High levels of personal damage were reported in these groups of workers. In total, 301 (23.3%) workers were displaced from their homes because of the damage caused by the GEJE. There were no significant differences in "displacement" among occupations. One hundred and nine (8.5%) workers lost family members, with firefighters having the highest percentage (10.6%) and municipality workers (6.4%) having the lowest among the worker groups. Six hundred and ninety-six (54.4%) participants reported "near-death experience"; medical workers (65.7%) were most likely and municipality workers (48.7%) were least likely to report such experiences.

Workplace factors differed significantly between occupations. A significantly greater percentage of municipality workers and medical workers reported "lack of communication" (20.4% and 18.9%, respectively) and "lack of rest" (40.8% and 47.6%, respectively), compared to firefighters (7.5%, 19.3%, respectively). Firefighters were most likely to report "dead or missing colleague(s)" (79.8%). "Mainly disaster-related work" was highest in municipality workers (32.5%), and lowest in medical workers (4.6%).

Prevalence of probable PTSD, probable depression, and high general psychological distress

The prevalence of probable PTSD among municipality workers, medical workers, and firefighters with the most conservative combined criteria was 6.6% (adjusted odds ratio = 4.0), 6.6% (adjusted odds ratio = 4.0), and 1.6%, respectively. The prevalence among municipality workers and medical workers was significantly higher than that of firefighters.

The prevalence of probable depression among municipality workers, medical workers, and firefighters with the most conservative combined criteria was 15.9% (adjusted odds ratio = 4.5), 14.3% (adjusted odds ratio = 4.2), and 3.8%, respectively. The prevalence among municipality workers and medical workers was significantly higher than that of firefighters.

The prevalence of high general psychological distress among municipality workers, medical workers, and firefighters was 14.9% (adjusted odds ratio = 6.2), 14.5% (adjusted odds ratio = 5.9), and 2.6%, respectively. The prevalence among municipality workers and medical workers was significantly higher than that of firefighters.

Risk factors for probable PTSD

Table 2 shows the results of bivariate and multivariate analysis of factors associated with probable PTSD. In firefighters, "lack of communication" (adjusted odds ratio = 8.98, $P < 0.05$) was the only factor associated with probable PTSD in bivariate analysis, and thus, multivariate analysis was not performed for this group. Multivariate analysis revealed that "lack of rest," "dead or missing family member(s)", and "near-death experience" was associated with probable PTSD in both municipality workers [adjusted odds ratio = 3.90 ($P < 0.01$), 4.37 ($P < 0.01$), and 2.72 ($P < 0.05$), respectively] and medical workers [adjusted odds ratio = 4.41 ($P < 0.05$), 5.29 ($P < 0.01$), and 6.38 ($P < 0.05$), respectively]. Probable PTSD was associated with "lack of communication" in medical workers (adjusted odds ratio = 3.70, $P < 0.01$), and "mainly disaster-related work" and "displacement" in municipality workers [adjusted odds ratio = 3.89 ($P < 0.001$) and 2.27 ($P < 0.05$), respectively]. "Age," "female sex," "supervisory work status," and "dead or missing colleague(s)" was not associated with probable PTSD in any of the occupations in bivariate analysis.

Risk factors for probable depression

Table 3 shows the results of bivariate and multivariate analysis of factors associated with probable depression. In firefighters, "lack of rest" (adjusted odds ratio = 6.25, $P < 0.01$) was the only factor associated with probable depression in the bivariate analysis; thus, multivariate analysis was not conducted for this group. Multivariate analysis revealed that "lack of communication" showed the highest odds ratio and "lack of rest" showed the second highest odds ratio in municipality workers [adjusted odds ratio = 3.02 ($P < 0.001$) and 2.70 ($P < 0.001$), respectively] and medical workers [adjusted odds ratio = 3.11 ($P < 0.001$) and 2.93 ($P < 0.001$), respectively]. Furthermore, "mainly disaster-related work" and "near-death experience" were significant factors for municipality workers (adjusted odds ratio = 1.94, $P < 0.05$) and medical workers (adjusted odds ratio = 2.22, $P < 0.05$), respectively.

Although "displacement," "dead or missing family member(s)," and "age" were significantly associated with probable depression in municipality workers in the bivariate analysis, none of these survived multivariate analysis. "Female sex," "supervisory work status," and "dead or missing colleague(s)" were not associated with probable depression in any of the occupations in the bivariate analysis.

Risk factors for high general psychological distress

Table 4 shows the results of bivariate and multivariate analysis of factors associated with high general psychological distress. Multivariate analysis revealed that, among workplace factors, "lack of communication" was associated with psychological distress in medical workers and firefighters [adjusted odds ratio = 2.75 ($P < 0.01$) and 13.41 ($P < 0.01$), respectively]; "lack of rest" was a factor for municipality and medical workers [adjusted odds

Table 2 Bivariate analysis and multivariate analysis of factors associated with probable PTSD

	Local municipality workers				Hospital medical workers				Firefighters			
Bivariate analysis	β	SE	OR	P	β	SE	OR	P	β	SE	OR	P
Age	0.00	0.02	1.00	0.96	0.04	0.02	1.04	0.11	−0.02	0.04	0.98	0.66
Female sex	−0.26	0.37	0.77	0.48	0.63	0.75	1.87	0.41				
Workplace factors												
Supervisory work status	0.06	0.50	1.07	0.90	0.13	0.77	1.14	0.87	−17.18	8038.59	0.00	1.00
Mainly disaster-related work	1.54	0.38	4.68	<0.001	0.61	0.78	1.84	0.43	−0.57	1.13	0.57	0.61
Lack of communication	0.44	0.39	1.56	0.26	1.12	0.44	3.06	<0.05	2.20	0.94	8.98	<0.05
Lack of rest	1.71	0.43	5.55	<0.001	1.76	0.56	5.81	<0.01	18.77	2562.61	141708318.91	0.99
Dead or missing colleague(s)	−0.13	0.46	0.87	0.77	0.95	0.50	2.59	0.06	17.35	4874.11	34226161.92	1.00
Personal factors												
Displacement	1.16	0.36	3.19	<0.01	0.21	0.47	1.23	0.66	−0.11	1.13	0.90	0.92
Dead or missing family member(s)	1.52	0.47	4.56	<0.01	1.45	0.49	4.25	<0.01	0.75	1.13	2.12	0.51
Near-death experience	0.79	0.37	2.20	<0.05	1.47	0.63	4.33	<0.05	17.74	3361.11	50801095.58	1.00
Multivariate analysis	β	SE	OR	P	β	SE	OR	P	β	SE	OR	P
Age												
Female sex												
Workplace factors												
Supervisory work status												
Mainly disaster-related work	1.36	0.40	3.89	<0.001								
Lack of communication					1.31	0.49	3.70	<0.01				
Lack of rest	1.36	0.45	3.90	<0.01	1.48	0.58	4.41	<0.05				
Dead or missing colleague(s)												
Personal factors												
Displacement	0.82	0.39	2.27	<0.05								
Dead or missing family member(s)	1.48	0.54	4.37	<0.01	1.67	0.55	5.29	<0.01				
Near-death experience	1.00	0.41	2.72	<0.05	1.85	0.77	6.38	<0.05				

SE = standard error, OR = adjusted odds ratio.

ratio = 3.90 ($P < 0.001$) and 2.31 ($P < 0.05$), respectively]; and "mainly disaster-related work" was a factor for municipality workers (adjusted odds ratio = 3.89, $P < 0.01$). Among personal factors, "dead or missing family member(s)" was associated with psychological distress in municipality workers and firefighters [adjusted odds ratio = 4.37 ($P < 0.01$) and 11.11 ($P < 0.01$), respectively]; "near-death experience" was a factor for municipality and medical workers [adjusted odds ratio = 2.72 ($P < 0.05$) and 2.53 ($P < 0.05$), respectively]; and "displacement" was a factor for municipality workers (adjusted odds ratio = 2.27, $P < 0.05$).

Although "female sex" and "lack of rest" were significantly associated with psychological distress in medical workers and firefighters, respectively, in the bivariate analysis, these factors did not survive multivariate analysis. "Age," "supervisory work status," and "dead or missing colleague(s)" were not associated with high general psychological distress in any of the occupations in bivariate analysis.

Discussion

To the best of our knowledge, this is the first study to investigate the prevalence of and risk factors for probable PTSD, depression, and high general psychological distress in local workers engaged in lengthy relief and reconstruction projects following a large-scale natural disaster. These workers were living in the disaster-affected community as survivors and serving as disaster relief and reconstruction workers at the same time. As community reconstruction can take years, it is crucial to ensure that the mental health of these local workers is maintained.

