



The Relationship Between Functional Independence and Psychological Distress in Elderly Adults Following the Fukushima Daiichi Nuclear Power Plant Accident: The Fukushima Health Management Survey

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Abstract

This study aimed to explore the relationship between psychological distress and degree of functional independence among elderly adults following the Great East Japan Earthquake. Participants were 20282 adults aged 65 and older who lived in the Great East Japan Earthquake evacuation zone specified by the government on March 31, 2011. This study is a part of a detailed survey on mental health and lifestyle, the Fukushima Health Management Survey, which was conducted in 2012. Psychological distress was assessed using the Kessler 6 scale. Functional independence in different daily activities was assessed by asking participants whether they could independently perform activities: eating, dressing, toileting, and shopping. According to the multiple logistic regression analysis, psychological distress was significantly associated with independence in all models: without adjustment (Model 1), adjusting for demographic characteristics (Model 2), and adjusting for demographic characteristics and disaster-related factors (Model 3), with an adjusted odds ratio of 2.32 (95% confidence interval = 1.97-2.73). High psychological distress was associated with low functional independence, after controlling for demographic characteristics and disaster-related factors. Thus, using psychological distress as the dependent variable, we examined the relationship between low functional independence and psychological distress among elderly adults who were evacuated.

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Introduction

On March 11, 2011, the Great East Japan Earthquake hit Japan with a magnitude of 9.0 on the Richter scale, and the subsequent tsunami initiated a nuclear accident at the Tokyo Electric Power Company's Fukushima Daiichi Nuclear Power Plant (NPP). This complex disaster caused a radiation hazard in Fukushima Prefecture,¹ and thus, the government designated an evacuation zone within the area. More than 160 000 residents were forced to evacuate. According to the reports from the NPP accident in Chernobyl in 1986, major health problems experienced by affected residents include psychological distress.² The evacuees in Fukushima experienced disaster damage, traumatic stress, and lifestyle change. Consequently, they suffered from psychological distress due to stressors that arose from the evacuation, including perceived risk of radiation effects on health.³

Appropriate health interventions need to be developed for elderly adults after a disaster. Natural disasters have a greater impact on psychological health among elderly adults than their younger counterparts at the time of disaster.^{4,5} Furthermore, within the elderly population, functional independence varies from those who live independently and provide care for others, to those who need support typically due to dementia or a bedridden state. To our knowledge, previous research has only focused on the relationship between psychological well-being and its related factors among the general population; thus, the relationship between functional independence and psychological well-being among the elderly population warrants further investigation.

Psychological Distress and Functional Independence

Presently, subclinical depression, or minor depression, is common among community-dwelling elderly adults, although there is a wide range of reported prevalence rates depending on sample characteristics and measurement methods used.⁶ Daily functioning is related to mental health among elderly adults,^{7,8} and in some longitudinal research, depressive status predicts further functional decline among community-dwelling elderly adults.^{9,10} Functional assessment, which is now incorporated in the Japanese national elderly care program,¹¹ could be an avenue for assessing further needs related to psychological health among elderly adults. Such assessment is crucial due to the barriers that elderly adults face in seeking psychological help in Japan.¹² Furthermore, in times of disasters, psychological distress commonly increases among elderly adults, partially because of a relative disadvantage in socioeconomic status.¹³⁻¹⁵ Moreover, in times of disaster, psychological and functional factors are associated with resilience among elderly adults.¹⁶ Thus, to promote resilience in elderly adults, appropriate public health interventions that address both psychological and functional aspects after a complex disaster are warranted. Since our survey focused on the support for mental health based on the experience in Chernobyl, we examined the degree of functional independence, which could be easily measured, to explain the psychological distress.

The aim of this study was to explore the relationship between psychological distress and degree of functional independence among elderly adults after the Great East Japan Earthquake.

