

Drinking Behavior and Mental Illness Among Evacuees in Fukushima Following the Great East Japan Earthquake: The Fukushima Health Management Survey

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Background: Recent evidence from alcohol and trauma studies suggests that disasters are associated with increases in the consumption of alcohol. The Great East Japan Earthquake and the associated nuclear disaster have continued to affect the mental health of evacuees from Fukushima. This study aimed to extend these findings by examining the relationship between drinking behaviors and the risk of mental illness after the compound disaster.

Methods: We conducted the Mental Health and Lifestyle Survey with 56,543 evacuees. Kessler's K6 was used to assess the risk of mental illness, and logistic regression models were applied to analyze how drinking behavior patterns influence the risk of serious mental illness after adjustment for confounding variables.

Results: Logistic regression analysis evidenced that beginning heavy and light drinkers had the highest and a higher risk of serious mental illness, respectively. Individuals who were nondrinkers pre- and postdisaster had the lowest proportional risk of mental illness. Abstainers also had some risk to their mental health after the compound disaster.

Conclusions: The results of this study highlight that beginning drinkers have a high risk of serious mental illness. Thus, mental health professionals should pay attention to the drinking behaviors of evacuees, which might predict increased risk of serious mental illness and consequently indicate a need for psychological intervention.

Key Words: Alcohol, Mental Illness, Evacuees, Great East Japan Earthquake, Nuclear Reactor Accident.

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IT IS WELL established that disasters are associated with the use and abuse of alcohol (Keyes et al., 2011; Nordløyken et al., 2013; Stewart, 1996), increased prevalence of mental illness (Galea et al., 2007; Hussain et al., 2011), and a high prevalence of suicidal ideation (Caldera et al., 2001). Studies conducted after Hurricane Katrina have shown an association between evacuees' exposure to traumatic events and increased alcohol consumption (Cerda et al., 2011; Flory et al., 2009). In general, experience of stressful life events leads to the consumption of larger quantities of alcohol when individuals drink (Blomeyer et al., 2011). However, few studies have examined directly the association between postdisaster alcohol consumption and the risk of serious mental illness among evacuees after a compound disaster. The available studies suggest that traumatic events can be associated with increases or decreases in alcohol consumption (McFarlane, 1998). However, other cohort studies have suggested that exposure to disasters does not increase alcohol consumption (Fergusson et al., 2014; Keyes et al., 2011). Thus, it remains unclear as to how pre- to postdisaster changes in alcohol consumption impact mental illness, and conversely, how mental illness affects alcohol consumption, postdisaster.

The Great East Japan Earthquake on March 11, 2011, was one of the most severe disasters in Japanese history and caused the subsequent radiation leak at the Tokyo Electric

Power Company Fukushima Daiichi nuclear power station. This compound disaster resulted in loss of property, death, relocation, and subsequent adjustment to new circumstances, all of which created very stressful situations for the evacuees. Previously, the Fukushima Health Management Survey used the Mental Health and Lifestyle Survey (Yasumura et al., 2012) to show that 14.6% of adult evacuees had K6 scores equal to or greater than the standard cutoff of 13 (Yabe et al., 2014). Long-term evacuation could be significantly associated with the risk of serious mental illness among evacuees (Wagner et al., 2009). In this study, we examined drinking behavior and the risk of serious mental illness following the Great East Japan Earthquake disaster and subsequent meltdown at the Tokyo Electric Power Company's Fukushima Daiichi nuclear power plant. Based on prior research, we hypothesized that some evacuees would change their drinking patterns following the compound disaster, and that newly started drinkers would be at risk of serious mental illness. In addition, we hypothesized that postdisaster abstainers would also have some risk of serious mental illness due to the loss of their community as a consequence of the disaster.

MATERIALS AND METHODS

Study Design

This cross-sectional study used data from the 2012 Mental Health and Lifestyle Survey, which assesses the mental state of evacuees of the Fukushima Daiichi Nuclear Power Plant accident. The complete protocol of this survey is published elsewhere (Yasumura et al., 2012). The target participants of this study lived in evacuation zones specified by the government: Hirono Town, Naraha Town, Tomioka Town, Kawauchi Village, Okuma Town, Futaba Town, Namie Town, Katsurao Village, Minamisoma City, Tamura City, Yamakiya district of Kawamata Town, and Iitate Village. Questionnaires have been continually mailed to those residents since January 18, 2012 (Yasumura et al., 2012). The study was approved by the ethics review committee of Fukushima Medical University (No. 13020).

