  coefficients were 0.88. Based on previous research on K6 in Japan, the respondents were classified into having a serious mental health problem (SMHP) (the score of 13+), moderate mental health problem (MMHP) (5–12), and no mental health problem (0–4) [3,20–22].

**Correlates.** We collected by self-administered questionnaire information on demographic characteristics, presence or absence of health complaints, economic status, frequency of relocation, and social network. To assess health complaints, we asked respondents, "In the past few days, have you had any health problems?" (yes or no) Economic status was assessed by asking, "How do you feel about your current economic situation?" with 4 options: very severe, severe, slightly severe, and normal. On the basis of their answers, participants were categorized into 2 groups: severe (very severe, severe, and slightly severe) or normal. After the disaster, 386 evacuation centers were located in the Iwate Prefecture [23]. We asked them, "How many times have you been moved from an evacuation center?" with 5 options, no relocation, 1, 2, 3, and  $\geq 4$ . Frequency of relocation was categorized into 3 groups: no relocation, 1 or 2, and  $\geq 3$ . The Lubben's Social Network Scale was used to assess social networks size [24,25]. This measure used 6 questions: 3 questions evaluated 3 different aspects of social networks that are attributable to family ties and a parallel set to friendship ties. Although the original scale contained a definition sentence of family, we decided to avoid the description, taking into consideration the feelings of the bereaved. Each question was scored from 0 to 5. The total score ranged from 0 to 30, and a high score indicated a larger social network size. In this study, Cronbach's  $\alpha$  coefficients were 0.86. In previous studies, a cut-off point of  $<12$  has been used to screen for social isolation. We classified respondents with scores of  $<12$  as lacking a social network [24].

## Statistical Analysis

Participants were divided into five categories according to their age at survey: 18–44, 45–54, 55–64, 65–74, and  $\geq 75$  years. First, we presented characteristics of total, male and female participants by age categories and the chi-square test was used to evaluate differences in characteristics. Second, we also presented characteristics of total, male and female participants by K6 groups. Third, we examined the associations between K6 score and the following variables: sex, age, health complaints, economic status, frequency of relocations, and social network. Multinomial logistic regression was used to determine correlates of MMHPs (a score of 5–12 on the K6) and SMHPs (a score of 13+) relative to no mental health problem (0–4). In the multivariate models, the above variables and municipality were all adjusted for each other. Tests for an interaction between sex and each study variable were

conducted by entering an interaction term for sex and each risk factor in multivariate models. All statistical analyses were performed with SPSS version 20.0 (IBM), and all statistical tests were 2-sided. P values  $<0.05$  were considered to indicate statistical significance.

## Results

The characteristics are presented in Table 1. A total of 42.6% of the study population were classified with either MMHPs or SMHPs: 36.4% (31.2% of male participants, 39.7% of female participants) with MMHPs and 6.2% (4.5% of male participants, 7.3% of female participants) with SMHPs. The proportion of respondents with health complaints was about 50% in participants aged 18–44 years and 45–54 years, whereas in those aged 65–74 years, it was about 40%. In participants aged 55–65 years, 65–74 years, and 75 years older, about half of them experienced relocation from their former homes, whereas about 60% had relocated. Nearly half of the respondents in participants aged 18–44 years and 45–54 years had lacked a social network (score  $<12$ ). The tendencies above were not much different between sexes.

Table 2 shows the descriptive data according to K6 score. Female participants were more likely to have MMHPs and SMHPs than male participants. More than 70% of respondents with SMHPs reported having health complaints, and severe economic status. These were also reported by about 60% of those with MMHPs. Nearly one third of those with SMHPs reported  $\geq 3$  relocations, whereas one quarter of MMHPs reported the same. Separated by sex, more male (68.0% of MMHPs, 83.1% of SMHPs) than female (61.6%, 71.5%) respondents had reported severe economic status. In male, 60% of respondents with SMHPs and 47.6% of those with MMHPs lacked a social network, whereas in female, 53.1% of SMHPs and 44% of MMHPs did.

Table 3 shows the results of multinomial logistic regression analysis with the no case group as the reference category. Multivariate analysis showed that female respondents were more likely to have MMHPs [odds ratio (OR), 1.5; 95% confidence interval (CI), 1.4–1.7] and SMHPs (OR, 1.8; 95% CI, 1.5–2.3). In multivariate models, the factors associated with both MMHPs and SMHPs were: health complaints (OR, 2.1; 95% CI, 1.9–2.3 and OR, 4.6; CI, 3.8–5.6); severe economic status (OR, 2.3; 95% CI, 2.1–2.5 and OR, 3.4; 95% CI, 2.8–4.2); 1 to 2 relocations (OR, 1.2; 95% CI, 1.1–1.4 and OR, 1.4; 95% CI, 1.2–1.8);  $\geq 3$  relocations (OR, 1.4; 95% CI, 1.3–1.6 and OR, 2.0; 95% CI, 1.6–2.4); and lack of social network (OR, 1.3; 95% CI, 1.1–1.4 and OR, 1.8; 95% CI, 1.5–2.1).