Methods

Study Design

This study is a part of a detailed survey on mental health and lifestyle, the Fukushima Health Management Survey, conducted in 2012, within a year after the accident. We examined the cross-sectional data of elderly adults aged 65 years and older as of March 11, 2011.^{17,18}

Setting

The Fukushima Health Management Survey was implemented to assess the health and lifestyle of those evacuated during the Fukushima Daiichi NPP accident. Details of the protocol and data set used in the present study have been described elsewhere.¹⁷⁻²⁵ The survey was a self-administered questionnaire, and the target population included adults and children (aged 15 years and older) who were registered as residents within the government-designated evacuation zone (n = 210 189). The questionnaires were mailed to the target population beginning January 18, 2012, and they were asked to return them within approximately 2 weeks. The responses that arrived until October 31, 2012, were analyzed and the others were excluded. The evacuation zone designated by the government includes Hirono-machi, Naraha-machi, Tomioka-machi, Kawauchimura, Okuma-machi, Futaba-machi, Namie-machi, Katsurao-mura, Iitate-mura, Minamisoma City, Tamura City, and a part of Date City.

Participants

The target population of this study was the elderly-adult cohort, those aged 65 and older as of April 1, 2011 (n = 53 220), and among them 25 890 responded to the Mental Health and Lifestyle Survey between January 30 and October 31, 2012. Although it was a self-administered survey, caregivers were allowed to complete the survey as a proxy for those who were not able to do so themselves, because of existing dementia, or living in nursing homes.

Measurements

Psychological Distress. The outcome variable was psychological distress, measured by the Kessler 6 (K6) scale.²⁶ This tool uses a 5-point Likert-type scale to assess symptoms of mental illness during the past 30 days. Higher scores indicate worse mental health status (total range = 0-24). The Japanese version of the K6, which was used in this study, has been validated.²⁷ Based on a previous research, we defined those who scored between 13 and 24 as “psychologically distressed” and those who scored between 0 and 12 as “others.”^{26,28}

Functional Independence. The explanatory variable was functional independence. Respondents reported their ability to perform daily activities, including eating, dressing, toileting, and shopping for daily necessities, with a binary response option: 1 = I can do it by myself; 2 = I cannot do it by myself. Specifically, we asked participants to indicate if they could “eat meals without assistance (does not include meal preparation),” “get dressed without assistance,” “go to the toilet without assistance,” and “go shopping for daily necessities without assistance.” We defined participants with *high independence* as those who reported, “I can do it by myself” to all 4 items and *low independence* as those who indicated “I cannot do by myself” to any of the 4 items.

Basic Characteristics and Disaster-Related Factors. To control for confounding variables, we measured general characteristics and disaster-related factors. General characteristics included gender, age, educational attainment, history of mental illness, and change in work. Disaster-related factors include residence place (Fukushima Prefecture or other), current living arrangement (shelter, temporary housing, rented house/apartment, relative’s home, own home, or other), the experience of the tsunami and NPP accident (Yes or No), and bereavement (loss of family or relatives; Yes or No). We defined the experience of the NPP accident as hearing any hydrogen explosion at the nuclear power plant accident to confirm the presence of trauma through a potentially life-threatening experience. Most of the variables were self-reported, and the incorrect response was anticipated because the respondents were elderly adults and we did not exclude people based on

their cognitive functioning. In our analyses, we excluded data that were not self-reported (ie, surveys completed by a caregiver) in order to minimize inclusion of elderly adults with cognitive problems and the associated error and biases. This study was approved by the ethics committee of Fukushima Medical University (No. 1316).

Statistical Analysis

We included data from those who completed all 6 items of the K6. With respect to missing data in functional independence, as long as “I cannot do it by myself” was recorded on any item, the participant was categorized into low independence.

To explore the relationship between psychological distress and functional independence, we used a χ^2 test to compare proportions of independence (low and high) between those with psychological distress and those without psychological distress. Subsequently, multiple logistic regression was used to examine the relationship between psychological distress and independence, controlling for potential confounding factors. Research has shown that psychological distress is associated with socioeconomic status, including age, gender, and disaster-related factors^{5,29-31}; thus, these variables were controlled for in the final model. As we assumed the variables were correlated, we introduced the variables stepwise to examine multicollinearity and robustness within the models. Logistic regression analyses were conducted on psychological distress and functional independence to calculate the odds ratio (OR) and 95% confidence interval (95% CI) for 3 models: without adjustment (Model 1), with adjustment for demographic characteristics (Model 2), and with adjustment for demographic characteristics and disaster-related factors (Model 3). Statistical procedures were performed using IBM SPSS Statistics version 21.0 (IBM, Corp, Armonk, NY).