Participants

Residents of all evacuation zones were targeted for this study. The total target population was 174,028 individuals (84,684 men and 89,344 women), all of whom were older than 20 years of age. This was broken down by age group into 68,610 (39.4%) 20 to 49 year olds, 49,508 (28.4%) 50 to 64 year olds, and 55,910 (32.1%) individuals aged 65 years and older. Compared to the target population, the distribution of genders in the analysis population was similar, but differences were present in the age distribution. The number of individuals from 50 to 64 years old (33.7%) was the lower in the analysis sample, whereas the number of individuals 65 years old and older was the lower in the target population (29.2%).

We used the data from survey respondents who were older than 20 years of age ($n = 71,100$), and results were based on those who responded to the polls ($n = 62,156$). This study excluded respondents diagnosed with chronic hepatitis ($n = 1,405$), and those who failed to answer any questions for the K6 ($n = 4,208$). The data for the remaining 56,543 individuals were used for the analysis. The

response rate was 26.9% ($n = 210,189$; Yabe et al., 2014). The total number of participants whose data were dropped due to exclusion criteria and/or missing data was 14,082 (6,185 men [43.9%] and 7,897 women [56.1%]). By age group, these excluded observations consisted of 2,123 (15.1%) 20 to 49 year olds, 2,574 (18.3%) 50 to 64 year olds, and 9,385 (66.6%) individuals aged 65 and older. Compared to the target population, the distribution of gender in the analysis population was similar, but some differences were present in the age distribution. The number of those between 65 years old and older (66.6%) was the highest in the participants who were dropped due to exclusion criteria and/or missing data. On the other hand, the number of those in the 65 years and older category was lower in the target population (29.2%).

Measurements

Risk of Serious Mental Illness Including Mood and Anxiety Disorders. This study used Kessler's K6 to analyze risk of serious mental illness among the evacuees. This scale is used to screen for nonspecific serious mental illness (Kessler et al., 2003), including DSM-IV mood and anxiety disorders (Furukawa et al., 2008). Scores on the K6 scale range from 0 to 24. Based on previous K6 validation (Kessler et al., 2003), responses were divided into 2 groups: Those in the 13 to 24 range were classified as "probable serious mental illness," while those in the 0 to 12 range were classified as "probable mild-moderate/probable no mental illness" (Kessler et al., 2006). Participants were asked whether they had experienced any of the following symptoms during the past 30 days: "feeling so sad that nothing could cheer you up," "nervous," "hopeless," "restless or fidgety," "that everything was an effort," and "worthless" (Kessler et al., 2010). Each question was rated on a 5-point Likert scale from zero ("never") to 4 ("all of the time") (Furukawa et al., 2008). Kessler's K6 scale shows a screening capacity to indicate psychological distress and has been used in disaster settings, such as in the aftermath of Hurricane Katrina (Galea et al., 2007). This study used the Japanese version of the K6, which has been empirically validated as an independent means of screening for serious mental illness among evacuees (Furukawa et al., 2008).

Classification of Drinking Behavior Patterns. Respondents assessed their predisaster alcohol consumption as "didn't drink or only rarely (less than once a month)" or "drank (at least once a month)." In this survey, the participants assessed their predisaster consumption via the postdisaster survey; that is, they were not queried regarding their alcohol consumption directly in the predisaster period.

Respondents assessed their current (i.e., postdisaster) drinking as "don't drink or only rarely (less than once a month)," "quit" (i.e., with a history of drinking, but not a current drinker), or "drink (at least once a month)." Current drinkers were categorized into 3 types of drinking patterns based on their frequency of drinking, beverage type consumed, and the amount consumed per typical drinking bout. We defined heavy drinking as 4 drinks (44 g and more of ethanol intake per day), while lower consumption levels were defined as "light drinkers." A drink in this definition was c. 120 ml of spirits (e.g., whiskey or brandy), 480 ml of wine, 1,000 ml of beer, or 360 ml of Japanese sake.

