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The association between effective workplace communication with superiors and lower psychological distress among workers in the evacuation area after the Fukushima Daiichi Nuclear Power Plant accident

Masatsugu Orui | **Seiji Yasumura**

Department of Public Health, Fukushima Medical University School of Medicine, Fukushima City, Japan

Correspondence
Masatsugu Orui, Department of Public Health, Fukushima Medical University School of Medicine, 1 Hikarigaoka, Fukushima City 960-1295, Japan.
Email: oruima@fmu.ac.jp

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Abstract

Objectives: Well-managed workplace communication may promote well-mental health status among workers, even those who may have experienced drastic changes in their workplace and living environment after the Fukushima Daiichi Nuclear Power Plant accident. This study aimed to compare the workplace and living environment of workers in the evacuation area to the non-evacuation area, as well as the association between workplace communication and psychological distress.

Method: This cross-sectional questionnaire survey was conducted in two manufacturing companies in the evacuation area and a company in the non-evacuation area. Psychological distress was defined by a Kessler K6 distress scale score ≥5. Workplace communication was measured by the status of communication ("Do you feel that you can talk freely?") and consultation ("Can you consult when having troubles?") with superiors, managers and colleagues. Work burden, overtime, and irregular mealtimes as changes in the workplace and domestic life were determined. Differences in the workplace and living environment were compared using the chi-squared test, with the association between workplace communication and psychological distress analyzed by logistic regression.

Results: The proportion of workers with an increased work burden, overtime, and irregular meals was significantly higher among workers in the evacuation areas. There was also a significant association between low-psychological distress status and communication and consultation with superiors or managers, with no significant association with colleagues.

Conclusion: Only workplace communication with superiors or managers was associated with low-psychological distress, even after drastic changes in the workplace. Therefore, superiors or managers should initiate open communication and active consultation after a disaster.

KEYWORDS

nuclear disaster, occupational health, organizational management, workplace communication, workplace stress

1 | INTRODUCTION

The Great East Japan earthquake that occurred on 11 March 2011 generated a massive tsunami, causing enormous damage to the Pacific Coast, subsequently hitting the Fukushima Daiichi Nuclear Power Plant operated by the Tokyo Electric Power Company. This Fukushima Daiichi nuclear disaster caused long-term evacuation of residents from many surrounding municipalities, with the Japanese government designating evacuation areas according to spatial radiation dose rates. The evacuation area was classified into the following three categories: (a) difficult-to-return areas, with a radiation dose rate of ≥50 millisieverts (mSv) per year; (b) residence restriction areas, with a radiation dose rate of ≥20 and <50 mSv per year; and (c) areas where evacuation orders are ready to be lifted, with a radiation dose rate of <20 mSv per year. The residents of these areas were forced to relocate to non-evacuation regions immediately following the disaster. However, for "residence restriction areas" and "areas where evacuation orders are ready to be lifted," evacuees and workers who have worked in companies in these areas were permitted temporary entry.[1]

Devastating disasters and their aftermath cause psychological distress not only to residents but also workers in the affected areas. Previous studies have reported that public servants working in the area devastated by the Great East Japan earthquake were overworked (eg >100 hours of overtime per month), leading to increased risk of mental distress.[2,3] In another study regarding workers' stress after the Hanshin-Awaji earthquake in 1995, the workers complained of increased job pressure and being overworked due to the decreased number of workers for disaster-related reasons, declining income as well as difficulty traveling to and from the relocated area.[4] Therefore, workers who have worked in companies in the evacuation areas may be confronted with a heavy workload due to the drastic workplace and life changes after this nuclear disaster, thereby at increased risk of psychological distress.