Results

The number of elderly adults who responded to the survey was 25 890 (response rate = 48.6%). Because the outcome was psychological distress, a subjective evaluation, we excluded those who responded by proxy ($n = 5608$), resulting in 20 282 valid responses (valid response rate = 38.1%). We excluded an additional 3190 from this analysis due to missing values in the outcome variable of the K6, resulting in 17 092 for the analyses. Overall, the average score of K6 (SD) was 6.2 (5.9), and the number of those who were classified as having psychological distress (those who scored 13 or higher on the K6 scale) was 2566 (15.0%).

Table 1 shows the results of the bivariate analyses between psychological distress and the degree of independence, and other possible confounding factors. First, a significant association was found between psychological distress and low independence. Then, associations between psychological distress and the background characteristics were found, including gender, educational attainment, history of mental illness, and change in work. In terms of disaster-related factors, place of residence, living arrangement, experience of tsunami, experience of NPP accident, and bereavement were associated with psychological distress.

Table 2 presents the associations between psychological distress and functional independence by item. More people were found to have psychological distress among those with low independence than among those with high independence for eating, clothing, toileting, and shopping. Notably, 46.9% of those who had low independence for eating were psychologically distressed.

Table 3 shows the results of multiple logistic regression analyses. Low independence increased the likelihood of psychological distress by crude OR of 2.59 (95% CI = 2.24-3.00; Model 1), OR of 2.39 (95% CI = 2.03-2.81) adjusting for background characteristics (Model 2), and OR of 2.32 (95% CI = 1.97 to 2.73) adjusting for background characteristics and disaster-related factors (Model 3).

Table 1. Relationships Between Psychological Distress and Degree of Independence, and Other Possible Confounding Factors (N = 17 092).

	Total		Probable Serious Psychological Distress (K6: ≥ 13)		Others (K6: < 13)		df	χ ²	P Value ^a
	n	%	n	%	n	%			
Functional independence									
High ^b	16 149		2284	89.0%	13 865	95.4%	1	173.47	<.001
Low	943		282	11.0%	661	4.6%			
Background characteristics									
Gender									
Male	8141		922	35.9%	7219	49.7%	1	165.67	<.001
Female	8951		1644	64.1%	7307	50.3%			
Age									
Mean ± SD, median (IQR)	74.3 ± 6.0, 73 (69-78)		74.3 ± 5.8, 74 (70-78)		74.3 ± 6.0, 73 (69-78)				
65-74 years	9654		1422	55.4%	8232	56.7%	2	2.92	.23
75-84 years	6356		991	38.6%	5365	36.9%			
85 years and older	1082		153	6.0%	929	6.4%			
Educational attainment									
Elementary school or junior high school ^b	8006		1252	48.8%	6754	46.5%	3	33.62	<.001
High school	6903		1049	40.9%	5854	40.3%			
Vocational or junior college	1375		200	7.8%	1175	8.1%			
University or graduate school	808		65	2.5%	743	5.1%			
History of mental illness									
Yes	799		353	13.8%	446	3.1%	1	558.88	<.001
No ^b	16 293		2213	86.2%	14 080	96.9%			
Change in the work									
Yes	6641		1299	50.6%	5342	36.8%	1	176.03	<.001
No ^b	10 451		1267	49.4%	9184	63.2%			

(continued)

Table 1. (continued)

	Total		Probable Serious Psychological Distress (K6: ≥13)		Others (K6: <13)		df	χ ²	P Value ^a
	n	%	n	%	n	%			
Disaster-related factors									
Residence place									
Fukushima prefecture	14 669		2090	81.4%	12 579	86.6%	1	47.48	<.001
Other prefectures	2423		476	18.6%	1947	13.4%			
Living arrangement									
Shelter, temporary housing	2075		388	15.1%	1687	11.6%	1	25.15	<.001
Rented house/apartment, relatives home, own home, or other ^b	15 017		2178	84.9%	12 839	88.4%			
Experience of the tsunami									
Yes	3914		789	30.7%	3125	21.5%	1	105.34	<.001
No ^b	13 178		1777	69.3%	11 401	78.5%			
Experience of the nuclear power plant accident^c									
Yes	10 257		1881	73.3%	8376	57.7%	1	222.36	<.001
No ^b	6835		685	26.7%	6150	42.3%			
Bereavement									
Yes	3602		802	31.3%	2800	19.3%	1	188.14	<.001
No ^b	13 490		1764	68.7%	11 726	80.7%			

Abbreviations: K6, Kessler 6 scale; df, degree of freedom; SD, standard deviation; IQR, interquartile range.