The present results show that 14 months after the GEJE, the consequences of the disaster on workers' mental health differed across occupations: the prevalence of probable PTSD, depression, and high general psychological distress was significantly greater among municipality workers and medical workers compared to firefighters. Furthermore, the prevalence of high general psychological distress among municipality workers and

Table 3 Bivariate analysis and multivariate analysis of factors associated with probable depression

	Local municipality workers				Hospital medical workers				Firefighters			
Bivariate analysis	β	SE	OR	P	β	SE	OR	P	β	SE	OR	P
Age	0.00	0.01	1.00	0.88	0.03	0.02	1.04	<0.05	0.01	0.02	1.01	0.68
Female sex	−0.27	0.24	0.77	0.27	0.56	0.49	1.75	0.26				
Workplace factors												
Supervisory work status	0.17	0.32	1.18	0.61	−0.4	0.63	0.67	0.53	−0.02	1.06	0.98	0.99
Mainly disaster-related work	0.87	0.24	2.38	<0.001	−1.18	1.04	0.31	0.26	−0.33	0.68	0.72	0.63
Lack of communication	1.31	0.25	3.71	<0.001	1.17	0.32	3.22	<0.001	0.95	0.81	2.59	0.24
Lack of rest	1.32	0.26	3.73	<0.001	1.22	0.32	3.39	<0.001	1.83	0.60	6.25	<0.01
Dead or missing colleague(s)	−0.29	0.32	0.75	0.37	−0.41	0.50	0.66	0.41	0.28	0.79	1.32	0.73
Personal factors												
Displacement	0.58	0.26	1.78	<0.05	0.24	0.32	1.27	0.46	1.01	0.60	2.76	0.09
Dead or missing family member(s)	0.96	0.38	2.62	<0.05	−0.35	0.55	0.70	0.52	0.54	0.80	1.72	0.50
Near-death experience	0.00	0.23	1.00	0.99	0.77	0.35	2.16	<0.05	0.22	0.60	1.25	0.71
Multivariate analysis	β	SE	OR	P	β	SE	OR	P	β	SE	OR	P
Age					0.03	0.02	1.03	0.05				
Female sex												
Workplace factors												
Supervisory work status												
Mainly disaster-related work	0.66	0.25	1.94	<0.05								
Lack of communication	1.11	0.26	3.02	<0.001	1.14	0.34	3.11	<0.001				
Lack of rest	0.99	0.27	2.70	<0.001	1.07	0.33	2.93	<0.001				
Dead or missing colleague(s)												
Personal factors												
Displacement	0.32	0.28	1.38	0.25								
Dead or missing family member(s)	0.76	0.44	2.14	0.08								
Near-death experience					0.80	0.37	2.22	<0.05				

SE = standard error, OR = adjusted odds ratio.

medical workers was higher than that of survivors living in temporary housing or the general population living in tsunami-affected areas [27,28]. Workplace risk factors such as lack of rest, lack of communication, and involvement in disaster-related work affected risk of PTSD, depression, and high psychological distress differently in each occupation.

Risk of PTSD

In the present study, the prevalence of probable PTSD in municipality workers and medical workers was 6.6%, which is much higher than the 12-month prevalence of PTSD in the general population in Japan (0.4%) [32]. In firefighters, PTSD prevalence was 1.6%, which is higher than that of the general population, but much lower than that of municipality and medical workers. The incidence of probable PTSD in the present sample was lower than that of firefighters, medical personnel, and government agencies 2 to 3 years after working at the WTC disaster site (12.2%, 11.6%, and 11.8%, respectively) [7]. The prevalence of PTSD is affected by type of disaster, and PTSD risk is reportedly lower after natural disasters than after human-made/technological disasters such as terror attacks [5,6]. Additionally, coastal areas of Miyagi prefecture have been repeatedly hit by huge tsunamis at intervals of several decades (i.e., at 1896, 1933, and 1960) [33], and people were culturally prepared (people of the area sustained effort to instill a culture of resilience and prevention based on continuous learning) to cope with tsunami disasters [34]. Thus, in these areas, past experience with disasters may have served as a moderator and consequently lessened the impact of the GEJE [35].

The lower PTSD risk among firefighters relative to municipality workers and medical workers observed in the present study is consistent with the finding that firefighters dispatched to the tsunami-affected area immediately after the GEJE did not exhibit PTSD symptoms [36]. Although we did not have any quantitative data on prior disaster training or experience for any of the studied occupations, we speculate that the lower risk of

Table 4 Bivariate analysis and multivariate analysis of factors associated with high general psychological distress

	Local municipality workers				Hospital medical workers				Firefighters			
Bivariate analysis	β	SE	OR	P	β	SE	OR	P	β	SE	OR	P
Age	0.00	0.02	1.00	0.96	0.02	0.02	1.02	0.14	0.01	0.03	1.01	0.63
Female sex	−0.26	0.37	0.77	0.48	1.59	0.74	4.90	<0.05				
Workplace factors												
Supervisory work status	0.07	0.50	1.07	0.90	−0.05	0.56	0.95	0.93	−17.67	8038.59	0.00	1.00
Mainly disaster-related work	1.54	0.38	4.68	<0.001	0.09	0.64	1.09	0.90	−1.18	1.08	0.31	0.27
Lack of communication	0.44	0.39	1.56	0.26	0.97	0.32	2.65	<0.01	2.75	0.75	15.67	<0.001
Lack of rest	1.71	0.43	5.55	<0.001	1.05	0.32	2.87	<0.01	1.49	0.72	4.44	<0.05
Dead or missing colleague(s)	−0.13	0.46	0.88	0.77	−0.66	0.54	0.52	0.22	0.64	1.08	1.90	0.55
Personal factors												
Displacement	1.16	0.36	3.19	<0.01	0.40	0.32	1.49	0.21	−0.63	1.08	0.54	0.56
Dead or missing family member(s)	1.52	0.47	4.56	<0.01	0.75	0.41	2.12	0.07	2.20	0.73	9.00	<0.01
Near-death experience	0.79	0.37	2.20	<0.05	1.02	0.37	2.77	<0.01	1.02	0.83	2.77	0.22
Multivariate analysis	β	SE	OR	P	β	SE	OR	P	β	SE	OR	P
Age												
Female sex					1.34	0.76	3.81	0.08				
Workplace factors												
Supervisory work status												
Mainly disaster-related work	1.36	0.40	3.89	<0.01								
Lack of communication					1.01	0.34	2.75	<0.01	2.60	0.89	13.41	<0.01
Lack of rest	1.36	0.45	3.90	<0.001	0.84	0.33	2.31	<0.05	0.92	0.86	2.51	0.28
Dead or missing colleague(s)												
Personal factors												
Displacement	0.82	0.39	2.27	<0.05								
Dead or missing family member(s)	1.48	0.54	4.37	<0.01					2.41	0.83	11.11	<0.01
Near-death experience	1.00	0.41	2.72	<0.05	0.93	0.38	2.53	<0.05				

SE = standard error, OR = adjusted odds ratio.

PTSD among firefighters may be partially explained by their prior training and experience with disaster [7,31].

After the Kobe earthquake in 1995, the importance of critical incident stress management programs for firefighters has been widely acknowledged and practiced in Japan [37,38], and such a program was provided to the present firefighters at their workplace on several occasions following the GEJE [38]. Thus, there is a possibility that these pre and post measures might have mitigated PTSD risk in this population. On the other hand, as is common to local municipal offices or hospitals in Japan, the workplace mental health care system was insufficient, and few workplaces had mental health support programs ready for implementation following a disaster.

In the present study, lack of communication was associated with increased PTSD risk in medical workers. To our knowledge, this is the first study that has demonstrated such a relationship in workers following a large-scale disaster. However, the importance of social support and sustained attachment to one's social group during recovery from traumatic experiences has been repeatedly shown in previous studies [39-41]. Wang et al. [9] noted that feeling connected and positive at the workplace might be important for recovery from mass trauma and post-traumatic growth in local relief workers. Therefore, measures to promote communication at the workplace might facilitate psychological recovery in local medical workers.

At the time of survey, municipality and medical workers were more likely than firefighters to indicate lack of rest, and increased PTSD risk was associated with lack of rest among municipality and medical workers. Since the GEJE, municipality workers had been involved in large-scale and multi-year post-disaster reconstruction activities in addition to their ordinary duties, and chronic staff shortages have plagued most of the municipality offices in these areas [42]. Moreover, the exhaustion of medical workers has also been a concern. Since most local hospitals and clinics in the affected areas were damaged by the disaster, and a

substantial number of them were permanently closed or still non-functional at the time of assessment, the number of emergency patients admitted to disaster base hospitals was increasing even 12 months after the GEJE [43]. Therefore, at the time of survey, municipality and medical workers were still suffering from increased workload and staff shortages; conversely, working conditions had normalized for firefighters by this time.