Finally, we defined 6 groups according to pre- and postdisaster alcohol consumption patterns, as follows: Group A consisted of individuals who were pre- and postdisaster nondrinkers ("nondrinkers"); Group B consisted of predisaster nondrinkers who became light drinkers postdisaster ("newly started light drinkers"); Group C consisted of nondrinkers predisaster who became heavy drinkers postdisaster ("newly started heavy drinkers"); Group D consisted of drinkers predisaster who became abstinent postdisaster

(“abstainers”); Group E contained drinkers predisaster transitioning to light drinkers postdisaster (“light drinkers”); and Group F encapsulated drinkers predisaster who became heavy drinkers postdisaster (“heavy drinkers”).

Sociodemographic Variables and Disaster-Related Variables. Previous studies have linked demographic variables, education, occupational status, and disaster exposure with alcohol use and mental health in postdisaster contexts (Cerda et al., 2011; Nordlökken et al., 2013). Therefore, we also considered background information, socioeconomic factors, and disaster-related factors as potential confounding variables for use in logistic regression analyses. Background information consisted of gender (men vs. women), age (20 to 49, 50 to 64, 65 years or older), educational attainment (elementary school, junior high school, high school, obtaining at least an undergraduate degree), and history of mental illness (yes or no). Socioeconomic factors consisted of change in work (i.e., any change in work from pre- to postdisaster; yes or no), loss of employment (yes or no), and decrease in income (yes or no). Disaster-related factors consisted of house damage (less than partial collapse vs. partial collapse), experience of tsunami (yes or no), experience of nuclear power plant accident (defined as an experience hearing the explosion sound; yes or no), and loss of family or relatives (yes or no).

Statistical Analysis

Initially, we performed an exact chi-square test to assess the proportion of K6 scores ≥ 13 according to predisaster alcohol drinking or nondrinking behavior among the participants. A 2×2 chi-square test was used to assess differences in predisaster alcohol consumption for “no serious mental illness” and “serious mental illness” categories. We analyzed the differences in the distribution of “no serious mental illness” and “serious mental illness” among groups A, B, and C of the “predisaster nondrinkers,” and groups D, E, and F of the “postdisaster drinkers.” We showed how each postdisaster drinking pattern influenced the risk of serious mental illness. We applied logistic regression models to analyze how drinking patterns influenced the risk of serious mental illness after adjustment for the potentially confounding variables background information, socioeconomic factors, and disaster-related factors. Drinking behavior patterns were included in Model 1. Drinking behavior patterns, background information (gender, age, educational attainment, history of mental illness), and socioeconomic factors (change in work, loss of employment, decrease in income) were included as variables in Model 2. In addition to drinking behavior patterns, background information, and socioeconomic factors, disaster-related factors (house damage, experience of tsunami, experience of nuclear plant accident, loss of family or relatives) were included in Model 3. As there were some missing data in confounding variables, we used dummy variable for missing data to analysis in the multiple-adjusted models. Significance was set at $p < 0.05$. All statistical analyses were conducted using IBM SPSS Statistics version 21.0 (IBM Corp. Armonk, NY).

RESULTS

Table 1 provides the distribution of participants’ basic characteristics, socioeconomic factors, disaster-related factors, and K6 scores. The proportion of those with “probable serious mental illness” differed significantly from those without such illness with respect to gender, educational attainment, history of mental illness, change in work, loss of employment, decrease in income, house damage, experience

of tsunami, experience of nuclear power plant accident, and loss of family or relatives (p -values < 0.01 in all cases).

As shown in Table 2, we divided participants into 2 groups, nondrinkers and drinkers, and compared the predisaster risk of serious mental health using the K6 scores. Surprisingly, both men and women predisaster nondrinkers (15.8%) had a higher proportional risk of serious mental illness than did predisaster drinkers (12.6%; $p < 0.01$). Then, we analyzed the influence of postdisaster drinking behavior on the risk of serious mental illness (Table 3). Men and women newly started heavy drinkers (Group C) had the highest risk of serious mental illness among the predisaster nondrinker groups. The proportional risk of serious mental illness among newly started light drinkers (Group B) was higher than that of nondrinkers (Group A). However, abstainers (Group D) had the highest proportional risk of serious mental illness among the predisaster drinker groups.