^aChi-square tests were used.

^bIncluding missing values.

^cWe defined it hearing any hydrogen explosion at the nuclear power plant accident.

Table 2. Relationships Between Psychological Distress and Functional Independence by Item (N = 17 092).

	Total	Probable Serious Psychological Distress (K6: ≥ 13)		Others (K6: < 13)		df	χ^2	P Value ^a
		n	n	%	n			
Functional independence								
High	16 149	2284	89.0%	13 865	95.4%	1	173.47	<.001
Low	943	282	11.0%	661	4.6%			
Eating								
Independent	16 996	2521	98.2%	14 475	99.6%	1	76.82	<.001
Dependent	96	45	1.8%	51	0.4%			
Clothing								
Independent	16 957	2515	98.0%	14 442	99.4%	1	55.27	<.001
Dependent	135	51	2.0%	84	0.6%			
Toileting								
Independent	17 017	2542	99.1%	14 475	99.6%	1	17.04	<.001
Dependent	75	24	0.9%	51	0.4%			
Shopping								
Independent	16 179	2293	89.4%	13 886	95.6%	1	167.57	<.001
Dependent	913	273	10.6%	640	4.4%			

Abbreviations: K6, Kessler 6 scale; df, degree of freedom.

^aP value for the χ^2 tests.

Discussion

Psychological distress was associated with low functional independence among elderly adults who were evacuated after the Great East Japan Earthquake and Fukushima NPP accident 10 to 19 months after the disaster. This association remained after controlling for background characteristics and disaster-related factors. These findings suggest that priority should be given to low-functioning elderly adults in providing psychological care after a disaster.

In general, it is well known that elderly people, even under normal conditions, are more likely to be in a depressive state than younger people, which often causes a decline in the activities of daily living (ADL) or independent living skills.⁸⁻¹⁰ Both cross-sectional and longitudinal studies have revealed the association between low functional independence and psychiatric disorders. A cross-sectional study demonstrated that the prevalence of depression was significantly higher in individuals who were dependent for ADL or instrumental ADL compared with those who were not.³² A 4-year prospective cohort study demonstrated that increasing levels of depressive symptoms were predictors of a greater decline in physical performance.³³ Iwasa et al examined a longitudinal relationship between a depressive status and functional decline among Japanese community-dwelling older adults, using a 12-year population-based prospective cohort study design. As a result, an independent relationship was found between a depressive status and a longitudinal change in functional capacity among community-dwelling older individuals, suggesting that depression is a reliable predictor of a decline in both basic ADL and higher-level competence in older adults.¹³ Therefore, psychological distress could be associated with an increased risk of functional dependence and vice versa.

In reviewing previous disaster studies focusing on the psychological well-being of elderly adults, risk factors for psychological distress were examined using basic characteristics and disaster-related factors.^{5,29-31} This study added the knowledge that psychological distress was associated with low functional independence, even after controlling for such known

Table 3. Relationships Between Degree of Independence and Probable Serious Psychological Distress (K6 \geq 13) (Multiple Logistic Regression Analysis; N = 17 092).

	Model 1 ^a , OR (95% CI)	Model 2, OR (95% CI)	Model 3, OR (95% CI)
Functional independence (reference: High)			
Low	2.59 (2.24-3.00)	2.39 (2.03-2.81)	2.32 (1.97-2.73)
Background characteristics			
Gender (reference: Male)			
Female		1.72 (1.57-1.88)	1.72 (1.57-1.88)
Age (reference: 65-74 year old)			
75-84 years		1.06 (0.97-1.17)	1.02 (0.93-1.12)
85 years and older		0.86 (0.70-1.04)	0.84 (0.69-1.02)
Educational attainment (reference: Elementary school or junior high school)			
High school		0.94 (0.85-1.03)	0.84 (0.76-0.92)
Vocational or junior college		0.86 (0.73-1.01)	0.80 (0.68-0.95)
University, or graduate school		0.60 (0.46-0.79)	0.56 (0.43-0.74)
History of mental illness (reference: No)			
Yes		4.36 (3.75-5.07)	4.13 (3.54-4.81)
Change in the work (reference: No)			
Yes		1.87 (1.71-2.04)	1.63 (1.49-1.79)
Disaster-related factors			
Residence place (reference: Fukushima prefecture)			
Other prefectures			1.35 (1.20-1.52)
Living arrangement (reference: Rented house/ apartment, relatives home, own home, or other)			
Shelter, temporary housing			1.21 (1.07-1.37)
Experience of the tsunami (reference: No)			
Yes			1.26 (1.14-1.39)
Experience of the nuclear power plant accident (reference: No)			
Yes			1.68 (1.52-1.86)
Bereavement (reference: No)			
Yes			1.47 (1.33-1.62)