Factors indicating exposure to traumatic events as disaster survivors (i.e., dead or missing family member(s), displacement, or near-death experience) were associated with probable PTSD. This finding is consistent with those of previous studies showing that more severe exposure to a traumatic event is associated with more pronounced PTSD symptoms [5,44,45]. For example, losing family members or one's home and possessions [29,46,47], or experiencing fear during a disaster might result in augmented PTSD symptoms [48].

Risk of depression

In our participants, one in seven municipality and medical workers showed probable depression, which is approximately four to five times higher than the 12-month prevalence of major depression (3%) in the general population of Japan [32], indicating that depression risk may increase in some occupations among local workers. Although risk of depression among disaster-related workers has been studied less than that of PTSD, previous studies showed an increased risk of depression among disaster workers responding to an airplane crash [49] and the 9/11 WTC attacks [8].

On the other hand, depression risk was much lower in firefighters relative to municipality and medical workers, which is consistent with a previous finding [8] that depression risk differed between New York City police officers and other rescue and recovery workers one year after the 9/11 WTC attacks: the cumulative incidence of depression was 1.7% in the former and 10.8% in the latter. Probable depression in our sample was more prevalent than probable PTSD, which contradicts the findings of the abovementioned study [8] in which risk of PTSD was higher than that of depression. As mentioned above, we speculate that the lower risk of PTSD after natural disasters relative to human-made/technological disasters [5,6], and the historical and cultural experience with tsunami in these areas may explain the lower risk of PTSD relative to depression in our sample.

Workplace factors were strongly associated with probable depression. Depression was associated with lack of communication in municipality and medical workers, with involvement in disaster-related work in municipality workers, and with lack of rest in all three occupations. Under ordinary working conditions, depression is associated with long working hours [50] and poor interpersonal relationships at the workplace [51]; however, after a devastating disaster such as the GEJE, local workers have an enormous amount of work to do for a longer period of time, which reduces the time available for rest and interpersonal communication. While other disaster-related factors may additionally contribute to this reduction, the importance of rest [11] and a good relationship with coworkers [9,11] for local disaster-related workers has been previously demonstrated, and the present findings corroborate this notion in terms of preventing depression.

Risk of general psychological distress

The prevalence of high general psychological distress among municipality (14.9%) and medical (14.5%) workers was more than twice that of the general population in Miyagi prefecture before the GEJE in 2010 (5.5%), and also higher than that of the general population of tsunami-devastated areas at 4 months (7.3%) [27], or displaced survivors living in temporary housing in Miyagi prefecture at 11 months after the GEJE (8.1%) [28]. On the other hand, the prevalence of high general psychological distress among firefighters was less than one-fifth that of municipality and medical workers, and less than that of the general population in the affected areas. This finding corresponds to the lower risk of PTSD and depression among firefighters in the present sample.

Similar to the present study, general psychological distress in public servants was examined in the Miyagi prefectural government at 7 months after the GEJE. The percentage of prefectural government workers who scored 13 or more on the K6 scale was 4.4% [11], which is slightly higher than that of local public servants (2.5%) [52], but much lower than that of the municipality workers in our study. Thus, although the prefectural and municipality government workers were working as public servants in the same disaster-affected prefecture and the former were investigated at a time closer to the disaster, severe psychological distress was more common in municipality workers. This is likely because, under the Japanese local government system, municipal government workers are required to be more directly involved in disaster-related work [11], and most of the present workers lived in the more severely damaged areas and had consequently experienced more direct loss and damage due to the GEJE.

Limitations

There are several limitations to this study. First, since this study was cross-sectional and correlational, we cannot draw conclusions regarding the causation of the risk factors. Thus, our findings should be examined in future studies using prospective designs. Second, although

several pre-disaster baseline risk factors, such as prior psychiatric problems, disaster experience, exposure to traumatic events, stress exposure, and alcohol consumption, are known to affect the mental health of affected people after a disaster [6,53], we could not obtain such data because they were beyond the scope of the workplace health examinations. As a result, we could not eliminate the possibility that the firefighters had had fewer mental health problems before the disaster. Third, because we used self-administered questionnaires to assess psychological symptoms and did not conduct a psychiatric diagnostic interview to confirm the results of the self-administered questionnaires, the prevalence of PTSD and depression could have been overestimated [54]. However, the present diagnostic estimation of PTSD and depression correspond to that reported in previous studies [2,7,55], enabling us to compare results from different studies. Fourth, we did not directly assess the degree of previous training experience and preparedness for disaster, participation in mental health interventions, or workload in each occupation; thus, we could not determine whether such factors might have been responsible for the differences in mental health conditions among the different occupations. Finally, the study questionnaires were distributed through the participants' workplaces. Although we notified the participants that the results would remain confidential and would not be considered in performance evaluations, it is nonetheless possible that some participants may not have answered honestly because of the stigma attached to poor mental health [56].

Conclusions

In this study, we examined mental health in local workers who were residents of the affected area and continuously involved in relief and reconstruction activities 14 months after a large-scale natural disaster, the GEJE. We found differences in PTSD and depression risk among the three local occupations: the risk was greater for municipality and medical workers than for firefighters. Although all workers were impacted by the disaster as members of the affected community and as local disaster relief and reconstruction workers, the effects of these circumstances may have been reduced in firefighters because of high preparedness, early mental health interventions, and a more prompt return of ordinary working conditions.

We revealed that work-related factors were strongly associated with increased risk of PTSD and depression. Lack of rest was associated with increased risk of PTSD and depression in municipality and medical workers; lack of communication was linked to increased risk of PTSD in medical workers and depression in municipality and medical workers; and involvement in disaster-related work was associated with increased risk of PTSD and depression in municipality workers. Unlike the direct effects of disasters, risk factors at the workplace, such as lack of communication and rest, can be modified after a disaster. Thus, we should develop countermeasures to improve working conditions for local disaster relief and reconstruction workers (e.g., developing educational programs or leaflets to inform workers of the psychological response after a disaster and stress management techniques, as well as to educate supervisory employees about the importance of staff rotation to prevent burn-out). Such interventions should be particularly geared towards promoting workplace communication and rest after a massive disaster.

Abbreviations

PTSD: Post-traumatic stress disorder; GEJE: Great east Japan earthquake; PCL-S: PTSD Checklist–specific version; PHQ-9: Patient health questionnaire-9.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

AS and KM drafted the manuscript. AS, YT, IT, HM, KM designed the study. AS, YS, YT, and KM developed the questionnaire. AS, YT, IU, HS, MK, MA, AN collected data. AS, YT, and MK performed the statistical analysis. All authors contributed in interpretation of the data and revision of the manuscript. All authors read and approved the final manuscript.

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ORIGINAL RESEARCH

The Association Between Medical Treatment of Physical Diseases and Psychological Distress After the Great East Japan Earthquake: The Shichigahama Health Promotion Project

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ABSTRACT

Objective: Physical disease patients are known to experience high levels of psychological distress. This study examined the association between the medical treatment of physical diseases and psychological distress in the coastal area affected by the Great East Japan Earthquake.

Methods: Using cross-sectional data, we studied 3032 individuals aged ≥40 years who lived in Shichigahama, Miyagi, Japan. We examined the associations between 8 medical treatments for physical diseases and psychological distress, defined as Kessler Psychological Distress scale score ≥13 of 24 points. To investigate the associations, we performed multiple logistic regression analyses.

Results: There were statistically significant associations between psychological distress and medical treatments for myocardial infarction/angina pectoris (odds ratio [OR] = 1.8, 95% confidence interval [CI] = 1.0-3.0) and liver disease (OR = 3.1, 95% CI = 1.0-7.7). The other 4 medical treatments for physical diseases had ORs of 1.3 or higher and were positively associated with psychological distress: cancer, hyperlipidemia, kidney disease, and diabetes mellitus. The degree of damage to homes did not affect the association between most of the medical treatments for physical diseases and psychological distress.

Conclusions: In the disaster area, most of the medical treatments for physical diseases had positive associations with psychological distress, irrespective of the degree of damage to homes. (*Disaster Med Public Health Preparedness.* 2015;9:374-381)

Key Words: psychological warfare, preventive health services, mental disorders, public health, earthquakes

The number of patients with mood (affective) disorders, including depressive disorders, has been consistently high among Japanese people since 2005 (0.924 million in 2005, 1.041 million in 2008, and 0.958 million in 2011) according to the Patient Survey by the Ministry of Health, Labour, and Welfare in Japan.[1] In Japan, individuals who suffer from depressive disorders have the second highest number of disability-adjusted life years.[2] Thus, determining the risk factors for depression (ie, major depression or elevated depressive symptoms) is important, as early detection may prevent severe cases of depression or psychological distress from developing.