According to several studies, an optimal environment for workplace communication involving frequent and interpersonal communication or well-managed workplace communication could consequently promote well-mental health status among workers under regular work conditions.[5-9] Conversely, the opposite could happen, for example, the lack of workplace communication among local welfare workers after the Great East Japan earthquake was significantly associated with high-psychological distress.[10] Moreover, poor workplace communication was a risk factor for developing mental health problems 7 months[11] and 14 months[2] after the Great East Japan earthquake. In this study, it was hypothesized that such environments for workplace communication might promote well-mental health status among workers confronted with changes in their workplace environment and domestic life based on a conceptual model (Figure 1). Due to limited reports regarding the association between workers' psychological distress and workplace communication, even among workers affected by disasters, this study aimed to investigate whether workplace communication is associated with psychological distress among workers who have worked in the evacuation area, while their workplace and living environment may have changed drastically. Therefore, the present study examined (a) differences in the workplace and living environment among the employees between the evacuation

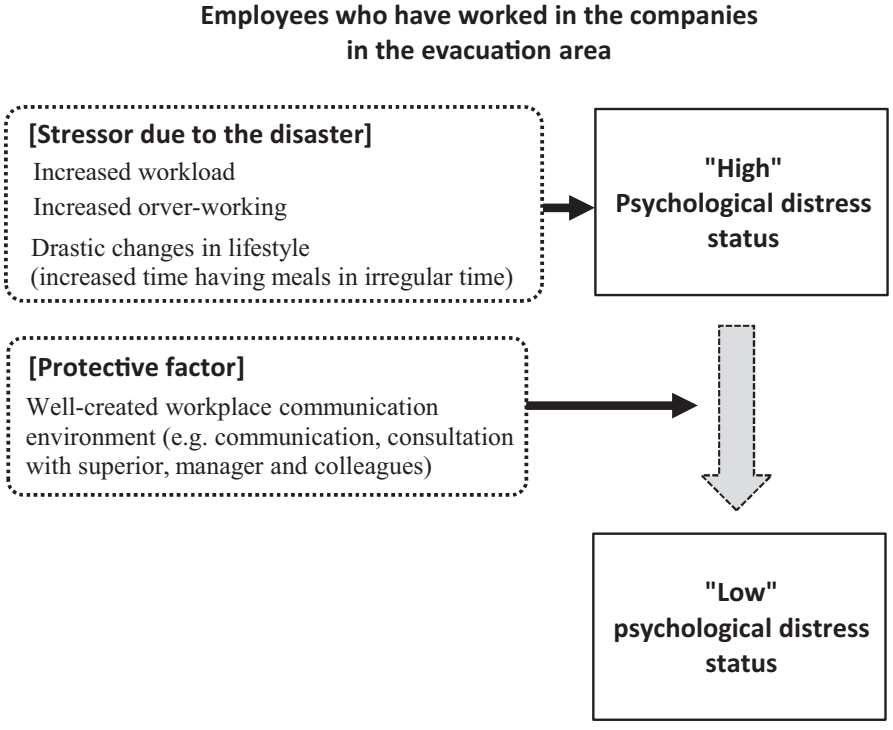

FIGURE 1 A conceptual frame model of the association between psychological distress and workplace communication in the evacuation area. Owing to stressors following the disaster, there may a negative impact on employees' psychological status. However, an optimal workplace communication environment could be a protective factor to prevent any deterioration or even improving psychological status

and non-evacuation areas, and (b) the association between workers' psychological distress and workplace communication among those who worked in manufacturing companies in the evacuation area to utilize mental health promotion strategies for workers after disasters.

2 | METHODS

2.1 | Study design and subjects

This study was based on cross-sectional data collected from an employee questionnaire survey at two medium-sized manufacturing companies in the evacuation areas and a medium-sized manufacturing company in the non-evacuation area (Figure 2). This survey was conducted for workers' health management in the evacuation area due to the Fukushima Daiichi Nuclear Power Plant accident including a control company in the non-evacuation area. The manufacturing industry was the focus of this study because most companies that continued operations in the evacuation area were manufacturing companies. Six hundred and forty-seven workers participated in this study, 383 workers in the evacuation area and 264 workers in the non-evacuation area. The survey was approved by the ethical review committee of Fukushima Medical University on 29 July 2016 and the questionnaire was distributed from September to November 2016.