The results of bivariate and multivariate analyses showed similar tendencies, except with regard to the age category. In bivariate analysis, younger or middle-aged survivors were more likely to have mental health problems. However, this association was attenuated in the multivariate model. Table 4 shows the association between mental health and independent variables by sex. In both sexes, MMHPs and SMHPs were more frequent in those with health complaints, severe economic status, and limited social network, after adjustment for all other variables. Sex differences were observed for SMHPs. Multivariate analysis showed that men aged  $<44$  years (OR, 2.4; 95% CI, 1.5–3.9) were more likely to have had SMHPs as compared with those aged 65–74 years, while no such trend was observed among female participants. An interaction effect of sex and age on SMHP was statistically significant ( $P<0.01$ ). In addition, men with severe economic hardships showed a higher risk of developing SMHPs (OR, 4.9; 95% CI, 3.2–7.5) compared with women (OR, 3.0; 95% CI, 2.4–3.8). An interaction effect of sex and economic status on

**Table 1.** Demographic characteristics of the sample, 2011 (n = 10,025).

		Age Range, y						
All		18–44	45–54	55–64	65–74	75 or older		
		(n = 1,650)	(n = 1,161)	(n = 2,520)	(n = 3,019)	(n = 1,675)		
No. (%)		No. (%)	No. (%)	No. (%)	No. (%)	No. (%)	p value	
<b>Total</b>								
Sex	Male	3934 (39.2)	583 (35.3)	404 (34.8)	913 (36.2)	1277 (42.3)	757 (45.2)	P<0.001
	Female	6091 (60.8)	1067 (64.7)	757 (65.2)	1607 (63.8)	1742 (57.7)	918 (54.8)	
Health complaint	Yes	4505 (45.6)	827 (50.6)	570 (49.8)	1151 (46.3)	1195 (40.3)	762 (46.4)	P<0.001
Economic status	Severe	5142 (51.4)	998 (60.5)	725 (62.5)	1408 (55.9)	1373 (45.7)	638 (38.2)	P<0.001
Relocation	No	4829 (48.4)	676 (41.0)	523 (45.2)	1248 (49.7)	1523 (50.8)	859 (51.8)	P<0.001
	1–2	2972 (29.8)	563 (34.2)	366 (31.6)	749 (29.8)	844 (28.2)	450 (27.1)	
	≥3	2172 (21.8)	409 (24.8)	269 (23.2)	515 (20.5)	630 (21.0)	349 (21.0)	
Social network	<12	4084 (41.6)	753 (46.1)	541 (47.5)	1065 (43.0)	1089 (36.9)	636 (39.2)	P<0.001
K6	0–4	5753 (57.4)	892 (54.1)	603 (51.9)	1358 (53.9)	1858 (61.5)	1042 (62.2)	P<0.001
	5–12	3648 (36.4)	622 (37.7)	475 (40.9)	1014 (40.2)	1005 (33.3)	532 (31.8)	
	13–24	624 (6.2)	136 (8.2)	83 (7.1)	148 (5.9)	156 (5.2)	101 (6.0)	
<b>Male participants</b>								
All		18–44	45–54	55–64	65–74	75 or older		
No. (%)		No. (%)	No. (%)	No. (%)	No. (%)	No. (%)	p value	
Health complaint	Yes	1534 (39.5)	259 (44.8)	169 (42.3)	344 (38.2)	440 (35.0)	322 (43.3)	P<0.001
Economic status	Severe	2082 (53.1)	386 (66.3)	273 (67.7)	539 (59.1)	592 (46.7)	292 (38.6)	P<0.001
Relocation	No	1943 (49.7)	243 (41.8)	180 (44.8)	448 (49.3)	662 (52.2)	410 (54.7)	P<0.001
	1–2	1177 (30.1)	222 (38.1)	133 (33.1)	279 (30.7)	358 (28.2)	185 (24.7)	
	≥3	791 (20.2)	117 (20.1)	89 (22.1)	182 (20.0)	248 (19.6)	155 (20.7)	
Social network	<12	1660 (43.0)	293 (50.8)	197 (49.4)	395 (43.9)	467 (37.3)	308 (42.1)	P<0.001
K6	0–4	2528 (64.3)	320 (54.9)	239 (59.2)	563 (61.7)	882 (69.1)	524 (69.2)	P<0.001
	5–12	1228 (31.2)	215 (36.9)	143 (35.4)	304 (33.3)	359 (28.1)	207 (27.3)	
	13–24	178 (4.5)	48 (8.2)	22 (5.4)	46 (5.0)	36 (2.8)	26 (3.4)	
<b>Female participants</b>								
Health complaint	Yes	2971 (49.5)	568 (53.7)	401 (53.8)	807 (50.9)	755 (44.1)	440 (49.0)	P<0.001
Economic status	Severe	3060 (50.4)	612 (57.4)	452 (59.7)	869 (54.1)	781 (45.1)	346 (37.9)	P<0.001
Relocation	No	2886 (47.6)	433 (40.6)	343 (45.4)	448 (49.3)	861 (49.8)	449 (49.9)	P<0.001
	1–2	1795 (29.6)	341 (32.0)	233 (30.8)	279 (30.7)	486 (28.1)	265 (29.2)	

Table 1. Cont.

	Age Range, y					p value
	All	18–44 (n = 1,650)	45–54 (n = 1,161)	55–64 (n = 2,520)	65–74 (n = 3,019)	
	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)	
≥3	1381 (22.8)	292 (27.4)	180 (23.8)	182 (20.0)	382 (22.1)	194 (21.4)
<12	2424 (40.6)	460 (43.6)	344 (46.4)	670 (42.5)	622 (36.5)	328 (36.9)
0–4	3225 (52.9)	572 (53.6)	364 (48.1)	795 (49.5)	976 (56.0)	518 (56.4)
5–12	2420 (39.7)	407 (38.1)	332 (43.9)	710 (44.2)	646 (37.1)	325 (35.4)
13–24	446 (7.3)	88 (8.2)	61 (8.1)	102 (6.3)	120 (6.9)	75 (8.2)
Social network						
K6						
						P<0.001
						P<0.001

Numbers vary because of missing data, perceived symptom; male (55) female (91), economic status; male (12) female (15), relocation; male (23) female (29), and social network; male (76) female (125).  
No case (K6; 0–4), MMHP, mild mental health problem (K6; 5–12), SMHP, severe mental health problem (K6; 13–24).  
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SMHP was statistically significant. For women, experiences of relocation were associated with SMHPs, whereas no such association was found for men. However, apart from age and economic status, the interaction between sex and other study variables was not statistically significant.