For many years, depression has been common among patients with physical diseases, such as diabetes,[3] cardiovascular disease,[4] HIV infection,[5] rheumatoid arthritis,[6] and cancer.[7] In our previous large cross-sectional study,[8] a history of physical diseases such as cancer, diabetes mellitus, and hypertension was positively associated with psychological distress among 43 487 subjects living in a community located in Miyagi Prefecture before the disaster. In terms of the mechanisms involved in the associations between physical disease and psychological distress, subjects with a physical disease may experience physiological stress reactions,[9] an increased level of fatigue,[10] or a decreased level of activity of daily life (ADL)/quality of life (QOL).[11-13] Further, it has been shown that psychological distress acts as one of the major factors causing various physical diseases.[14,15]

On March 11, 2011, the northeastern coast of Japan was devastated by the Great East Japan Earthquake of

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magnitude 9.0 and the tsunami that followed the earthquake. On March 11, 2015, 18 475 people were recorded as dead or missing because of the earthquake.[16] Three years have passed since the disaster, and its adverse psychological effects on the survivors are now apparent.[17] Although previous studies have indicated that disaster influences occurrence and characteristics of various kinds of physical diseases, and psychological distress has been considered to be an important factor underlying this influence,[18-20] the association between psychosocial distress and medical conditions in postdisaster settings has not been well characterized. If those who have physical disease experience a disaster simultaneously, the level of psychological distress may be high. In that case, special attention for mental health care will be needed in postdisaster medical settings.

In this study, we examined the psychological distress among patients who received treatment for physical diseases in the disaster area, and we also examined whether these associations were affected by the degree of damage to homes. We used data obtained from a population-based study of over 3000 subjects to investigate the associations between medical treatments for physical disease, psychological distress, and the degree of damage to homes, which were adjusted for the potentially confounding effects of various lifestyle-related and socioeconomic factors.

MATERIALS AND METHODS

Study Design, Setting, and Participants

This study was based on a health survey as a part of a project named Shichigahama Health Promotion Project, a cooperative project between Tohoku University and Shichigahama Town in regards to health promotion activities, a health survey, and health supports for the people affected by the Great East Japan Earthquake. The survey aimed to evaluate the current overall health and life status of community members in 5 specific seashore areas of Shichigahama Town during September 2012, where more than 10% of households were partially or totally destroyed by the Great East Japan Earthquake and tsunami.

The entrusted survey teams visited all households in the target area and asked for participation in the survey. A form for written informed consent and the questionnaire were handed directly to the residents who expressed willingness to participate in the survey and subsequently collected. First, in October 2012, there was a survey for residents whose homes were suffered by large-scale damage, which was followed in December 2012 by a survey of residents of the same affected seashore area whose homes underwent small-scale damage. Definition of large-scale damage was based on the criterion of "partially or totally destroyed" in the building damage assessment conducted by the local government of Shichigahama town following the criteria issued by the Cabinet Office, and small-scale damage represented less or no damage due to the disaster.

Of the study population of 7036 subjects (2910 with large-scale damage and 4126 with small-scale damage), 6840 participants (97%) were reached by the survey team, and 4949 (70%) participated in the survey upon written informed consent and returned the questionnaire. Among the total participants, 3886 (55%) completed the Kessler Psychological Distress scale (K6) survey section, and of them, 3032 (43% of the total) were aged ≥40 years. Thus, data from the 3032 participants (1206 with large-scale damage and 1826 with small-scale damage) were subjected to the following analyses (Figure 1). In this study, we excluded the subjects who were less than 40 years old (n = 854) because almost no subjects received treatment for physical diseases: stroke (n = 0), myocardial infarction or angina pectoris (n = 0), cancer (n = 0), kidney disease (n = 1), liver disease (n = 0), hypertension (n = 7), diabetes mellitus (n = 9), and hyperlipidemia (n = 4).

Measurements

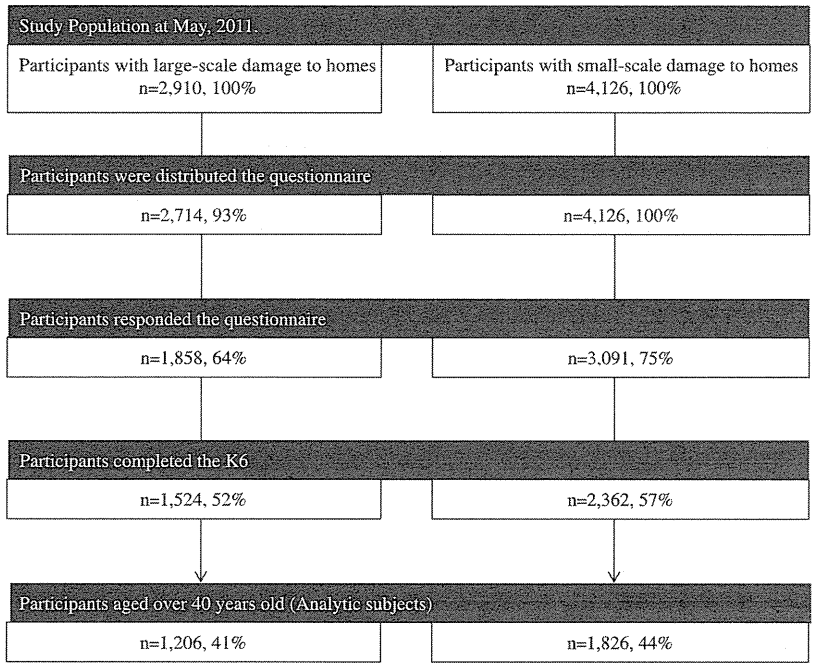
Data regarding current treatments for selected physical diseases were collected using a self-administered questionnaire, which asked whether the subjects were undergoing treatment for any of the following 8 physical diseases: stroke, myocardial infarction or angina pectoris, cancer, kidney disease, liver disease, hypertension, diabetes mellitus, or hyperlipidemia. These diseases were selected based on the rationale that they are frequent among Japanese and may be related to psychological stress. Basic individual information (ie, age, gender, income, body weight and height, time spent walking per day, smoking status, and alcohol drinking status), as well as detailed information of personal experience of the Great East Japan Earthquake (eg, the subject's location during the great earthquake, evacuation, presence of posttraumatic stress response, and the death of family members) were collected through the questionnaire.

Psychological Distress

The K6 scale was used as an indicator of psychological distress.[21-23] The respondents were asked about their mental status over the previous month based on 6 questions, to which they responded by selecting: "all of the time" (4 points), "most of the time" (3 points), "some of the time" (2 points), "little of the time" (1 point), or "none of the time" (0 points). The total scores ranged from 0 to 24. The questions were as follows: "Over the last month, how often have you felt the following: [i] nervous, [ii] hopeless, [iii] restless or fidgety, [iv] so sad that nothing could cheer you up, [v] that everything was an effort, or [vi] worthless?" K6 is based on modern psychometric theory and it outperforms other scales.[21,22] The Japanese version of K6 was developed recently using the standard back-translation method and it has been validated.[24] As suggested by several researchers, we classified individuals with scores of ≥13 of 24 points as having psychological distress.[8,17,23-25] Furukawa et al[24] investigated whether K6 could predict the 30-day prevalence of *Diagnostic and Statistical Manual of Mental Disorders* (Fourth Edition) (DSM-IV)–defined mood and anxiety disorders based

FIGURE 1

Study Participants in the Shichigahama Health Promotion Project, Shichigahama, Miyagi, Japan (n = 3032)



on the World Health Organization Composite International Diagnostic Interview in the Australian National Survey. They showed that K6 detected DSM-IV–defined mood and anxiety disorders (area under the receiver operating curve [AUC]: 0.89; 95% confidence interval [CI]: 0.88-0.90) better than the General Health Questionnaire 12 (AUC: 0.80; 95% CI: 0.78-0.82).

Ethical Issues

The study protocol was reviewed and approved by the Ethics Committee of Tohoku University Graduate School of Medicine.

Statistical Analyses

Multiple logistic regression analyses were implemented to evaluate association between medical conditions and psychological distress. The multivariate odds ratios (ORs) were adjusted for gender, age in years (40-49, 50-59, 60-69, ≥70), current cigarette smoking (no smoking, 1-19 cigarettes/day, ≥20 cigarettes/day, unknown), alcohol consumption (no drinking, ≤1 *go*/day, ≥2 *go*/day, unknown; 22.8 g of alcohol amounts to 1 *go* or traditional unit of sake (180 ml), which also approximates two glasses of wine (200 ml), or beer (500 ml) in terms of alcohol contents.), time spent walking (<0.5 hours/day, ≥0.5 hours/day, unknown), income (difficult to live, no problem or easy to live, unknown), and degree of damage to homes (large-scale, small-scale).

Stratified analyses according to differences in the degree of damage to homes were applied to evaluate whether this factor significantly interacted with the association between medical conditions and psychological distress.