Next, we conducted logistic regression analyses to examine how drinking behavior influenced the risk of serious mental illness, adjusting for background information, socioeconomic factors, and disaster-related factors (Table 4). The light drinkers (Group E) were used as a reference in this analysis, because they had the lowest frequency of serious mental illness. Newly started heavy drinkers had a higher likelihood of serious mental illness compared to all other groups. When the light drinkers (Group E) were used as a reference in this analysis, newly started heavy drinkers (Group C) had the highest risk of serious mental illness (Model 1; OR = 5.20, 95% CI: 3.62 to 7.47). The model showed that beginning light drinkers (Group B) were also at higher risk of serious mental illness (Model 1; OR = 1.99, 95% CI: 1.76 to 2.25). After adjusting for background information, educational attainment, and socioeconomic factors (Model 2), compared with light drinkers (Group E), beginning heavy drinkers were 4.74 times more likely to have serious mental illness (Group C), and beginning light drinkers were 1.79 times more likely to have such illness (Group B). Model 3 showed that after adjusting for background information, educational attainment, socioeconomic factors, and disaster-related factors, compared with light drinkers (Group E), newly heavy drinkers were 4.13 times more likely to have serious mental illness (Group C), and beginning light drinkers (Group B) were 1.74 times more likely to have such illness. Regarding serious mental illness stratified by gender, the multivariable-adjusted odds ratios (95% CI) for serious mental illness for the newly started light drinkers and heavy drinkers were 1.66 (1.34 to 2.06) and 4.43 (2.78 to 7.04) for men, respectively, and 1.72 (1.47 to 2.02) and 3.34 (1.67 to 6.68) for women.

DISCUSSION

Key Findings

In this study, to understand the risk of serious mental illness among the evacuees after a compound disaster, we

Table 1. Participants' Sociodemographic Information and Disaster-Related Situations ($N = 56,543$)

	Total <i>n</i>	Probable no serious mental illness ($K6 < 13$)		Probable serious mental illness ($K6 \geq 13$)		df	χ^2	<i>p</i>
		<i>n</i>	%	<i>n</i>	%			
Gender ($N = 56,543$)								
Men	24,789	21,873	88.2	2,916	11.8	1	272.8	<0.01
Women	31,754	26,452	83.3	5,302	16.7			
Age ($N = 56,543$)								
20 to 49 years old	20,991	18,011	85.8	2,980	14.2	2	3.2	0.20
50 to 64 years old	19,047	16,229	85.2	2,818	14.8			
65 years old and older	16,505	14,085	85.3	2,420	14.7			
Educational attainment ($N = 54,824$)								
Primary or middle school	11,852	10,012	84.5	1,840	15.5	3	63.4	<0.01
High school	27,871	23,755	85.2	4,116	14.8			
Vocational college or junior college	10,107	8,677	85.9	1,430	14.1			
University or graduate school	4,994	4,447	89.0	547	11.0			
History of mental illness ($N = 54,706$)								
Yes	2,701	1,492	55.2	1,209	44.8	1	2,207.6	<0.01
No	52,005	45,505	87.5	6,500	12.5			
Socioeconomic factors								
Change in work ($N = 53,777$)								
Yes	30,310	24,897	82.1	5,413	17.9	1	717.1	<0.01
No	23,467	21,189	90.3	2,278	9.7			
Loss of employment ($N = 56,543$)								
Yes	12,341	9,855	79.9	2,486	20.1	1	400.0	<0.01
No	44,202	38,470	87.0	5,732	13.0			
Decrease in income ($N = 56,543$)								
Yes	11,032	9,136	82.8	1,896	17.2	1	77.6	<0.01
No	45,511	39,189	86.1	6,322	13.9			
Disaster-related factors								
House damage ($N = 52,947$)								
Partial collapse and more severe	8,309	6,613	79.6	1,696	20.4	1	301.6	<0.01
Less than partial collapse	44,638	38,768	86.8	5,870	13.2			
Experience of tsunami ($N = 56,543$)								
Yes	11,505	9,361	81.4	2,144	18.6	1	195.6	<0.01
No	45,038	38,768	86.5	6,074	13.5			
Experience of nuclear power plant accident ($N = 56,543$)								
Yes	29,778	24,332	81.7	5,446	18.3	1	713.9	<0.01
No	26,765	23,993	89.6	2,772	10.4			
Loss of family or relatives ($N = 55,465$)								
Yes	10,959	8,602	78.5	2,357	21.5	1	717.1	<0.01
No	44,506	38,884	87.4	5,622	12.6			

Table 2. The Impact of Predisaster Drinking Behavior on the Risk of Serious Mental Illness