Abbreviations: K6, Kessler 6 scale; OR, odds ratio; CI, confidence interval.

^aModel 1: Not adjusted odds ratio. Model 2: Adjusted odds ratio by background characteristics. Model 3: Adjusted odds ratio by background characteristics and disaster-related factors.

disaster-related risk factors. Elderly adults are reported to be more vulnerable^{4,5} and take longer to recover than their younger counterparts in times of disaster.³⁴ The population in this study was a very specific and unique population, that is, the elderly adults who used to reside within the evacuation zone. Generalizing these results to other populations should be done with caution; however, the relationships established between psychological distress and potential confounding factors, that is, demographic characteristics and disaster-related factors, were comparable to previous findings in disaster research, which helps corroborate our study's validity. In the event of the Fukushima NPP accident, adaptation to new living environments may have increased psychological burden among elderly adults, especially those who are frail. Mortality rates among the institutionalized elderly were exceptionally high during the first 3 months after the NPP accident.³⁵ Indeed, relocation is associated with poor mental health among elderly who experience several natural disasters.^{36,37}

Furthermore, loneliness predicts functional decline among elderly adults.³⁸ Although loneliness was not directly measured in this study, living outside of one's home or outside of Fukushima may have been associated with psychological distress through loneliness. Further study of this association is recommended. Another explanation for our findings points to secondary stress, such as separation from family members, unclear compensation, and exposure to public stigma, experienced after the evacuation, as a large body of research shows that

secondary stressors are associated with psychological distress during disasters.³⁹ While physical and cognitive decline are key sources of low functional independence, secondary stressors may influence elderly evacuees to live less active lives in temporary housing or other housing arrangements that require additional adjustment effort. This may have created a self-perpetuating cycle, whereby the frail elderly became even more inactive. Thus, mental health care for those with low functional independence may also be an effective preventive measure for increased frailty.

Nevertheless, the strength of the present study is that it is the first to examine the relationship between psychological distress and independence after controlling for known risk factors using a large sample of elderly adults who were evacuated after the NPP accident in Fukushima, and its potential limitations warrant consideration. First, it is possible that the reverse relationship exists due to the cross-sectional nature of the study design. For example, psychological distress may have influenced functional impairment, as history of mental illness was strongly associated with psychological distress, suggesting a poor psychological condition prior to the disaster. The analysis of longitudinal data in future research is recommended to explore the causal relationship between independence and psychological distress. Second, functional independence was broadly operationalized and did not distinguish between basic ADL, such as eating, dressing, and toileting, and instrumental ADL, such as shopping. We attempted to analyze the basic and instrumental ADL data separately. Finally, since we analyzed the data obtained from only the elderly people who completed the questionnaire themselves, the participants of our study are likely to be more independent. This should be considered when generalizing the results of the present study.

In conclusion, our findings demonstrate that psychological distress is associated with low functional independence, even after controlling for demographic characteristics and disaster-related factors. Thus, using psychological distress as the dependent variable in the analysis models, we examined the relationship between low functional independence and psychological distress among elderly adults who were evacuated.