Finally, we conducted multiple logistic regression analyses. The categories of the degree of damage to homes and each medical treatment for physical disease were combined, and we then grouped subjects into 4 categories: damage (small-scale) and physical disease (−), damage (small-scale) and physical disease (+), damage (large-scale) and physical disease (−), and damage (large-scale) and physical disease (+).

All statistical analyses were performed using SAS version 9.3 (SAS Inc, Cary, NC) and all statistical tests were 2-sided. $P < 0.05$ was considered to indicate statistical significance.

RESULTS

Tables 1 and 2 summarize medical conditions for the 8 physical diseases of the participants, along with the demographic data, lifestyle, socioeconomic characteristics of the subjects, and prevalence of psychological distress for each category. Prevalences of receiving treatment for stroke, myocardial infarction or angina pectoris, cancer, kidney disease, liver disease, hypertension, diabetes mellitus, and hyperlipidemia were 1%, 6%, 3%, 1%, 1%, 33%, 10%, and

TABLE 1

Demographics, Lifestyle, and Socioeconomic Characteristics in the Shichigahama Health Promotion Project, Shichigahama, Miyagi, Japan (n = 3032)

Demographic Variables	No. of Subjects	No. of Subjects With K6 Score ≥13 of 24 (%)	*P* Value of χ^2 Test
Total	3032	160 (5)	—
Age at survey, y			.02
40–49	629	33 (5)	
50–59	689	35 (5)	
60–69	773	27 (3)	
≥70	941	65 (7)	
Gender			<.01
Men	1416	57 (4)	
Women	1616	103 (6)	
Current smoking status			.83
No smoking	2076	111 (5)	
1–19 cigarettes/d	287	17 (6)	
20 cigarettes or more/d	428	22 (5)	
Unknown	241	10 (4)	
Alcohol consumption			<.01
No drink	987	68 (7)	
≤1 *go*/d[a]	779	25 (3)	
≥2 *go*/d	321	14 (4)	
Unknown	945	53 (6)	
Time spent walking			<.01
Less than 0.5 h/d	989	75 (8)	
≥0.5 h/d	1979	78 (4)	
Unknown	64	7 (4)	
Income			<.01
Difficult for living	1304	105 (8)	
No problem or easy for living	1683	50 (3)	
Unknown	45	5 (3)	
Degree of damage to homes			<.01
Large-scale	1206	86 (7)	
Small-scale	1826	74 (4)	

[a]22.8 g of alcohol amounts to 1 *go* or traditional unit of sake (180 ml), which also approximates two glasses of wine (200 ml), or beer (500 ml) in terms of alcohol contents.

17%, respectively. Older subjects, women, and non–alcohol drinkers experienced higher levels of psychological distress (K6 score ≥13 of 24 points). Subjects who spent less time walking or who had lower incomes (difficulty living) also suffered from psychological distress. Furthermore, subjects with large-scale property damage due to the great earthquake experienced higher levels of psychological distress.

The multiple logistic regression models detected significant associations between psychological distress and current medical treatment for the following physical diseases: myocardial infarction/angina pectoris (OR = 1.8, 95% CI = 1.0-3.0) and liver disease (OR = 3.1, 95% CI = 1.0-7.7). Although the factors of receiving treatment for cancer, hyperlipidemia, kidney disease, and diabetes mellitus tended to be associated with a higher prevalence of psychological distress (OR ≥ 1.3), the associations did not reach statistical significance (Table 2).

We also conducted stratified analyses of the OR for psychological distress according to the differences in the degree of damage to homes. Most medical treatment of physical diseases was consistently and positively associated with psychological distress irrespective of the degree of damage to homes (Table 3).

We combined the categories of the degree of damage to homes and each medical treatment for physical disease, where the ORs were higher for psychological distress among the subjects with damage (large-scale) and each physical disease (+): stroke (OR = 2.9), myocardial infarction or angina pectoris (OR = 3.6), cancer (OR = 1.5), kidney disease (OR = 3.0), liver disease (OR = 7.0), hypertension (OR = 1.7), diabetes mellitus (OR = 2.3), and hyperlipidemia (OR = 2.4) (Table 4).

DISCUSSION

In this study, we examined the associations between medical treatments for physical diseases and psychological distress among the members of a community aged ≥40 years in a town affected by the Great East Japan Earthquake. Our results showed that most medical treatments for physical diseases had positive associations with psychological distress.

We considered medical treatments for 8 physical diseases, and most were associated with higher levels of psychological distress. In our previous large cross-sectional study of 43 487 people, which did not consider the effect of the Great Earthquake, the subjects with histories of various physical diseases (cancer, diabetes mellitus, hyperlipidemia, hypertension, myocardial infarction, stroke, gastric or duodenal ulcer, liver disease, arthritis, osteoporosis, kidney disease, and fall or fracture) also had high levels of psychological distress.[8] The results obtained in the current study are consistent with those reported in our previous study. The previous study focused on the past history of physical diseases,[8] and the current study focused on the current medical treatment of physical diseases. Thus, doctors and paramedics need to monitor patients with treatment continuously for psychological distress even after they leave the hospital following treatment for a physical disease.

In terms of the mechanisms responsible for the associations between physical diseases and psychological distress, the subjects with physical diseases suffered physiological stress reactions,[9] increased levels of fatigue,[10] or decreases in ADL/QOL.[11-13] Among the subjects with medical treatment for stroke (OR = 0.5, 95% CI = 0.03-2.5) and hypertension (OR = 1.1, 95% CI = 0.7-1.6), the ORs were not high

TABLE 2

Multivariate OR and 95% CI for Psychological Distress (K6 Score ≥13) by Medical Treatment of Physical Disease in the Shichigahama Health Promotion Project, Shichigahama, Miyagi, Japan (n = 3032)[a]

Medical Treatment of Physical Diseases	No. of Subjects	No. of Subjects With K6 Score ≥13 of 24 (%)	Multivariate Adjusted ORs (95% CIs)	*P*
Stroke				
None	2998	159 (5)	1.0 (reference)	—
Under treatment	34	1 (3)	0.5 (0.03–2.5)	.51
Myocardial infarction/angina pectoris				
None	2850	143 (5)	1.0 (reference)	—
Under treatment	182	17 (9)	1.8 (1.0–3.0)	.04
Cancer				
None	2938	151 (5)	1.0 (reference)	—
Under treatment	94	9 (10)	1.8 (0.8–3.5)	.14
Kidney disease				
None	2990	157 (5)	1.0 (reference)	—
Under treatment	42	3 (7)	1.3 (0.3–3.8)	.67
Liver disease				
None	2993	155 (5)	1.0 (reference)	—
Under treatment	39	5 (13)	3.1 (1.0–7.7)	.02
Hypertension				
None	2025	101 (5)	1.0 (reference)	—
Under treatment	1007	59 (6)	1.1 (0.7–1.6)	.65
Diabetes mellitus				
None	2728	139 (5)	1.0 (reference)	—
Under treatment	304	21 (7)	1.3 (0.8–2.2)	.24
Hyperlipidemia				
None	2522	123 (5)	1.0 (reference)	—
Under treatment	510	37 (7)	1.5 (1.0–2.2)	.06

Abbreviations: OR, odds ratio; CI, confidence interval; K6, Kessler Psychological Distress scale.

[a]The multivariate ORs have been adjusted for gender; age in years (40–49, 50–59, 60–69, ≥70); current cigarette smoking (no smoking, 1–19 cigarettes/d, 20 cigarettes or more/d, unknown); alcohol consumption (no drink, ≤1 *go*/d, ≥2 *go*/d, unknown; 22.8 g of alcohol amounts to 1 *go* or traditional unit of sake (180 ml), which also approximates two glasses of wine (200 ml), or beer (500 ml) in terms of alcohol contents.); time spent walking (≤0.5 h/d, ≥0.5 h/d, unknown); income (difficult to live, no problem or easy to live, unknown); and degree of damage to homes (large-scale damage, small-scale damage).

(Table 2). For stroke, this could be explained partly by the lack of statistical power due to the small number of participants who received medical treatment for stroke in our study (n = 34). Most patients with hypertension are asymptomatic even if they are undergoing treatment. This might explain why treatment for hypertension did not influence their stress reaction, fatigue, or ADL/QOL.

In this study, we also examined the potentially confounding effect of the degree of damage to homes on the ass ociation between medical treatments for physical disease and psychological distress. Various studies have reported associations between stressful life events and physical diseases.[26] In our study, most of the medical treatments for physical diseases were consistently and positively associated with psychological distress after stratification by the degree of damage to homes (Table 3). This result suggests that there were strong association between medical treatment for physical diseases and psychological distress irrespective of the scale of damage, whereas psychological distress was greater in individuals with large-scale damage than in those with small-scale damage. The medical treatment of physical disease and degree of damage to homes was independent of psychological distress (Table 4). Therefore, people who live in a community with large-scale damage and who are being treated for physical disease could have a high prevalence of psychological distress; thus, medical care should be provided.