## Discussion

The present study revealed that mental health problems were prevalent among survivors of the 2011 earthquake and tsunami in Japan, at 6–11 months after the disaster. We identified female sex, younger male, having health complaints, severe economic status relocations, and lack of social networks were associated with having moderate or serious mental health problem. In sex-stratified analysis, younger males and males with severe economic status were more likely to have severe mental health problem than their counterparts among females.

Consistent with other evidence of the negative effects of disasters on mental health [2–5], our results suggested that the Great-East earthquake lead to a host of problems in the residents of the disaster-stricken area. In our study, 42.6% of survivors were determined to have MMHPs (a K6 score ranging from 5 to 12) or SMHPs (a K6 score of 13–24). A previous study which was conducted among a representative community-based sample of residents in Japan aged 20–74 showed that 26.8% in respondents had a K6 score of 5 or higher [21]. Another study conducted in Japanese aged 25–59 showed 30.6% with the same scoring procedure [14]. The prevalence of SMHPs (6.2%) in the present study was higher than that in the Japanese adult population (4.2%) [20]. While the present sample included more older respondents than these population-based studies, the prevalence of mental health problems, either moderate or severe, seems 1.5 times greater compared to that in the general population of Japan. The finding suggests that survivors living in these affected areas had poorer mental health, as observed in many previous studies in Japan and other countries after natural disasters [2–5]. Further attention and appropriate long-term support are warranted for individuals with SMHPs and MMHPs.

The present study revealed factors associated with mental health among survivors. Women had significantly greater mental health problems than men. This finding is consistent with those of earlier studies assessing mental health problems among survivors of disasters [2,10,11]. It is also consistent with the findings of previous studies conducted in non-disaster settings [13,14].

A survey of survivors of the 2008 Sichuan Earthquake has shown that older persons have a greater risk of mental health problems than younger persons have [27]. However, the present study was consistent with most other studies, which has indicated that prevalence of mental health problems is higher in younger or middle ages than older age [2,8,9]. In addition, our study has important implications for sex-specific intervention. Stratified analysis showed that there was a sex difference in age-specific patterns of prevalence of SMHPs. Compared with older age, younger and middle-aged persons were more likely to have SMHPs among men, while there was no such association between age and SMHPs among women. This may be attributable to the burden imposed on younger and middle-aged men. They are struggling to support their family after financial loss, and are in charge of reconstructing their community. Thompson et al have suggested that the middle-aged may be the most affected, compared to other age groups, because of their social and financial burden [28]. Moreover, men who suffered economic hardship had a greater risk for SMHPs than women did. Perceived obligation for their life may lead to an increase in mental health

**Table 2.** Characteristics according to K6 score (n = 10,025).

		K6			
		no case (n = 5,753)	MMHP (n = 3,648)	SMHP (n = 624)	
		No. (%)	No. (%)	No. (%)	p
<b>Total</b>					
Sex	Male	2528 (43.9)	1228 (33.7)	178 (28.5)	P<0.001
Age (yr)	18–44	892 (15.5)	622 (17.1)	136 (21.8)	P<0.001
	45–54	603 (10.5)	475 (13.0)	83 (13.3)	
	55–64	1358 (23.6)	1014 (27.8)	148 (23.7)	
	65–74	1858 (32.3)	1005 (27.5)	156 (25.0)	
	≥75	1042 (18.1)	532 (14.6)	101 (16.2)	
Health complaint	Yes	2005 (35.3)	2040 (56.9)	460 (75.3)	P<0.001
Economic status	Severe	2355 (41.1)	2321 (63.7)	466 (74.8)	P<0.001
Relocation	0	3027 (53.0)	1575 (43.3)	227 (36.5)	
	2-Jan	1619 (28.3)	1152 (31.7)	201 (32.3)	
	≥3	1070 (18.7)	908 (25.0)	194 (31.2)	
Social network	<12	2132 (37.8)	1614 (45.2)	338 (55.2)	P<0.001
<b>Male participants</b>					
Age (yr)	18–44	320 (12.7)	215 (17.5)	48 (27.0)	P<0.001
	45–54	239 (9.5)	143 (11.6)	22 (12.4)	
	55–64	563 (22.3)	304 (24.8)	46 (25.8)	
	65–74	882 (34.9)	359 (29.2)	36 (20.2)	
	≥75	524 (20.7)	207 (16.9)	26 (14.6)	
Health complaint	Yes	792 (31.7)	615 (51.1)	127 (71.8)	P<0.001
Economic status	Severe	1100 (43.7)	834 (68.0)	148 (83.1)	P<0.001
Relocation	0	1342 (53.5)	531 (43.3)	70 (39.5)	P<0.001
	2-Jan	711 (28.3)	408 (33.3)	58 (32.8)	
	≥3	455 (18.1)	287 (23.4)	49 (27.7)	
Social network	<12	980 (39.6)	574 (47.6)	106 (60.6)	P<0.001
<b>Female participants</b>					
Age (yr)	18–44	572 (17.7)	407 (16.8)	88 (19.7)	P<0.001
	45–54	364 (11.3)	332 (13.7)	61 (13.7)	
	55–64	795 (24.7)	710 (29.3)	102 (22.9)	
	65–74	976 (30.3)	646 (26.7)	120 (26.9)	
	≥75	518 (16.1)	325 (13.4)	75 (16.8)	
Health complaint	Yes	1213 (38.1)	1425 (59.7)	333 (76.7)	P<0.001
Economic status	Severe	1255 (39.0)	1487 (61.6)	318 (71.5)	P<0.001
Relocation	0	1685 (52.5)	1044 (43.3)	157 (35.3)	P<0.001
	2-Jan	908 (28.3)	744 (30.9)	143 (32.1)	
	≥3	615 (19.2)	621 (25.8)	145 (32.6)	
Social network	<12	1152 (36.4)	1040 (44.0)	232 (53.1)	P<0.001