2.2 | Measurements

2.2.1 | Changes in the workplace environment and domestic life compared with pre-disaster

Changes in the workplace environment (burdensome on their work, frequency of working overtime) and domestic life (having meals at irregular times) before and after the nuclear power plant accident were measured on a 3-point scale (increase, no change or decrease compared with pre-disaster status).

2.2.2 | Workplace communication

Workplace communication was defined as the status of (a) communication and consultation with superiors or managers and (b) communication and consultation with colleagues. To evaluate workplace communication status, the following questions were asked: (a) Communication: "Do you feel that you can talk freely with superiors and managers/colleagues?," (b) "Can you consult with superiors and managers/colleagues when having troubles?," and were measured on a 4-point scale (very much, quite, somewhat, and none). In this analysis, "very much" and "quite" were combined and defined as being reflective of an optimal workplace communication environment; likewise, "somewhat" and "none" were combined

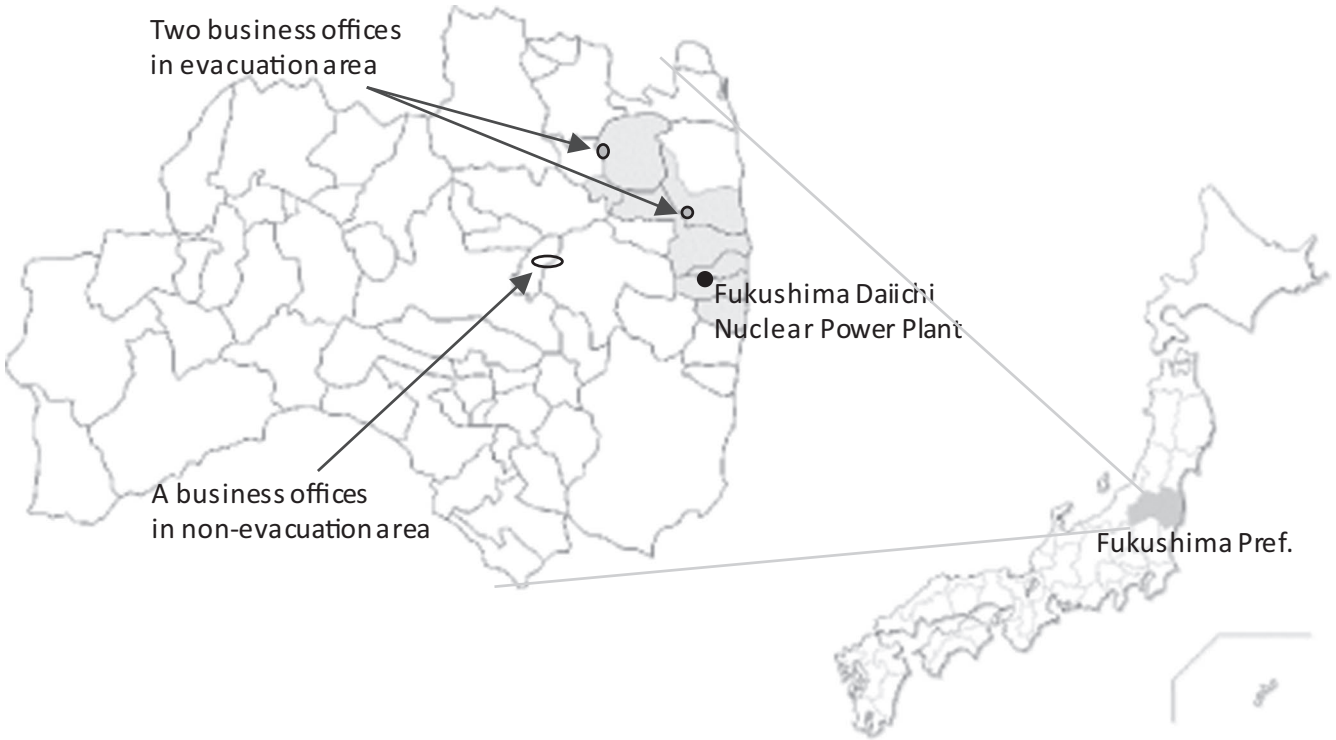

FIGURE 2 Location of three subject companies in the evacuation and non-evacuation area. Two medium-sized manufacturing companies in evacuation areas (Minami-Soma City and Iitate Village) and a medium-sized manufacturing company in a non-evacuation area (Tamura City) in Fukushima Prefecture