	Total <i>n</i>	Probable no serious mental illness ($K6 < 13$)		Probable serious mental illness ($K6 \geq 13$)		df	χ^2	<i>p</i>
		<i>n</i>	%	<i>n</i>	%			
Total ($N = 54,082$)								
Nondrinkers	29,389	24,733	84.2	4,656	15.8	1	114.5	<0.01
Drinkers	24,693	21,581	87.4	3,112	12.6			
Men ($N = 23,866$)								
Nondrinkers	7,940	6,878	86.6	1,062	13.4	1	32.9	<0.01
Drinkers	15,926	14,199	89.2	1,727	10.8			
Women ($N = 30,216$)								
Nondrinkers	21,449	17,855	83.2	3,954	16.8	1	4.2	<0.01
Drinkers	8,767	7,382	84.2	1,385	15.8			

investigated postdisaster alcohol drinking behavior, finding that the beginning heavy drinkers had the highest risk of serious mental illness. In addition, we found that the beginning light drinkers had a relatively high risk of mental health

problems. In contrast, our data showed that abstainers also had some risk to their mental health. Thus, to assess evacuees' risk of serious mental illness, it is important to assess any postdisaster changes in their drinking behavior.

Table 3. The Impact of Pre- and Postdisaster Drinking Behavior on the Risk of Serious Mental Illness

Predisaster	Postdisaster	Total <i>n</i>	Probable no serious mental illness (K6 < 13)		Probable serious mental illness (K6 ≥ 13)		df	χ^2	<i>p</i>
			<i>n</i>	%	<i>n</i>	%			
Nondrinkers (<i>N</i> = 28,700)	Group A: Nondrinkers	26,144	22,168	84.8	3,976	15.2	2	99.5	<0.01
	Group B: Newly started light drinkers	2,418	1,940	80.2	478	19.8			
	Group C: Newly started heavy drinkers	138	82	59.4	56	40.6			
Drinkers (<i>N</i> = 23,509)	Group D: Abstainers	1,572	1,254	79.8	318	20.2	2	116.1	<0.01
	Group E: Light drinkers	16,466	14,610	88.7	1,856	11.3			
	Group F: Heavy drinkers	5,471	4,722	86.3	749	13.7			

[Corrections added after publication on February 20, 2016: (N = 28,700) was moved from Group A to “Nondrinkers”; “Newly started light drinkers” in Group E was changed to “Light drinkers”; “Newly started heavy drinkers” in Group F was changed to “Heavy drinkers”]

Table 4. Impact of Drinking Behavior on Risk of Serious Mental Illness (K6 ≥ 13)

	Model 1 ^a (<i>n</i> = 44,358)		Model 2 ^b (<i>n</i> = 44,358)		Model 3 ^c (<i>n</i> = 44,358)	
	OR	95% CI	OR	95% CI	OR	95% CI
Reference (Group E): Light drinkers	1.00		1.00		1.00	
Group A: Nondrinkers	1.34	1.25 to 1.43	1.14	1.06 to 1.23	1.14	1.06 to 1.23
Group B: Newly started light drinkers	1.99	1.76 to 2.25	1.79	1.58 to 2.03	1.74	1.54 to 1.98
Group C: Newly started heavy drinkers	5.20	3.62 to 7.47	4.74	3.25 to 6.92	4.13	2.81 to 6.08
Group D: Abstainers	1.82	1.57 to 2.12	1.47	1.26 to 1.72	1.44	1.23 to 1.69
Group F: Heavy drinkers	1.24	1.12 to 1.37	1.31	1.18 to 1.45	1.26	1.13 to 1.40
Background information						
Gender (reference: Men)						
Women			1.46	1.37 to 1.56	1.50	1.40 to 1.60
Age (reference: 20 to 49 years old)						
50 to 64 years old			1.09	1.02 to 1.17	1.02	0.95 to 1.09
65 years and older			1.12	1.04 to 1.22	0.96	0.88 to 1.04
Educational attainment (reference: Primary or Middle school)						
High school			0.91	0.85 to 0.99	0.85	0.79 to 0.92
Vocational college or junior college			0.82	0.75 to 0.91	0.78	0.71 to 0.86
University or graduate school			0.77	0.68 to 0.87	0.73	0.64 to 0.82
History of mental illness (reference: No)						
Yes			5.58	5.08 to 6.13	5.40	4.91 to 5.94
Socioeconomic factors						
Change in work (reference: No)						
Yes			1.76	1.65 to 1.93	1.56	1.44 to 1.68
Loss of employment (reference: No)						
Yes			1.27	1.18 to 1.36	1.20	1.12 to 1.29
Decrease in income (reference: No)						
Yes			1.05	0.98 to 1.14	1.05	0.98 to 1.14
Disaster-related factors						
House damage (reference: Less than partial collapse)						
Partial collapse and more severe					1.26	1.17 to 1.36
Experience of tsunami (reference: No)						
Yes					1.10	1.03 to 1.18
Experience of nuclear plant accident ^d (reference: No)						
Yes					1.72	1.62 to 1.83
Loss of family or relatives (reference: No)						
Yes					1.54	1.44 to 1.64