Numbers vary because of missing data, perceived symptom; male (55) female (91), economic status; male (12) female (15), relocation; male (23) female (29), and social network; male (76) female (125). No case (K6; 0–4), MMHP, mild mental health problem (K6; 5–12), SMHP, severe mental health problem (K6; 13–24). doi:10.1371/journal.pone.0102497.t002

problems in men. Our results appear to underline the importance of economic support and employment, especially for men. Although the victims were able to find employment, some of these engagements were on a short-term or irregular basis. The creation of permanent jobs, in particular, has been emphasized. Measures to attract firms to invest in and establish plants in devastated areas are needed, as is support for victims seeking new

employment. Our study demonstrated an association between frequency of relocation and mental health problems. A previous study has also suggested that relocation after a disaster increases psychological distress [12]. It is noteworthy that the OR for suffering from SMHPs among females with relocation experience was significantly higher than those with no such experience; no increase in OR was noted for males, though, after adjusting for

**Table 3.** Multinomial logistic regressions for the categories of mental health.

	MMHP				SMHP			
	COR	95% CI	AOR	95% CI	COR	95% CI	AOR	95% CI
<b>Sex</b>								
Female	1.55	(1.42–1.68)	1.52	(1.39–1.67)	1.96	(1.64–2.36)	1.87	(1.54–2.26)
Male	1.00		1.00		1.00		1.00	
<b>Age (yr)</b>								
<44	1.29	(1.13–1.47)	1.02	(0.89–1.17)	1.82	(1.42–2.32)	1.24	(0.96–1.61)
45–54	1.46	(1.26–1.68)	1.13	(0.97–1.31)	1.64	(1.24–2.17)	1.06	(0.78–1.43)
55–64	1.38	(1.23–1.54)	1.18	(1.04–1.33)	1.30	(1.03–1.64)	1.01	(0.78–1.29)
65–74	1.00		1.00		1.00		1.00	
≥75	0.94	(0.83–1.07)	0.98	(0.85–1.13)	1.15	(0.89–1.50)	1.19	(0.90–1.58)
<b>Health complaint</b>								
Yes	2.42	(2.22–2.63)	2.13	(1.95–2.33)	5.58	(4.61–6.76)	4.57	(3.75–5.57)
No	1.00		1.00		1.00		1.00	
<b>Economic status</b>								
Severe	2.52	(2.32–2.75)	2.26	(2.06–2.48)	4.26	(3.53–5.14)	3.44	(2.82–4.20)
Normal	1.00		1.00		1.00		1.00	
<b>Relocation</b>								
≥3	1.63	(1.46–1.82)	1.40	(1.25–1.58)	2.42	(1.97–2.96)	1.95	(1.57–2.43)
1 or 2	1.37	(1.24–1.51)	1.23	(1.11–1.37)	1.66	(1.36–2.02)	1.43	(1.16–1.77)
no	1.00		1.00		1.00		1.00	
<b>Social network</b>								
<12	1.36	(1.25–1.48)	1.25	(1.14–1.37)	2.03	(1.72–2.40)	1.75	(1.47–2.09)
≥12	1.00		1.00		1.00		1.00	

Abbreviations: COR, crude odds ratio; AOR, adjusted odds ratio; CI, confidential interval; MMHP, mild mental health problem; SMHP, severe mental health problem. OR are calculated by using a multinomial logistic regression model with no case (K6; 0–4) as a reference group. AOR were adjusted for the effect of all other variables shown in the table and municipality.

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**Table 4.** Multivariate multinomial regression of mental health by sex.

		MMHP				SMHP			
		COR	95% CI	AOR	95% CI	COR	95% CI	AOR	95% CI
<b>Male</b>									
Age (yr)	<44	1.65	(1.34–2.04)	1.29	(1.03–1.61)	3.67	(2.34–5.77)	2.44	(1.52–3.92)
	45–54	1.47	(1.16–1.87)	1.15	(0.89–1.49)	2.26	(1.30–3.91)	1.48	(0.84–2.63)
	55–64	1.33	(1.10–1.60)	1.14	(0.93–1.39)	2.00	(1.28–3.14)	1.50	(0.94–2.41)
	≥75	0.97	(0.79–1.19)	0.97	(0.78–1.21)	1.22	(0.73–2.04)	1.23	(0.72–2.12)
Health complaint	Yes	2.25	(1.96–2.60)	2.08	(1.79–2.41)	5.47	(3.90–7.68)	4.63	(3.27–6.55)
Economic status	Severe	2.73	(2.37–3.16)	2.42	(2.08–2.82)	6.36	(4.26–9.48)	4.93	(3.24–7.49)
Relocation	≥3	1.59	(1.33–1.91)	1.29	(1.07–1.57)	2.06	(1.41–3.02)	1.37	(0.91–2.05)
	1 or 2	1.45	(1.24–1.70)	1.23	(1.04–1.45)	1.56	(1.09–2.24)	1.14	(0.78–1.67)
Social network	<12	1.39	(1.21–1.59)	1.27	(1.10–1.47)	2.35	(1.71–3.21)	1.94	(1.40–2.69)
<b>Female</b>									
Age (yr)	<44	1.08	(0.91–1.26)	0.88	(0.74–1.05)	1.25	(0.93–1.68)	0.90	(0.66–1.23)
	45–54	1.38	(1.15–1.65)	1.11	(0.91–1.34)	1.36	(0.98–1.90)	0.92	(0.65–1.32)
	55–64	1.35	(1.17–1.55)	1.19	(1.02–1.39)	1.04	(0.79–1.38)	0.86	(0.64–1.16)
	≥75	0.95	(0.80–1.12)	1.00	(0.83–1.20)	1.18	(0.87–1.60)	1.22	(0.87–1.70)
Health complaint	Yes	2.41	(2.16–2.68)	2.17	(1.94–2.43)	5.35	(4.23–6.76)	4.62	(3.63–5.89)
Economic status	Severe	2.51	(2.25–2.79)	2.16	(1.93–2.43)	3.91	(3.15–4.87)	2.99	(2.37–3.76)
Relocation	≥3	1.63	(1.42–1.87)	1.49	(1.28–1.72)	2.53	(1.98–3.23)	2.31	(1.78–3.01)
	1 or 2	1.32	(1.17–1.50)	1.23	(1.08–1.40)	1.69	(1.33–2.15)	1.57	(1.21–2.03)
Social network	<12	1.37	(1.23–1.53)	1.23	(1.10–1.38)	1.98	(1.62–2.42)	1.68	(1.35–2.07)