and were reflective of a suboptimal workplace communication environment. These questions were also part of the questionnaire in the Stress-check program launched by the Ministry of Health, Labor and Welfare, Japan since 2015.[12,13]

2.2.3 | Psychological distress

The Kessler distress (K6) scale was used to assess psychological distress among workers. The K6 scale is used to screen for non-specific serious mental illnesses, including DSM (Diagnostic and Statistical Manual of Mental Disorders) -IV mood and anxiety disorders. The score on the K6 scale ranges from 0 to 24 points, with 0-4 points classified as no probable psychological distress and 5-24 points classified as having probable mild-moderate/serious psychological distress.[14] This study used the Japanese version of the K6, which has been empirically validated as an independent means of screening for mental distress among evacuees.[15,16] In this analysis, respondents who scored ≥5 points were defined as having probable psychological distress.

2.3 | Statistical analysis

The chi-squared test was performed to analyse differences in the workplace environment and domestic life between companies in the evacuation and non-evacuation area. Also, changes in the workplace environment and domestic life and workplace communication among workers in the companies in the evacuation area were divided into no probable psychological distress (K6 score ≤4) and any psychological distress group (K6 score ≥5). Additionally, to investigate related factors with psychological distress among workers who may have experienced an increased workload, a multivariate logistic regression model was utilized to examine the association between psychological distress, and workplace communication and changes in the workplace environment and domestic life. The psychological distress variable (ie K6 score ≤4 and ≥5) was set as a dependent variable, while workplace communication and changes in the workplace environment and domestic life were set as independent variables.

Statistical significance was evaluated using two-sided, design-based tests with a 5% level of significance. All statistical analyses were performed using SPSS 25.0 (IBM Corp., Armonk, NY).

3 | RESULTS

3.1 | Study subjects and their basic characteristics, changes in workplace environment and domestic life and workplace communication

Among 647 subjects, 530 responded to the questionnaire (276 workers, 72.1% in the evacuation area, 254 workers, 96.2% in non-evacuation area), with 14 respondents without age or gender information excluded, resulting in the final analysis of 516 respondents (265 respondents in the evacuation area; 251 respondents in the non-evacuation area) (Figure 3). There were more male than female workers, and a quarter had evacuated due to the nuclear power plant accident. The proportion of those with an increased work burden ($P < 0.01$), increased frequency of working overtime ($P < 0.01$), and increased frequency of meals at irregular times ($P < 0.01$) were significantly higher among workers in the evacuation areas. In total, 54.9% of workers had some psychological distress, with the proportion of such workers in the evacuation and non-evacuation area being 62.6% and 46.8%, respectively ($P < 0.01$) (Table 1).

3.2 | Differences in subjects with changes in the workplace environment and domestic life, workplace communication stratified by psychological distress status

Table 2 shows the basic characteristics and changes in the workplace and lifestyle and workplace communication with subjects stratified by probable no/any psychological distress status groups. Workers with low-psychological distress were statistically less likely to experience an increase in work burden, duration of working overtime, or having meals at irregular times compared with workers who perceived psychological distress. For workplace communication, workers without any psychological distress could communicate (Can you talk freely with them?) and consult (Can you consult them when having troubles?) with their superiors or managers significantly more than workers with any psychological distress.