^aModel 1: Unadjusted odds ratio.

^bModel 2: Odds ratio adjusted by background information and socioeconomic factors.

^cModel 3: Odds ratio adjusted by background information, socioeconomic factors, and disaster-related factors.

^dDefined as having heard the explosion caused by the nuclear accident.

Interpretation

Overall, these findings have implications for how we understand the association between drinking behavior and the risk of serious mental illness after a compound disaster. Previous studies have shown that alcohol consumption patterns change after traumatic events (Caldera et al., 2001;

McFarlane, 1998; Nordløyken et al., 2013) and there is a consequent risk of developing serious mental illness (Joseph et al., 1993). Nordløyken and colleagues (2013) reported that experience of the 2004 South-East Asia tsunami was associated with both increased and decreased drinking among 830 Norwegians survivors. The results of their study suggested

associations between disaster exposure and self-perceived changes in alcohol consumption after the traumatic event. We confirmed a similar association within a large sample ($n = 56,543$): The evacuees who experienced traumatic events after the compound disaster were more likely to report changes in their drinking behavior. Further, we found that newly started light drinkers had a greater risk of serious mental illness than those who had maintained a light-drinking habit. In addition, we found that abstainers had 1.44 times the risk of serious mental illness than those who continued to drink. Indeed, among the middle aged in Japan, ex-drinkers are more vulnerable to subsequent death by suicide compared to occasional drinkers (Akechi et al., 2006). The evacuees may have experienced withdrawal from their social life, which used to consist of drinking with their friends in the predisaster period. Thus, the postdisaster loss of community could be a direct cause of their risk of serious mental illness.

In this study, both men and women newly heavy drinkers had the greatest risk of serious mental illness; the onset of heavy drinking increased the postdisaster risk of serious mental illness. Prospective studies have indicated that heavy drinking has an attendant risk of serious mental illness (Gea et al., 2013; Sullivan et al., 2005). In contrast, heavy drinking could be associated with the social environment and related issues. Individuals with both depression and alcohol problems may have experienced significantly more negative life events than alcoholics without depression and nonalcoholics (Roy, 1996). This finding implies that the evacuees in Fukushima could have accumulated feelings of depression due to the long-term evacuation, as a consequence of which they might have started drinking. Nevertheless, there are 3 interpretations as to why newly heavy drinkers had a greater prevalence of mental health issues. First, increased postdisaster drinking heightens the risk of serious mental illness. Second, the onset of serious mental health problems increases the risk of engaging in heavy drinking. Third, both of these possibilities could operate concurrently.

Implications

We presented key data as to how the newly started heavy drinkers following a compound disaster suffer from serious mental illness. Therefore, it is important to consider how to assist this group as clinical practitioners. Although these heavy drinkers formed the smallest group among the drinking pattern groups, it is desirable to provide care for them in terms of the services they need. In addition to the beginning heavy drinkers, our findings showed that beginning light drinkers have some risk. The results suggest that the beginning drinkers following this compound disaster need to consider the risks to their mental health, and that their mental health needs must be addressed. It is necessary to develop an intervention plan for permanent multidisciplinary mental health care for beginning drinkers. Changed alcohol consumption behavior among evacuees after a compound disaster is common in those at risk of serious mental illness. It is

important to investigate the relationships between changing drinking behavior after a compound disaster and risk of mental illness, that is, knowing the pathway could help practitioners intervene regarding alcohol consumption behaviors and risk of serious mental illness.

To our knowledge, this is the first study to show that the drinking patterns after the Great East Japan Earthquake had an impact on the risk of serious mental illness. This information is important so that practitioners can develop intervention plans for the evacuees.