Abbreviations: COR, crude odds ratio; AOR, adjusted odds ratio; CI, confidential interval; MMHP, mild mental health problem; SMHP, severe mental health problem. OR are calculated by using a multinomial logistic regression model with no case (K6; 0–4) as a reference group. Adjusted OR were adjusted for the effect of all other variables shown in the table and municipality.  
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covariates. In the immediate aftermath of the disaster, many survivors were forced to take shelter wherever they could. Those who experienced multiple relocations might have been subjected to cumulative stress in the disaster's chaotic aftermath.

Consistent with previous findings [8,27], a lack of social networks appeared to be significantly associated with mental health problems. Social resources, such as social networks, seem to be especially vulnerable to the impact of disasters. For example, disasters can remove significant supporters from victims' networks through death [2]. Our study showed that nearly half of the respondents were classified as lacking social support. A study conducted before the disaster among residents of a neighboring community reported that approximately 20% lacked the support of a social network [29]. In the study areas, residents' social networks were often smaller than before the disaster because many had lost their families, relatives, and friends. In addition, temporary housing communities in these areas tended to be relatively small, which could make it more difficult to recreate an environment or sense of community [23]. Survivors who have lost their social networks require appropriate care. Efforts to rebuild the community in the aftermath of the disaster persist until this day. Victims have begun moving from temporary housing to public housing built for them. However, the reconstruction of networks and communities that has begun to occur in temporary housing complexes may be seriously impacted by this move. Town-building efforts should therefore be accompanied by community conscious planning. The Great East Japan Earthquake and Tsunami hit the older aged communities along the shores of Tohoku. Our study revealed that older survivors were not necessarily more vulnerable to mental health problems than were younger survivors. Rather, the results suggested that survivors' social circumstances, such as their lack of social networks as well as the presence of health complaints and severe economic hardships, were important risk factors. Considering the emergence of Japan's super-aging society, our findings hold implications for research as well as practice with regard to the welfare of older populations in the wake of a disaster.

The present study had several limitations. First, the sample may not have been representative of the wider community. We collected questionnaires at the municipal health check-up sites. Even though >90% of the examinees participated in our study, those attending health check-ups tend to be more conscious about their health. In addition, those with serious mental health problems prefer to stay indoors, and may not have come for a health check-up. Therefore, it is possible that some of the high-risk populations were not represented in the data. Such self-selection biases may have led to the underestimation of mental health issues in our results. On the contrary, it cannot be denied that there is the possibility that mental health issues were over-reported. There may have been a higher concentration of respondents in our sample who had suffered directly as a result of the disaster. For example, the proportion of young adults aged <44 was relatively low in our study. Younger survivors who had some form of employment at the time were probably unable to join our study.

Second, although the K6 scale has been validated previously, it is not a clinical interview. Third, because this was a cross-sectional study, causal relationships could not be inferred from the data. For example, the associations between limited social networks and mental health problems are probably interactive. Social isolation may result in mental health problems, in turn could result in a

limited social network. This issue should be examined in a follow-up study. Fourth, the correlations demonstrated in this study may not have adequately captured disaster specific patterns as they were not compared with those occurring in a non-disaster situation. We were not able to assess the damage caused by the disaster, such as the loss of property, family, and friends, or ask survivors if they lived alone in the present study. Due to the ethical issues involved in asking survivors still grieving the loss of a loved one to talk about their loss, we refrained from asking questions concerning their family members. In addition, we avoided using a voluminous questionnaire, given the burden it might pose on survivors. A challenge for future research is to combine data obtained on survivor health and welfare with another dataset on damage.

## Conclusions

Despite these limitations, to the best of our knowledge, this was the first epidemiological survey of mental health involving a large sample of residents living in Japan's coastal areas after the 2011 Great East Japan Earthquake and Tsunami. In conclusion, our results indicated that mental health problems were prevalent among survivors living in these areas. Furthermore, females were more likely to suffer from mental health problems. Thus, there is a need to focus on their risk factors, including the presence of health complaints and severe economic hardships, as well as having insufficient social networks. For males, interventions focusing on economic support and those who are younger in age may be particularly useful in reducing mental health problems after the disaster.

## Supporting Information

**Appendix S1 Age- and sex-specific numbers of participants, acceptance rates, and proportions of total population in the study area.**  
(XLSX)

**Appendix S2 Age- and sex-specific numbers of participants, acceptance rates, and proportions of total population in Yamada town.**  
(XLSX)

**Appendix S3 Age- and sex-specific numbers of participants, acceptance rates, and proportions of total population in Otsuchi town.**  
(XLSX)

**Appendix S4 Age- and sex-specific numbers of participants, acceptance rates, and proportions of total population in Rikuzentakata city.**  
(XLSX)

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## Author Contributions

Conceived and designed the experiments: SK KS AO. Performed the experiments: KS Y. Yaegashi Y. Yokoyama. Analyzed the data: TO Y. Yokoyama. Wrote the paper: NK KO KT KS Y. Yokoyama.