3.3 | Multivariate logistic regression analysis of workplace communication and psychological distress among workers in the evacuation area

The results of multivariate logistic regression analysis are shown in Table 3. In Model 1, which included input variables of age, gender, and changes in the workplace and domestic life, increasing burden in their workplace after this disaster was significantly associated with having psychological distress [Odds ratio (OR): 0.85, 95% confidence interval (CI): 0.73-0.99]. In the analysis of Model 2, the variable regarding workplace communication with superiors or managers was added to Model 1. Among workers in the evacuation area, communication with superiors or managers (OR: 1.21, 95% CI: 1.01-1.45) and consultation with them (OR: 1.30, 95% CI: 1.09-1.55) were significantly associated with a low-psychological distress status. Moreover, the variable of burden in their workplace no longer had a significant association with psychological

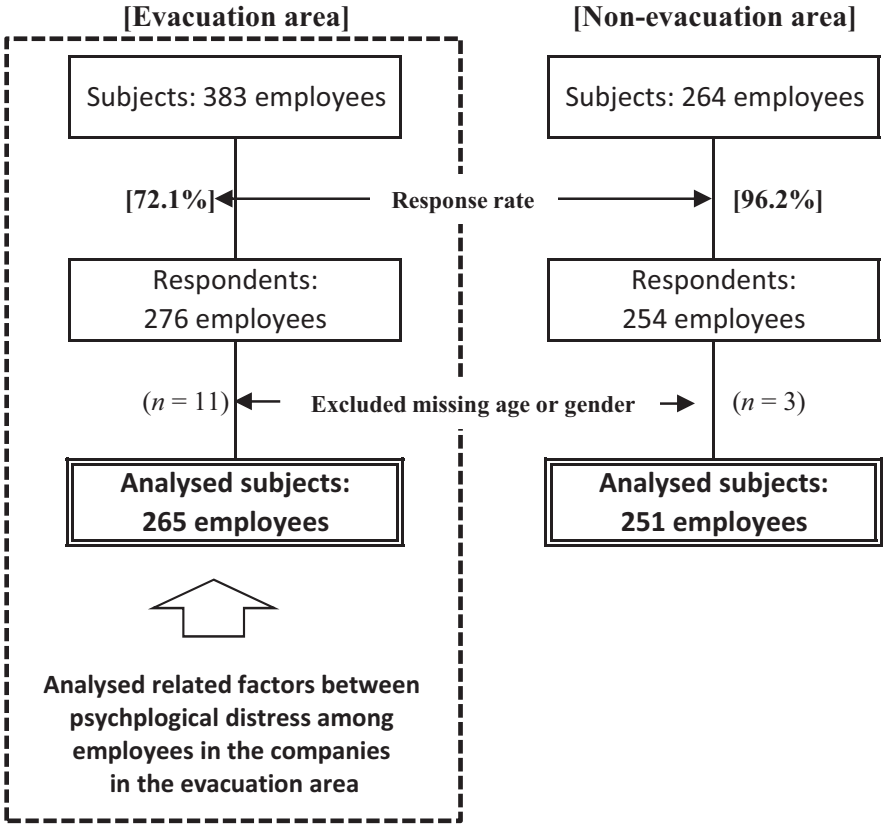

FIGURE 3 Sample Selection from business offices in evacuation and non-evacuation area. Among the 647 subjects, 276 workers in the evacuation area and 254 workers in the non-evacuation area responded to the questionnaire. After excluding respondents who failed to include information on age and gender, we analyzed 516 subjects

distress after adding the variable of workplace communication with superiors or managers. In the analysis of Model 3, the variable regarding workplace communication with colleagues was added to Model 1. However, there was no significant association between low-psychological distress status and workplace communication with colleagues. Furthermore, the variable of burden in the workplace was a significant factor associated with psychological distress.

4 | DISCUSSION

It was hypothesized that an optimal workplace environment with frequent interpersonal communication or counseling between superiors, managers, and colleagues could consequently promote well-mental health status, even among workers affected by disasters. The study findings showed a significant association between low-psychological distress status and only workplace communication with superiors or managers, even if they experienced a heavy workload due to the drastic changes in workplace and domestic life after this nuclear disaster. However, workplace communication with colleagues was not significantly associated with a low-psychological distress status among workers who worked in companies in the evacuation area.