Strengths and Limitations

Our study confirms that increased alcohol consumption following a compound disaster influences the risk of serious mental illness. This was a large-scale study of all evacuees who were residents within the designated evacuation zone in Fukushima, and the study was conducted about 1 year after the Great East Japan Earthquake in 2011. This study also had a methodological advantage, namely that we formed 6 groups based only on pre- and postdisaster alcohol consumption among the evacuees. In addition, few research studies have investigated the association between alcohol consumption behavior and the risk of serious mental illness after a compound disaster. Therefore, this study is significant in that it examined how drinking behaviors impact mental illness following a compound disaster, which included both the natural disaster itself and a subsequent radiation hazard.

However, our study also had some limitations. First, we assessed participants' mental illness using the K6 screening scale, which has been validated only when used to make an assessment (Stewart, 1996). Therefore, the assessment of mental illness among the participants in this study was not equivalent to a clinical diagnosis and might have been overestimated or underestimated (Myers and Weissman, 1980). Second, only respondents who returned their survey could be considered. Thus, some evacuees suffering from serious mental illness might not have been represented. Third, there were some differences in the distribution of ages between the study sample and the target population. Therefore, the results of the study may not reflect all of the evacuation zones specified by the government. Fourth, the predisaster data is lacking, and we were unable to determine accurately how much alcohol the participants consumed predisaster that would necessitate a prospective study. Fifth, the study lacks an assessment of alcohol abuse and dependence, for example, we did not use the CAGE questionnaire, which screens for alcoholism.

In conclusion, our results suggest that beginning drinkers have a higher proportional risk of serious mental illness. It should be noted that drinking behavior patterns are key to assessing the risk of serious mental illness among evacuees. As a result, prevention of alcohol abuse may have an important role in assessing serious mental illness. Understanding drinking behavior patterns among evacuees will have signifi-

cant clinical implications for how to address mental illness in this population.

APPENDIX

The Fukushima Health Management Survey Group, consisting of Masafumi Abe (Director General, Radiation Medical Center for the Fukushima Health Management Survey), Shunichi Yamashita (Vice Director, Radiation Medical Center for the Fukushima Health Management Survey), Kenji Kamiya (Vice Director, Radiation Medical Center for the Fukushima Health Management Survey), Seiji Yasumura (Vice Director, Radiation Medical Center for the Fukushima Health Management Survey), Makoto Akashi (National Institute of Radiological Sciences), Kazunori Kodama and Kotaro Ozasa (The Radiation Effects Research Foundation), Hirooki Yabe (Chairman of Mental Health Survey, Radiation Medical Science Center for the Fukushima Health Management Survey), Kenneth E. Nolle, Ohtsura Niwa, Akira Ohtsuru, Shiro Matsui, Shinichi Niwa, Tetsuya Ohira, Yasuto Kunii, Shuntaro Itagaki, Tetsuya Shiga, Hajime Iwasa, Yuriko Suzuki, Yoko Nakayama, Misao Ohta, Aya Goto, Mitsuru Hisata, Norito Kawakami, Mitsuaki Hosoya, Akiko Yagi, Yu-ichi Oiwa, Naoko Horikoshi, Yu-ya Kashiwazaki, Go Takeda, Tetsunobu Hata, Hiroyuki Sugimoto, Yukiko Ito, Yuko Hino, Keisuke Hiyamizu, Kuni Kanke, Suzuko Yasuhara, Shizu Igarashi, Ai Kawamura, Aiko Matsuda, Mariko Hara, Yuriko Kimura, Yuki Kumasaki, Natusumi Sasaki, Miho Onji, Ryuchi Kurosawa, and Fumiko Mori.

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AUTHOR CONTRIBUTIONS

YU designed analyzed data and wrote the paper. HY, MM, TO, and SY drafted the paper and supervised this study. MH helped to design the analysis. SF, S-IN, AO, and HM revised the paper critically for important intellectual content. All authors approved the final version of the report for submissions.

CONFLICT OF INTEREST

None reported.

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SUPPORTING INFORMATION

Additional Supporting Information may be found in the online version of this article:

Table S1. Impact of drinking behavior on risk of serious mental illness ($K6 \geq 13$) among men.

Table S2. Impact of drinking behavior on risk of serious mental illness ($K6 \geq 13$) among women.