Appendix

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Authors' Note

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References

1. World Health Organization. *Health Risk Assessment From the Nuclear Accident After the 2011 Great East Japan Earthquake and Tsunami*. Geneva, Switzerland: World Health Organization; 2013.
2. World Health Organization. *Health Effects of the Chernobyl Accident and Special Health Care Programmes*. Geneva, Switzerland: World Health Organization; 2006.
3. Hori A, Tsumuraya K, Kanamori R, Maeda M, Yabe H, Niwa S. Report from Minamisoma City: diversity and complexity of psychological distress in local residents after a nuclear power plant accident [in Japanese]. *Seishin Shinkeigaku Zasshi*. 2014;116:212-218.
4. Cherniack E. The impact of natural disasters on the elderly. *Am J Disaster Med*. 2008;3(3):133-139.
5. Jia Z, Tian W, Liu W, Cao Y, Yan J, Shun Z. Are the elderly more vulnerable to psychological impact of natural disaster? A population-based survey of adult survivors of the 2008 Sichuan earthquake. *BMC Public Health*. 2010;10:172.
6. Polyakova M, Sonnabend N, Sander C, et al. Prevalence of minor depression in elderly persons with and without mild cognitive impairment: a systematic review. *J Affect Disord*. 2014;152-154:28-38.
7. Kilijanek TS, Drabek TE. Assessing long-term impacts of a natural disaster: a focus on the elderly. *Gerontologist*. 1979;19:555-566.
8. Bolin R, Klenow DJ. Response of the elderly to disaster: an age-stratified analysis. *Int J Aging Hum Dev*. 1982;16:283-296.
9. Phifer JF, Kaniasty KZ, Norris FH. The impact of natural disaster on the health of older adults: a multiwave prospective study. *J Health Soc Behav*. 1988;29:65-78.
10. Wada T, Ishine M, Sakagami T, et al. Depression in Japanese community-dwelling elderly—prevalence and association with ADL and QOL. *Arch Gerontol Geriatr*. 2004;39:15-23.
11. Tsutsui T, Muramatsu N. Care-needs certification in the long-term care insurance. *J Am Geriatr Soc*. 2005;53:522-527.
12. Kuzuya M, Masuda Y, Hirakawa Y, et al. High prevalence rate of depression among community-dwelling frail elderly Japanese [in Japanese]. *Nihon Ronen Igakkai Zasshi*. 2006;43:512-517.
13. Iwasa H, Yoshida Y, Kumagai S, Ihara K, Yoshida H, Suzuki T. Depression status as a reliable predictor of functional decline among Japanese community-dwelling older adults: a 12-year population-based prospective cohort study. *Int J Geriatr Psychiatry*. 2009;24:1192-1200.
14. Yamazaki S, Nakano K, Saito E, Yasumura S. Prediction of functional disability by depressive state among community-dwelling elderly in Japan: a prospective cohort study. *Geriatr Gerontol Int*. 2012;12:680-687.
15. Kanehara A, Umeda M, Kawakami N. Barriers to mental health care in Japan: results from the World Mental Health Japan Survey. *Psychiatry Clin Neurosci*. 2015;69:523-533.
16. Hardy SE, Concato J, Gill TM. Resilience of community-dwelling older persons. *J Am Geriatr Soc*. 2004;52:257-262.
17. Yasumura S, Hosoya M, Yamashita S, et al. Study protocol for the Fukushima Health Management Survey. *J Epidemiol*. 2012;22:375-383.
18. Yabe H, Suzuki Y, Mashiko H, et al. Psychological distress after the Great East Japan Earthquake and Fukushima Daiichi Nuclear Power Plant accident: results of a mental health and lifestyle survey through the Fukushima Health Management Survey in FY2011 and FY2012. *Fukushima J Med Sci*. 2014;60:57-67.
19. Iwasa H, Suzuki Y, Shiga T, et al. Psychometric evaluation of the Japanese Version of the Posttraumatic Stress Disorder Checklist in community dwellers following the Fukushima Daiichi Nuclear Power Plant incident: the Fukushima Health Management Survey. *SAGE Open*. 2016;6(2). doi:10.1177/2158244016652444.