This study had several limitations. First, our sample size of 3032 was not sufficiently large to obtain adequate statistical power to measure the real effect of specific current medical treatments on psychological distress. Second, because of the nature of cross-sectional designs, we could not determine the causal links between medical treatments for physical disease and psychological distress in this study. Third, because we assessed the medical treatments for physical disease using a self-reported assessment, the exact physical disease status might have been classified incorrectly. However, this possibility of misclassification does not guarantee a negative bias. Fourth, the valid response rate (55%, n = 3886) was not high among the study population of 7036; thus, the study may have been biased toward healthier people in the community. However, this bias does not affect the internal validity of the association between medical treatment for physical diseases and psychological distress. Finally, we

TABLE 3

Multivariate OR and 95% CI for Psychological Distress (K6 Score ≥13) by Medical Treatment of Physical Disease Stratified by the Degree of Damage to Homes (Large-Scale, Small-Scale) in the Shichigahama Health Promotion Project, Shichigahama, Miyagi, Japan (n = 3032)[a]

Medical Treatment of Physical Diseases	No. of Subjects	No. of Subjects With K6 score ≥13 of 24 (%)	Multivariate Adjusted ORs (95% CIs)	P
Stroke				
Large-scale damage				
None	1193	85 (7)	1.0 (reference)	—
Under treatment	13	1 (8)	2.4 (0.1–13.9)	.42
Small-scale damage				
None	1805	74 (4)	1.0 (reference)	—
Under treatment	21	0 (0)	Not applicable	—
Myocardial infarction/angina pectoris				
Large-scale damage				
None	1133	76 (7)	1.0 (reference)	—
Under treatment	73	10 (14)	2.3 (1.0–4.8)	.04
Small-scale damage				
None	1717	67 (4)	1.0 (reference)	—
Under treatment	109	7 (6)	1.4 (0.5–3.0)	.47
Cancer				
Large-scale damage				
None	1167	83 (7)	1.0 (reference)	—
Under treatment	39	3 (8)	0.8 (0.2–2.6)	.78
Small-scale damage				
None	1771	68 (4)	1.0 (reference)	—
Under treatment	55	6 (11)	3.1 (1.1–7.3)	.02
Kidney disease				
Large-scale damage				
None	1187	84 (7)	1.0 (reference)	—
Under treatment	19	2 (11)	1.6 (0.2–6.3)	.56
Small-scale damage				
None	1803	73 (4)	1.0 (reference)	.88
Under treatment	23	1 (4)	0.9 (0.05–4.4)	
Liver disease				
Large-scale damage				
None	1191	83 (7)	1.0 (reference)	—
Under treatment	15	3 (20)	5.0 (1.1–18.0)	.02
Small-scale damage				
None	1802	72 (4)	1.0 (reference)	—
Under treatment	24	2 (8)	2.5 (0.4–9.1)	.24
Hypertension				
Large-scale damage				
None	784	55 (7)	1.0 (reference)	—
Under treatment	422	31 (7)	1.0 (0.6–1.6)	.91
Small-scale damage				
None	1241	46 (4)	1.0 (reference)	—
Under treatment	585	28 (5)	1.3 (0.8–2.2)	.34
Diabetes mellitus				
Large-scale damage				
None	1078	74 (7)	1.0 (reference)	—
Under treatment	128	12 (9)	1.4 (0.7–2.7)	.33
Small-scale damage				
None	1650	65 (4)	1.0 (reference)	—
Under treatment	176	9 (5)	1.3 (0.6–2.7)	.44
Hyperlipidemia				
Large-scale damage				
None	985	66 (7)	1.0 (reference)	—
Under treatment	221	20 (9)	1.4 (0.8–2.4)	.23
Small-scale damage				
None	1537	57 (4)	1.0 (reference)	—
Under treatment	289	17 (6)	1.6 (0.8–2.7)	.14

Abbreviations: OR, odds ratio; CI, confidence interval; K6, Kessler Psychological Distress scale.

[a]The multivariate odds ratios (ORs) have been adjusted for gender; age in years (40–49, 50–59, 60–69, ≥70); current cigarette smoking (no smoke, 1–19 cigarettes/d, 20 cigarettes or more/d, unknown); alcohol consumption (no drink, ≤1 *go*/d, ≥2 *go*/d, unknown; 22.8 g of alcohol amounts to 1 *go* or traditional unit of sake (180 ml), which also approximates two glasses of wine (200 ml), or beer (500 ml) in terms of alcohol contents.); time spent walking (≤0.5 h/d, ≥0.5 h/d, unknown); and income (difficult to live, no problem or easy to live, unknown).

focused on subjects who received medical treatments for physical disease, but we did not have the disease severity or the symptoms of the subjects in detail. Thus, the disease severity or the symptoms could have affected and modified psychological distress.

Among most individuals receiving medical treatments for physical disease, there was a positive association with psychological distress, irrespective of the scale of damage to homes. Thus, doctors and paramedics need to monitor patients with treatment continuously for psychological

TABLE 4

Multivariate OR and 95% CI for Psychological Distress (K6 Score ≥13) by Category of Combination With Medical Treatment of Physical Disease and Degree of Damage to Homes (Large-Scale, Small-Scale) in the Shichigahama Health Promotion Project, Shichigahama Town, Miyagi, Northern Japan (n = 3032)[a]

	Damage (Small) and Physical Disease (–)	Damage (Small) and Physical Disease (+)	Damage (Large) and Physical Disease (–)	Damage (Large) and Physical Disease (+)
Stroke	1.0 (reference)	Not applicable	1.6 (1.2–2.3)	2.9 (0.2–15.7)
OR (95% CI) and *P* value	—	—	<.01	.33
Myocardial infarction/ angina pectoris	1.0 (reference)	1.4 (0.6–3.0)	1.6 (1.1–2.3)	3.6 (1.6–7.4)
OR (95% CI) and *P* value	—	.45	<.01	<.01
Cancer	1.0 (reference)	3.4 (1.2–8.1)	1.8 (1.3–2.5)	1.5 (0.3–4.4)
OR (95% CI) and *P* value	—	<.01	<.01	.56
Kidney disease	1.0 (reference)	0.8 (0.05–4.2)	1.6 (1.2–2.3)	3.0 (0.5–11.3)
OR (95% CI) and *P* value	—	.87	<.01	.16
Liver disease	1.0 (reference)	2.4 (0.4–8.6)	1.6 (1.2–2.3)	7.0 (1.5–23.8)
OR (95% CI) and *P* value	—	.25	<.01	<.01
Hypertension	1.0 (reference)	1.3 (0.8–2.1)	1.9 (1.2–2.8)	1.7 (1.0–2.9)
OR (95% CI) and *P* value	—	.34	<.01	.03
Diabetes mellitus	1.0 (reference)	1.3 (0.6–2.6)	1.7 (1.2–2.4)	2.3 (1.1–4.3)
OR (95% CI) and *P* value	—	.47	<.01	.02
Hyperlipidemia	1.0 (reference)	1.6 (0.9–2.7)	1.7 (1.2–2.5)	2.4 (1.3–4.0)
OR (95% CI) and *P* value	—	.13	<.01	<.01

Abbreviations: OR, odds ratio; CI, confidence interval; K6, Kessler Psychological Distress scale.

[a]The multivariate odds ratios (ORs) have been adjusted for gender; age in years (40–49, 50–59, 60–69, ≥70); current cigarette smoking (no smoking, 1–19 cigarettes/d, 20 cigarettes or more/d, unknown); alcohol consumption (no drink, ≤1 *go*/d, ≥2 *go*/d, unknown; 22.8 g of alcohol amounts to 1 *go* or traditional unit of sake (180 ml), which also approximates two glasses of wine (200 ml), or beer (500 ml) in terms of alcohol contents.); time spent walking (≤0.5 h/d, ≥0.5 h/d, unknown); and income (difficult to live, no problem or easy to live, unknown). The categories of degree of damage to homes and each medical treatment of physical disease were combined, and we newly categorized the subjects with damage (small-scale) and physical disease (–), damage (small-scale) and physical disease (+), damage (large-scale) and physical disease (–), and damage (large-scale) and physical disease (+).

distress even after they leave the hospital following treatment for a physical disease. Undertaking screening for psychological distress among subjects with physical diseases will help to prevent severe consequences.