4.1 | Differences in subjects with changes in the workplace environment and domestic life between the evacuation and non-evacuation areas

Firstly, subjects in those companies located in the evacuation area experienced a heavier workload due to the drastic workplace environment and domestic life changes after this nuclear disaster than workers in the non-evacuation area. A previous study of public servants working in the area devastated by the Great East Japan earthquake also reported that they were overworked.[2,3] Moreover, increased job pressure and being overworked has been a problem among workers after the Hanshin-Awaji earthquake 1995.[4] Our findings corroborate the previous study, that workers experience an increased work burden due to a decrease in the number of workers or increased commuting time, suggesting that superiors or managers should pay more attention to the inevitable increase in workload after disasters.

4.2 | Association between workplace communication and psychological distress among workers in the evacuation area

According to previous studies, frequent and interpersonal communication in a workplace or well-managed workplace

TABLE 1 Basic characteristics and differences of status in workplace and lifestyle, psychological status of subjects (Total/Company location)

	Total (n = 516)	Company location		
		Evacuation area (n = 265)	Non-evacuation area (n = 251)	
	n (%)	n (%)	n (%)	*P* value (χ^2)
Age (as of March 11, 2011)				
Less than 30 years old	110 (21.3)	75 (28.3)	35 (13.9)	
30-39 years old	121 (23.4)	40 (15.1)	81 (32.3)	<0.01 (χ^2 = 29.0)
40-49 years old	160 (31.0)	83 (31.3)	77 (30.7)	
50 years old and more	125 (24.2)	67 (25.3)	58 (23.1)	
Gender				<0.01 (χ^2 = 17.0)
Male	387 (75.0)	219 (82.6)	168 (66.9)	
Female	129 (25.0)	46 (17.4)	83 (33.1)	
Evacuees due to a nuclear disaster				<0.01 (χ^2 = 149.4)
Evacuees	127 (24.6)	125 (47.2)	2 (0.8)	
Non-evacuees	389 (75.4)	140 (52.8)	249 (99.2)	
Burdensome on their work				<0.01 (χ^2 = 49.6)
Increased	142 (28.7)	107 (43.0)	35 (14.3)	
No change/Decrease	352 (71.3)	142 (57.0)	210 (85.7)	
Time of overtime-working				0.01 (χ^2 = 9.66)
Increased	74 (14.8)	50 (19.7)	24 (9.8)	
No change/Decrease	425 (85.2)	204 (80.3)	221 (90.2)	
Having meals in irregular time				<0.01 (χ^2 = 38.3)
Increased	133 (26.0)	99 (37.6)	34 (13.7)	
No change/Decrease	379 (74.0)	164 (62.4)	215 (86.3)	
Psychological distress				<0.01 (χ^2 = 12.9)
K6 score ≥5	281 (54.9)	164 (62.6)	117 (46.8)	
K6 score ≤4	231 (45.1)	98 (37.4)	133 (53.2)	

communication could promote well-mental health status among workers.[5-9] Conversely, lack of workplace communication was significantly associated with high-psychological distress[10] and was a related factor for mental health problems after the Great East Japan earthquake.[2,11] In our study, an increasing burden in the workplace after this disaster was significantly associated with experiencing psychological distress (Model 1 of the multivariate logistic regression analysis), similar to previous studies.[2,10,11]

However, only communication and consultation with superiors or managers was associated with a low-psychological distress status among workers in the evacuation area. In the case of a dramatic change in the workplace environment following a devastating disaster, such as this nuclear disaster, communication and consultation with supervisors, but not with colleagues may be associated with reducing workers' stress. After a disaster, given drastic changes in the workers' workplace environment and domestic life, they are likely to face more complicated personal troubles which can be resolved by simple communication with colleagues. Naturally, managing an increased work burden or overtime by superiors and manager is essential for health management to prevent deterioration of workers' general and mental health status.[17-19] In addition, superiors or managers may be required to take the initiative to engage in open communication and active consultation to reduce psychological distress after a disaster. After the devastation of a disaster, therefore, it may be necessary to promote workplace communication with superiors or managers while implementing ordinal health management, including managing the work burden and overtime.