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# Factors Related to Oral Health Status of Disaster Victims 9 Months after Great East Japan Earthquake

Mitsuo Kishi\* Fumie Aizawa\* Miki Matsui\* Ruriko Suzuki\*\*  
Hiroyuki Miura\*\*\* Yukari Yokoyama\*\*\*\* Kiyomi Sakata\*\*\*\*\* Akira Ogawa\*\*\*\*\*

\*Division of Preventive Dentistry, Department of Oral Medicine,  
Iwate Medical University School of Dentistry

\*\*Faculty of Community Nursing, Iwate College of Nursing

\*\*\*Division of Orthodontics, Department of Oral Health Enhancement,  
Iwate Medical University School of Dentistry

\*\*\*\* Faculty of Social Welfare, Nihon Fukushi University

\*\*\*\*\*Department of Hygiene and Preventive Medicine,  
Iwate Medical University School of Medicine

\*\*\*\*\*President of Iwate Medical University

## 東日本大震災 9 か月後の被災地住民の口腔の健康状態に関する要因

岸 光男\* 相澤文恵\* 松井美樹\* 鈴木るり子\*\*

三浦廣行\*\*\* 横山由香里\*\*\*\* 坂田清美\*\*\*\*\* 小川 彰\*\*\*\*\*

\* 岩手医科大学歯学部口腔医学講座予防歯科学分野

\*\* 岩手看護短期大学地域看護学専攻

\*\*\* 岩手医科大学歯学部口腔保健育成学講座歯科矯正学分野

\*\*\*\* 日本福祉大学社会学部社会福祉学科

\*\*\*\*\* 岩手医科大学衛生学公衆衛生学講座

\*\*\*\*\* 岩手医科大学理事長 学長

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\*Division of Preventive Dentistry, Department of Oral Medicine,  
Iwate Medical University School of Dentistry

\*\*Faculty of Community Nursing, Iwate College of Nursing

\*\*\*Division of Orthodontics, Department of Oral Health Enhancement,  
Iwate Medical University School of Dentistry

\*\*\*\* Faculty of Social Welfare, Nihon Fukushi University

\*\*\*\*\*Department of Hygiene and Preventive Medicine,  
Iwate Medical University School of Medicine

\*\*\*\*\*President of Iwate Medical University

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\* 岩手医科大学歯学部口腔医学講座予防歯科学分野

\*\* 岩手看護短期大学地域看護学専攻

\*\*\* 岩手医科大学歯学部口腔保健育成学講座歯科矯正学分野

\*\*\*\* 日本福祉大学社会学部社会福祉学科

\*\*\*\*\* 岩手医科大学衛生学公衆衛生学講座

\*\*\*\*\* 岩手医科大学理事長 学長

#### < Abstract >

Nine months after the Great East Japan Earthquake, we performed an oral health survey including questionnaire and oral examinations for 2001 individuals living in Otsuchi Town, one of the most severely damaged municipalities by the disaster.

As compared with Japanese national survey, our subjects had greater numbers of decayed teeth and teeth with a periodontal pocket. Among 357 subjects who had visited dental facilities before the disaster, the dental care remained interrupted in 35.6% at the time of the survey. Past and current oral conditions were worse in subjects whose dental care remained interrupted or whose removable dentures had been lost or damaged as compared to others. In conclusions many living in a severely damaged area required dental care at 9 months after the disaster. Providing continuous dental care was needed for people in the victim area.

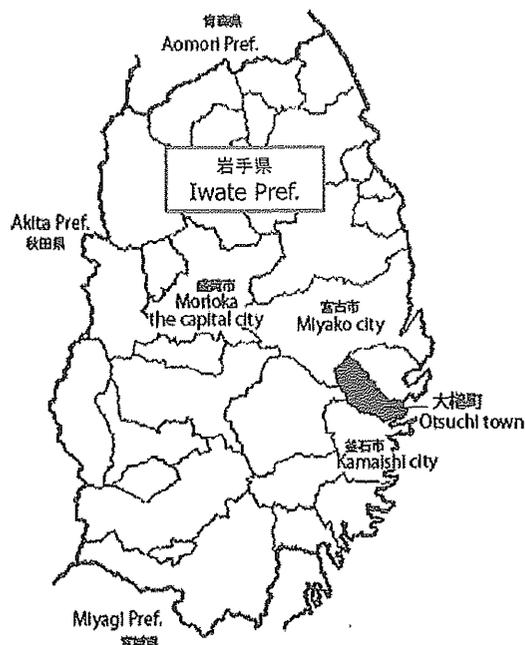


Figure 1 Location of Otsuchi town in Iwate Prefecture

in the town, all of which were destroyed. At the time of our survey (9 months after the disaster), dental services were being provided by a temporary dental clinic.

## 2. Subjects

The pre-disaster population of Otsuchi Town in 2010 was 15,300. According to the report of the town administration in October 2011, the total number of dead and missing in the disaster was 1322 (8.6% of population). In addition, a large number had evacuated and were living elsewhere. Consequently the population at the time of our survey was decreased to approximately 13,000.

We attempted to investigate the oral health status and oral health-related experiences following the disaster of all adult dwellers of Otsuchi Town 18 years old or older. Our survey was planned to be performed at the same time of systemic health check-up examinations, which were conducted by the town government as a public health service.