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Periodontal Disease Is Associated with Insomnia among Victims of the Great East Japan Earthquake: A Panel Study Initiated Three Months after the Disaster

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In March 2011, the Great East Japan Earthquake (GEJE), which was followed by a devastating tsunami, destroyed the societal and the public hygiene systems in Japanese coastal areas. Insomnia, the greatest issue among disaster victims, has detrimental effects on both physical and psychological health. Periodontitis causes chronic discomfort and inflammation, and little is known about its impact on insomnia. Three months after the earthquake, a health panel survey was conducted over four surveys, till September 2013, in which information regarding 8,015 adults was collected and used. In addition to the heath-related questionnaire, other variables including subjective symptoms of oral diseases were recorded, and the Athens Insomnia Scale was used to evaluate the severity of insomnia. The association between insomnia and periodontal disease was examined using multilevel logistic models on the panel data, after adjusting for sex, age, economic status, comorbidities, body mass index, post-traumatic stress reactions, habitual smoking and alcohol drinking, and the Kessler Psychological Distress Scale score. In addition to the higher prevalence of insomnia among GEJE victims, significant association was revealed between insomnia and gum problems (OR = 2.16, 95% CI = 1.43-3.26), and difficulty chewing (OR = 2.22, 95% CI = 1.40-3.51), after adjusting for all covariates. The present study revealed significant association between insomnia and periodontal disease among GEJE victims. This indicated that together, integrated oral health care for disaster victims would contribute not only to prevention of oral infectious diseases, but may also help alleviate other problems caused by these harmful events.

Keywords: insomnia; large-scale disaster; oral health; panel study; periodontal disease
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Introduction

The Great East Japan Earthquake (GEJE), a large earthquake of 9.0 magnitude on the Richter scale, which was followed by a devastating tsunami, destroyed the eastern coastal towns and villages of Japan on March 11, 2011 (Ishigaki et al. 2013). This was the greatest disaster ever recorded in Japan in which more than 18,000 people were reported dead or missing, and an additional 6,000 people were injured. The disaster also affected over 20 prefectures, including Miyagi, and almost 400,000 buildings were damaged or destroyed. In April 2014, there were still more

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than 260,000 evacuees throughout Japan, especially in Miyagi, where approximately 85,000 evacuees lived in about 20,000 temporary units (Below et al. 2012; Ishigaki et al. 2013). It is widely recognized that natural disasters cause major public health problems owing to the impact of the environmental changes associated with the collapse of the societal and public hygiene systems (Cherniack 2008; Kako et al. 2014).

Under the severe conditions experienced following a large-scale disaster, oral hygiene deteriorates, which increases the risk of oral diseases such as dental caries and periodontal disease (Liu et al. 2010; Hosokawa et al. 2012). A cross-sectional study reported that declining oral hygiene caused by the Wenchuan earthquake in Southwest China exacerbated periodontitis in elderly victims (Liu et al. 2010). Under these conditions, integrated oral health care could prevent not only oral diseases but also oral infectious diseases like pneumonia and influenza (Adachi et al. 2007; Estupinan-Day et al. 2011; Yamamoto 2013). In addition, psychological stress, such as depression and anxiety experienced by disaster victims, is strongly associated with the progression of periodontal disease (Lopez et al. 2012; Cakmak et al. 2014).

Insomnia, characterized by a difficulty in falling asleep and/or maintaining sleep, is one of the most frequent symptoms following disasters (Lavie 2001; Mohsenin and Mohsenin 2014). It has been a great issue among GEJE victims (Matsumoto et al. 2014). Insomnia is recognized as the most common sleep disorder that has detrimental effects on both psychological and physiological health (Babson and Feldner 2010; Piccolo et al. 2013). Recently, epidemiological studies on patients, and their meta-analyses, have revealed a significant and bidirectional relationship between periodontal disease and obstructive sleep apnea, a sleep disorder (Al-Jewair et al. 2015). With respect to the potential mechanism in connecting the two diseases, however, only one an animal study has examined the unidirectional impact and indicated that sleep deprivation and the associated psychological fatigue exacerbated experimental periodontitis (Nakada et al. 2015). Therefore, it is still unclear how periodontal disease could affect sleep disorders. In this context, the comorbidity rate of insomnia in obstructive sleep apnea patients was approximately 40-60% (Luyster et al. 2010; Bjorvatn et al. 2014). However, little is known about the association of periodontal disease with insomnia in disaster-affected populations.

We hypothesized that the deterioration of oral hygiene in GEJE victims resulted in the progression of periodontal diseases along with insomnia. Here, using the panel data from repeated surveys in the GEJE- and tsunami-affected areas, we sought to clarify the association between periodontal diseases and insomnia after the large-scale disaster, after adjusting for baseline covariates, including psychological stress. The results could determine important targets for dental intervention and strategies to support the disaster victims.

Methods

Study population

A panel study was conducted semi-annually with GEJE victims, from June 2011, three months after the disaster, until September 2013 (across four phases: June to September 2011, October 2011 to February 2012, October 2012 to February 2013, and May to September 2013) by the Tohoku University Graduate School of Medicine. Five coastal areas in the Miyagi prefecture, namely, Wakabayashi-ku in Sendai; Ajishima, Ogatu, and Oshika in Ishinomaki city; and Shichigahama-cho, were selected based on discussions with local governments. We recruited subjects aged 18 years and older (as of June, 2011) based on data from the Basic Resident Registration system in each area, as well as those who had previously participated in health surveys, whose subsequent address has been known until May 2013. A self-administered questionnaire was mailed to the participants. Among the 31,009 residents aged 18 years or older (9,412, 7,663, 6,927, and 7,007 for each survey, respectively), the numbers of respondents and response rates for each of the four survey periods were 4,095 (43.8%), 1,874 (24.5%), 2,412 (34.8%), and 3026 (43.2%), respectively. After excluding invalid responses (e.g. missing of the agreement to participate into the survey), data on 8,015 individuals were included in the analysis.

Outcome variable

The Athens Insomnia Scale (AIS), a standardized self-assessment instrument based on ICD-10 criteria for insomnia, was used to assess the outcome variable, insomnia. It was administered as a self-reported questionnaire. The cut-off value of 6 points or more was utilized to establish the diagnosis of insomnia (Okajima et al. 2013).

Main predictors

Oral health-related symptoms ("toothache," "swollen or bleeding gums," and "difficulty in chewing") were determined through a self-reported questionnaire. These yes or no questions were derived from the Comprehensive Survey of Living Conditions, which is a national survey that is conducted in Japan (Ministry of Health, Labour and Welfare 2009; Hiyoshi et al. 2014). Use of this questionnaire also enabled a comparison of the present findings on disaster victims with the responses derived from a national sample in Japan.

Covariates

Socio-demographic characteristics, lifestyle, and health condition variables were recorded and the following were included in the analyses as covariates: sex, age, economic status, comorbidity, post-traumatic stress reactions (PTSRs), smoking habits, alcohol drinking, and the score on the Kessler Psychological Distress Scale (K6) (Kessler et al. 2002). In addition, body mass index (BMI) was measured in health examinations carried out along with this survey. These covariates have been recognized as predictor variables for insomnia/sleep disorders in previous studies (Palm et al. 2015). The participants were divided into the following groups by age: 29 years or younger, 30-39 years, 40-49 years, 50-59 years, 60-69 years, 70-79 years, and 80 years or older. The economic status was obtained using the following self-reported question: "How do you feel about the current economic condition of your household?" The response alternatives were "poorest," "poorer," "poor," or "fair." Comorbidities were surveyed by determining is they had recently undergone any medical treatments for stroke, diabetes, hypertension, and coronary heart dis-

ease (CHD). BMI was categorized into 4 groups (less than 18.5, 18.5-24.9, 25-29.9, 30 or more). PTSR was determined using the following 3 yes or no questions: "Are you experiencing any repeated, disturbing memories and/or dreams?", "Do you feel very upset when something reminds you of a stressful experience from the earthquake?", and "Do you have any physical reactions (e.g., heart pounding, trouble breathing, sweating, or dizziness) when something reminds you of a stressful experience from the earthquake?". Habitual smoking and alcohol drinking were determined. Psychological distress was assessed using the continuous K6 score. We used the Japanese version of the K6, which was developed through a standard back-translation procedure and has been validated (Furukawa et al. 2008).

Statistical analysis

In our data set, observations in each survey period were nested in individuals; therefore, a multilevel logistic analysis was applied to calculate the odds ratio (OR) and 95% confidential intervals (95% CI) for insomnia. This analysis was used to compensate for any missing observations in any of the panels (Hox 2010). At first, we calculated univariate ORs for each variable with reference to the insomnia level. In the covariate-adjusted models, we assessed the effect of each variable on insomnia, after adjusting for age, sex, economic status, comorbidity, oral health symptoms, BMI, PTSR, smoking habit, alcohol consumption, and the K6 score. To analyze missing data, we applied the "missing at random" assumption, and used multiple imputation with the multivariate normal imputation method (Cummings 2013). In the imputation models, variables in the main analysis and variables on comorbidities were included. Analyses were independently applied for 10 copies of the data, each with missing values suitably imputed. Estimates of the variables were averaged to compute a single mean estimate and adjusted standard errors using the Rubin's rule (Rubin 1987). The numbers of participants without missing data in each question have been shown in Table 1. The STATA version 13.1 (Stata Corp., College Station, TX, USA) was used for all analyses, and statistical significance was declared at $p < 0.05$.