20. Kunii Y, Suzuki Y, Shiga T, et al. Severe psychological distress of evacuees in evacuation zone caused by the Fukushima Daiichi Nuclear Power Plant accident: the Fukushima Health Management Survey. *PLoS One*. 2016;11(7):1-10.
21. Nagai M, Ohira T, Yasumura S, et al. Association between evacuation condition and habitual physical activity in Great East Japan Earthquake evacuees: the Fukushima Health Management Survey [in Japanese]. *Nihon Koshu Eisei Zasshi*. 2016;63:3-10.
22. Oe M, Fujii S, Maeda M, et al. Three-year trend survey of psychological distress, posttraumatic stress, and problem drinking among residents in the evacuation zone after the Fukushima Daiichi Nuclear Power Plant accident [The Fukushima Health Management Survey]. *Psychiatry Clin Neurosci*. 2016;70:245-252.
23. Suzuki Y, Yabe H, Horikoshi N, et al. Diagnostic accuracy of Japanese posttraumatic stress measures after a complex disaster: the Fukushima Health Management Survey [published online August 9, 2016]. *Asia Pac Psychiatry*. doi:10.1111/appy.12248.
24. Suzuki Y, Yabe H, Yasumura S, Ohira T, Niwa S, Ohtsuru A. Psychological distress and the perception of radiation risks : the Fukushima Health Management Survey. *Bull World Health Organ*. 2015;93:598-605.
25. Ueda Y, Yabe H, Maeda M, et al. Drinking behavior and mental illness among evacuees in Fukushima following the Great East Japan Earthquake: the Fukushima Health Management Survey. *Alcohol Clin Exp Res*. 2016;40:623-630.
26. Kessler RC, Barker PR, Colpe LJ, et al. Screening for serious mental illness in the general population. *Arch Gen Psychiatry*. 2003;60:184-189.
27. Furukawa T, Kessler RC, Slade T, Andrews G. The performance of the K6 and K10 screening scales for psychological distress in the Australian National Survey of Mental Health and Well-Being. *Psychol Med*. 2003;33:357-362.
28. Kessler RC, Galea S, Jones RT, Parker HA; Hurricane Katrina Community Advisory Group. Mental illness and suicidality after Hurricane Katrina. *Bull World Health Organ*. 2006;84:930-939.
29. Suzuki Y, Tsutsumi A, Fukasawa M, Honma H, Someya T, Kim Y. Prevalence of mental disorders and suicidal thoughts among community-dwelling elderly adults 3 years after the Niigata-Chuetsu earthquake. *J Epidemiol*. 2011;21:144-150.
30. Chen YL, Hsu WY, Lai CS, et al. One-year follow up of PTSD and depression in elderly aboriginal people in Taiwan after Typhoon Morakot. *Psychiatry Clin Neurosci*. 2015;69:12-21.
31. Zhang Z, Shi Z, Wang L, Liu M. Post-traumatic stress disorder, anxiety and depression among the elderly: a survey of the hard-hit areas a year after the Wenchuan earthquake. *Stress Health*. 2012;28: 61-68.
32. Arslantas D, Ünsal A, Ozbabalik D. Prevalence of depression and associated risk factors among the elderly in Middle Anatolia, Turkey. *Geriatr Gerontol Int*. 2014;14:100-108.
33. Penninx BW, Guralnik JM, Ferrucci L, Simonsick EM, Deeg DJ, Wallace RB. Depressive symptoms and physical decline in community-dwelling older persons. *JAMA*. 1998;279:1720-1726.
34. Toyabe S, Shioiri T, Kuwabara H, et al. Impaired psychological recovery in the elderly after the Niigata-Chuetsu Earthquake in Japan: a population-based study. *BMC Public Health*. 2006;6:230.
35. Yasumura S. Evacuation effect on excess mortality among institutionalized elderly after the Fukushima Daiichi Nuclear Power Plant accident. *Fukushima J Med Sci*. 2014;60(2):1-4.
36. Chen YL, Lai CS, Chen WT, et al. Risk factors for PTSD after Typhoon Morakot among elderly people in Taiwanese aboriginal communities. *Int Psychogeriatr*. 2011;23:1686-1691.
37. Viswanath B, Maroky AS, Math SB, et al. Psychological impact of the tsunami on elderly survivors. *Am J Geriatr Psychiatry*. 2012;20:402-407.
38. Perissinotto CM, Stijacic Cenzer I, Covinsky KE. Loneliness in older persons: a predictor of functional decline and death. *Arch Intern Med*. 2012;172:1078-1083.
39. Kessler RC, McLaughlin KA, Koenen KC, Petukhova M, Hill ED; WHO World Mental Health Survey Consortium. The importance of secondary trauma exposure for post-disaster mental disorder. *Epidemiol Psychiatr Sci*. 2012;21:35-45.