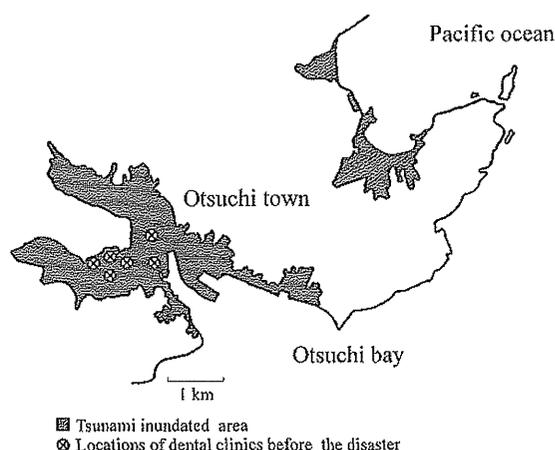


Figure 2 Tsunami inundated area of Otsuchi town.

Prior to the examinations, town officials notified all inhabitants 18 years old or older and recommended their participation. Eleven venues for the check-up examinations were prepared during the 15-day survey period (December 8-22, 2011), since Otsuchi Town consists of an amalgamation of several smaller and geographically separate communities. At the reception for the check-up in each venue, informed consent to participate was obtained from the subjects. Finally, 2001 individuals participated in our study, with age and gender summarized in Table 1.

This study was approved by the Medical Ethics Committee of Iwate Medical University (H23-69) and conducted in accordance with the guidelines of the Declaration of Helsinki.

## 3. Data collection

Geographic data for subject homes before disaster were obtained from the town administration. To classify damage levels caused by the disaster, the subjects were divided into 3 groups based on the degree of destruction of their home, as follows: 1. no damage, 2. partially destroyed or flooded, 3. entirely destroyed.

the relationships among responses to our questionnaire. In addition, to compare averages among multiple groups, Sheffe's multiple analyses of variance (ANOVA) was utilized. Statistical analyses were performed using the software package SPSS 19.0 for Windows (SPSS Inc., Chicago, IL, USA).

### III. Results

#### 1. Comparisons of oral conditions between subjects and national survey

The average numbers of present and

decayed teeth in our subjects as compared with those obtained in the National Survey of Dental Health in 2011.<sup>5)</sup> Data are summarized by age and gender in Table 2. In subjects aged 40 years and older, there were lower numbers of present teeth as compared with the national averages for both gender groups. Also, a comparison of the numbers of decayed teeth between our subjects and the national averages showed that the present subjects in the 40s and 50s age groups had greater numbers of decayed teeth. On the contrary, for

**Table 2 Average numbers of present and decayed teeth in subjects by gender and age group<sup>a</sup>**

		Age group (in years)						
		18-29	30-39	40-49	50-59	60-69	70-79	≥80
Male	Present	28.6±1.06 (28.9)	27.9±3.18 (28.5)	24.6±4.68** (27.4)	19.9±8.46** (25.0)	16.5±9.79** (22.0)	12.1±10.1** (16.6)	9.60±10.1* (12.4)
	Decayed	1.45±2.54 (1.44)	2.21±3.77 (1.25)	2.95±4.16** (0.91)	1.52±2.28 (1.17)	1.12±2.24 (1.12)	1.02±2.27 (1.24)	0.84±1.78** (1.50)
Female	Present	28.5±1.74 (28.1)	28.1±2.23 (28.4)	25.5±3.97** (27.5)	20.3±7.12** (25.1)	13.7±9.68** (21.8)	7.45±9.18** (16.5)	5.60±7.21** (9.92)
	Decayed	0.49±1.04 (0.87)	1.29±2.29* (0.81)	1.85±3.13** (1.09)	1.34±2.81* (0.85)	0.74±1.59* (0.91)	0.45±1.19** (0.77)	0.42±0.96** (0.93)
Total	Present	28.5±1.51 (28.4)	28.0±6.43 (28.4)	25.2±4.23** (27.5)	20.1±7.58** (25.1)	14.7±9.81** (21.9)	9.55±9.90** (16.6)	7.26±8.72** (11.0)
	Decayed	0.85±1.80 (1.08)	1.58±2.87* (0.98)	2.22±3.53** (1.02)	1.40±2.64** (0.98)	0.88±1.87 (1.00)	0.71±1.79** (0.99)	0.59±1.37** (1.18)

<sup>a</sup>Values are shown as the average ± standard deviation.

Values in parentheses are averages from the National survey conducted in 2011.

\*p<.05, \*\*p<.01; significantly different from National survey result (t test). The age group of 18-29 years was compared with that of 20-29 years in the National survey.

**Table 3 Number of subjects with a periodontal pocket<sup>a</sup>**

		Age group (in years)					
		18-29	30-39	40-49	50-59	60-69	70-79
Male	2/22 (9.09)	21/48 (43.8)	27/66 (40.9)	56/89 (62.9)	115/202 (56.9)	94/164 (57.3)	21/32 (65.6)
	18.2	26.0	35.3	46.4	59.9	61.8	69.3
Female	4/37 (10.8)	18/100 (18.0)	64/132 (48.5)*	78/184 (42.4)	145/306 (47.4)	62/133 (46.6)	19/32 (59.4)
	11.2	19.5	23.9	38.0	45.5	49.6	55.7
Total	6/53 (11.3)	39/148 (26.4)	91/198 (46.0)*	134/273 (49.1)	260/508 (51.2)	156/297 (52.5)	40/64 (62.5)
	13.7	22.0	28.0	41.3	51.5	55.1	62.0

<sup>a</sup>Data for subjects with at least 1 index tooth in the CPI (n=1547).

Numerator/denominator: number with a periodontal pocket/number of subjects excluding those with no index tooth (percent rate).

Lower number: Percent rate of subjects with a periodontal pocket among those with no index tooth from the National survey in 2011.

\*Significantly different (p<.05) as compared with the National survey result (Fisher's exact test).