Ethical considerations

The study protocol was reviewed and approved by the Ethics Committee on Research of Human Subjects at the Tohoku University Graduate School of Medicine (approved number: 201192 and 2014157). We explained the aims of the study to all participants, after which their written informed consent was obtained.

Results

The numbers of participants with valid in each of the four survey periods were 3,555, 1,511, 1,303, and 1,646, respectively. The insomnia prevalence with reference to each risk factor in all the participants has been shown in Table 1. Note that 580 out of the 8,015 participants missed the AIS data. The average prevalence of insomnia was 38.9%. In all the survey periods, the percentages of participants who reported toothache, gum problems, or difficulty in chewing were 4.2%, 4.2%, and 3.4%, respectively. Further, participants with oral health-related symptoms had remarkably higher prevalence rates of insomnia compared with participants without the symptom (toothache: 60.3% vs. 38.0%, gum problems: 65.3% vs. 37.7%, difficulty chewing: 71.8% vs. 37.7%, respectively). Survey participants who were in the middle age group (approximately 45% vs. 25.8% in the youngest group), were female (43.1%

Table 1. Characteristics of subjects and insomnia incidence in the survey: Areas experienced by Great East Japan Earthquake in Miyagi, Japan, 2011-2013.

Variables	N	Insomnia incidence, N (%)
Age (years)		
17-29	429	115 (26.8)
30-39	478	166 (34.7)
40-49	774	349 (45.1)
50-59	1,284	588 (45.8)
60-69	2,017	823 (40.8)
70-79	1,805	641 (35.5)
≥ 80	648	210 (32.4)
Gender		
Male	3,365	1,139 (33.8)
Female	4,070	1,753 (43.1)
Economic status		
Fair	3,003	758 (25.2)
Poor	2,054	879 (42.8)
Poorer	1,526	776 (50.9)
Poorest	800	452 (56.5)
Comorbidity		
Stroke	107	42 (39.3)
Diabetes	576	224 (38.9)
Hypertension	2,483	966 (38.9)
CHD	392	183 (46.7)
Oral symptoms		
Toothache	310	187 (60.3)
Gum problems	14	205 (65.3)
Difficulty chewing	255	183 (71.8)
BMI		
Less than 18.5	174	59 (33.9)
18.5-24.9	2,978	1,117 (37.5)
25.0-29.9	1,577	617 (39.1)
30 or more	300	121 (40.3)
PTSR		
Intrusion	2,442	1,418 (58.1)
Agitated	2,311	1,435 (62.1)
Hyperarousal	877	643 (73.3)
Habits		
Smoking	1,517	610 (40.2)
Alcohol drinking	2,565	908 (35.4)
Total	7,435	2,892 (38.9)
Missing for AIS	580	
K6 score	N	Average ± SD
Non-Insomnia	4,322	3.2 ± 3.5
Insomnia	2,725	8.0 ± 4.8

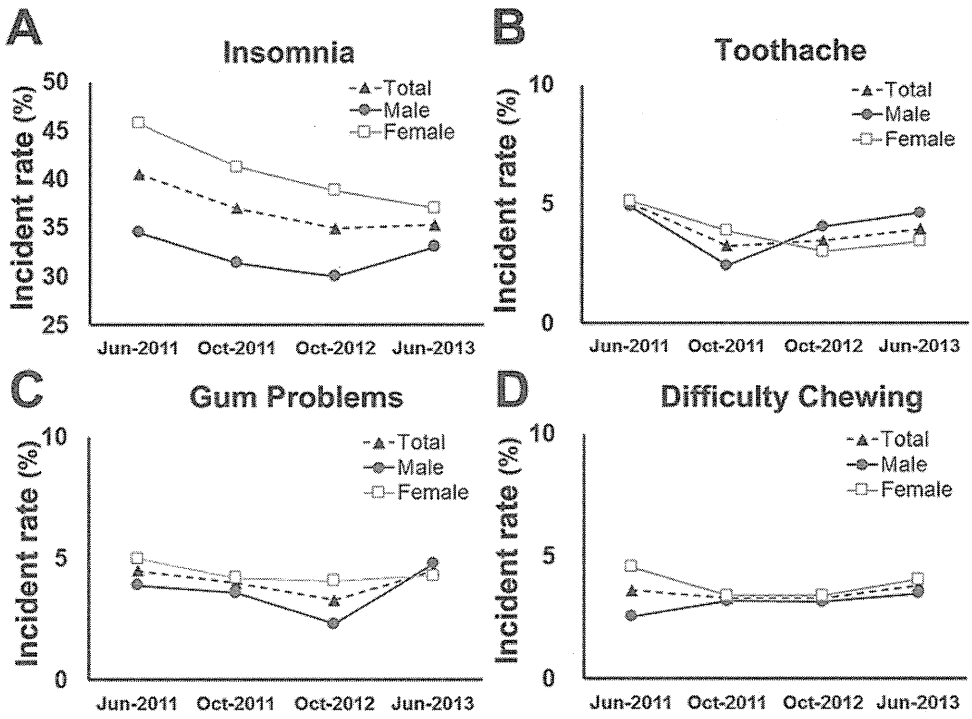

Fig. 1. Unadjusted average prevalence of insomnia and oral health-related symptoms.
Unadjusted average prevalence of insomnia (A) and oral health-related symptoms of toothache (B), gum problems (C), and difficulty chewing (D) by survey period. In both males and females, prevalence of insomnia was the highest at three months after the Great East Japan Earthquake and recovery was slow until October 2012. In males, the prevalence of insomnia, of toothache, and of gum problems increased again in June 2013.

vs. 33.8% in male), were from the lower economic status (approximately 50% vs. 25.2% in fair status), or had some PTSR variables (approximately 60-70% vs. 38.9% on the baseline value) showed higher prevalence of insomnia. Fig. 1 shows the unadjusted average prevalence of insomnia and of oral health-related symptoms during the survey period. The survey over two and a half years indicated a consistent and higher prevalence of insomnia (Fig. 1A) and of gum problems (Fig. 1C) in participants, especially in females (insomnia: 43.1% vs. 33.8%, gum problems: 4.4% vs. 3.7% in male participants, respectively). In addition, the prevalence of insomnia, of toothache and of gum problems only in male participants recently increased in June 2013 again.

Table 2 shows the covariate-adjusted ORs for each of the risk factor related to insomnia. The univariate models using multiple imputation revealed significantly higher ORs for all oral health-related variables (toothache: OR = 2.88, 95% CI = 1.90-4.36; gum problems: OR = 4.50, 95% CI = 2.97-6.81; difficulty chewing: OR = 5.55, 95% CI = 3.53-8.73, $p < 0.001$, respectively). When adjusted for covariates, the trends and significant relationships among participants were also similar. In addition to other risk factors such as age, sex, economic status, PTSRs, alcohol consumption, and psychological distress condition, multivariate logistic regression analyses showed that participants with each oral complaint (gum problems and difficulty chewing) had significantly higher ORs for insomnia as compared with those without oral complaints (OR = 2.16, 95% CI = 1.43-3.26, $p < 0.001$ and OR = 2.22, 95% CI = 1.40-3.51, $p < 0.01$, respectively). Surprisingly, the ORs for gum problems or difficulty in chewing associated with insomnia were similar to the ORs of the PTSRs. There was, however, no significant association between insomnia and toothache after adjusting for covariates ($p = 0.41$). Note that the multilevel logistic analysis without multiple imputation, the complete case analysis indicated the similar significant associations between each oral symptom and insomnia. The adjusted ORs of toothache, gum problems, and difficulty in chewing on insomnia were 1.47 (95% CI = 1.13-1.86, $p = 0.004$), 2.18 (95% CI = 1.68-2.82, $p < 0.001$) and 2.38 (95% CI = 1.78-3.18, $p < 0.001$), respectively.

Discussion

The present results revealed that two oral health problems, i.e., gum problems and difficulty in chewing, were strongly associated with the insomnia prevalence in a large-population of the 2011 GEJE victims of the Tsunami, but toothache was not. Further, the prevalence of self-reported oral health-related symptoms among the GEJE victims was almost two times higher than that found in a 2013 nationwide survey that was conducted using same questionnaires (Ministry of Health, Labour and Welfare 2013). Indeed, as observed in Fig. 1, so far from achieving to the national baseline in Japan, the prevalence of oral symptoms among