**Table 5 Comparison of oral status and experiences with dental care by level of damage**

Oral status and experiences with dental care	Damage level			Total	<i>p</i> -value
	1 (no damage)	2 (partially destroyed or flooded)	3 (entirely destroyed)		
No. of present teeth <sup>b</sup>	16.2±10.8	15.5±10.4	16.4±10.8	16.1±10.7	0.303
No. of decayed teeth <sup>b</sup>	1.05±2.06	1.00±2.41	1.13±2.36	1.08±2.30	0.565
With a periodontal pocket <sup>c</sup>	179/389 (46.0)	190/372 (51.1)	346/767 (45.1)	715/1528 (46.8)	0.157
Interruption of dental care <sup>d</sup>	30/88 (34.1)	35/94 (37.2)	61/172 (35.5)	126/354 (35.6)	0.906
Lost or fractured denture <sup>e</sup>	36/287 (12.5)	41/290 (14.1)	95/576 (16.5)	172/1159 (14.8)	0.281

<sup>a</sup>Data was obtained from available geographic data.

<sup>b</sup>Average ± standard deviation. The numbers of subjects in the respective damage level groups were as follows; 512 for level 1, 481 for level 2, and 980 for level 3.

<sup>c</sup>Data for subjects with 1 or more CPI index tooth (n=1528). Values indicate number of subjects with a periodontal pocket/all subjects in each damage level group (percentage).

<sup>d</sup>Data for subjects who had visited a dental clinic for treatment before the disaster. Values indicate number of subjects with interrupted care/number of subjects in damage level group (percentage).

<sup>e</sup>Data for subjects who were wearing a plate denture before disaster and available from geographic data.

to those in the 50s and 60s age groups. In addition, the proportion in the 40s group was significantly higher as compared with the 60s group. On the other hand, there were no significant differences among the age groups in regard to the proportion of subjects who had experienced denture loss or fracture and subsequent re-restoration or repair (Table 4).

### 3. Comparisons of oral conditions and experiences with dental care based on level of home damage

We compared oral status and experiences with dental care among the 3 groups classified by damage level caused by the disaster (Table 5). There were no differences regarding the numbers of present or decayed teeth. Similarly, the proportions of subjects with periodontal pockets did not differ by damage level. Furthermore, experiences with dental care after the disaster and loss or fracture of denture by the disaster occurred with similar frequencies among the 3 groups.

### 4. Relationships between experiences with dental care and historical/current oral

#### condition

Next, we examined the relationships between dental care-related experiences and oral health status in subjects 40 years old and older. Chi-squared test results indicated that the proportion of subjects with a history of difficulty with eating was significantly different based on dental care-related experiences. Multiple comparison tests also showed differences between subjects who had not received dental treatment before the disaster and those who had their dental treatments interrupted. Similarly, a history of difficulty with eating was related to experiences with fractured or lost dentures. Subjects with a history of difficulty with eating were more frequently found among those with experiences with fractured or lost dentures as compared to those who did not wear dentures. Furthermore, difficulty with eating was more frequently reported by subjects who had undergone re-restoration or repair of dentures as compared to those without fractured or lost dentures. There was also a relationship between experiences with dental care and history of difficulty with speaking (Table 6).

teeth with a periodontal pocket than subjects in the national survey. In addition, many teeth were lost in the higher aged subjects (Tables 2 and 3). Although lower numbers of decayed teeth were found in subjects aged 50 years and older, that was not considered to indicate wellness of their oral condition, as it could also show a low susceptibility to dental caries caused by lack of present teeth. Based on our findings, we concluded that our subjects had worse oral health conditions than the general Japanese population.

On the other hand, our survey revealed that dental and periodontal conditions did not differ with different damage levels (Table 5), which suggests that dental disease status does not rapidly change even after such a disaster, as dental caries and periodontitis are generally chronic conditions.<sup>6-8)</sup> Furthermore, Otsuchi Town is located in a remote area of Iwate Prefecture (Figure 1). Previous studies of geographic variations in oral health have shown that the oral status of residents living in rural or remote areas were mostly worse than those of residents living in urban areas.<sup>9-13)</sup> Therefore, it was very likely that the oral status of our subjects observed in this study was primarily related to natural oral characteristics present before the disaster, though there could be some influences of the disaster. Nevertheless, the long-term influence of the earthquake and tsunami remain unknown, thus it will be important to continuously observe the oral health status of these subjects in the future.

Our questionnaire survey also revealed that subjects with lost or fractured removable dentures more frequently experienced oral problems such as difficulties with eating and speaking as compared to the other denture wearers (Table 6). Our subjects also had fewer

present teeth than the national average (Table 2) and consequently they frequently wore removable dentures, with the proportion of denture wearers in their 40s, 50s, 60s, 70s, and 80s shown to be 13%, 31%, 55%, 74%, and 84%, respectively (data not shown in Results section). Among subjects who live in rural areas and frequently depend on removable dentures for their oral functions, many individuals may be at risk of developing oral problems after such a disaster. On the other hand, in denture wearers who did not lose or fracture their dentures during the disaster, the proportion of those who had experienced oral troubles was not different as compared with non-denture wearers. In addition, current oral status was reported as best by denture wearers without lost or fractured dentures, and worst by those who had lost or fractured dentures (Table 6). These results indicate that denture nonconformance occurred with very low frequency as a result of this large-scale disaster.

Among subjects with lost or fractured removable denture, those with oral trouble underwent re-restoration or repair more frequently than those without such troubles (Table 6). This finding suggests that individuals with high needs for dental care will make an effort to treat their problems even after experiencing a disaster. Also, subjects who underwent re-restoration or repair of their dentures had worse oral conditions as compared to those who did not receive re-restoration or repair (Table 6). Removable dentures usually require periodic adjustments. Kivovics et al. reported that 87% of new complete dentures required adjustment at least once.<sup>14)</sup> Thus, we consider that a lack of dental resources in the disaster areas prevented these subjects from undergoing adequate