4.3 | Limitations and strengths

The present study has some limitations. First, the findings were based on a cross-sectional study design, so it is uncertain if there is causality between workplace communication and psychological distress. Second, the definition of workplace communication utilized was a non-validated measurement. According to previous studies, lack of workplace communication was

TABLE 2 Basic characteristics and changes in the workplace and lifestyle and workplace communication of subjects in the evacuation area companies

	Psychological distress (-) (n=98) n (%)	Psychological distress (+) (n=164) n (%)	*P* value (χ^2)
Age (as of March 11, 2011)			0.94 ($\chi 2 = 0.40$)
Less than 30 years old	26 (26.5)	49 (29.9)	
30-39 years old	15 (15.3)	23 (14.0)	
40-49 years old	32 (32.7)	50 (30.5)	
50 years old and more	25 (25.5)	42 (25.6)	
Gender			0.08 ($\chi^2 = 3.05$)
Male	86 (87.8)	130 (79.3)	
Female	12 (12.2)	34 (20.7)	
Evacuees due to a nuclear disaster			0.94 ($\chi^2 = 0.01$)
Evacuees	49 (50.0)	74 (45.1)	
Non-evacuees	49 (50.0)	90 (54.9)	
Changes in workplace and domestic life			
Burdensome on their work			<0.01 ($\chi^2 = 9.32$)
Increased	28 (30.4)	78 (50.3)	
No change/Decrease	64 (69.6)	77 (49.7)	
Time of overtime-working			0.01 ($\chi^2 = 6.02$)
Increased	11 (11.6)	38 (24.2)	
No change/Decrease	84 (88.4)	119 (75.8)	
Having meals in irregular time			0.17 ($\chi^2 = 1.89$)
Increased	31 (31.6)	65 (40.1)	
No change/Decrease	67 (68.4)	97 (59.9)	
Workplace communication			
Superior, Manager			
Do you feel that you can talk freely with them?			<0.01 ($\chi^2 = 10.2$)
Very much and Quite	28 (28.9)	21 (12.9)	
Somewhat and None	69 (71.1)	142 (87.1)	
Can you consult with them when having troubles?			<0.01 ($\chi^2 = 15.4$)
Very much and Quite	34 (35.1)	23 (14.2)	
Somewhat and None	63 (64.9)	139 (85.8)	
Colleagues			
Do you feel that you can talk freely with them?			<0.01 ($\chi^2 = 8.17$)
Very much and Quite	50 (51.0)	54 (33.1)	
Somewhat and None	48 (49.0)	109 (66.9)	
Can you consult with them when having troubles?			0.03 ($\chi^2 = 4.52$)
Very much and Quite	36 (37.1)	40 (24.7)	
Somewhat and None	61 (62.9)	122 (75.3)	

determined dichotomously (asked whether workers felt that workplace communication was lacking) or by rating the quality of communication (poor, reasonable, or good). Previous studies also used subjective questions. Although workplace communication was determined using non-validated questions, it might still be sufficiently reasonable to evaluate workplace communication. Third, the hierarchy of workers in the workplace should also be taken into consideration because it could influence workplace communication, but this information was not obtained in this study (terminal, mid-level, or executive-level). The fourth limitation was the validity of measurements utilized in this study. Although the K6 item scale is a validated measurement, the others are non-validated and investigator-designed queries. The final limitation is that our study did not elucidate the mechanism by which workplace communication could influence psychological distress,

TABLE 3 Multivariate logistic regression analysis between workplace communication and psychological distress among employees in the evacuation area

	Model 1		Model 2 Workplace communication to superior, manager		Model 3 Workplace communication to colleagues	
	OR (95% CI)	***P* value**	**OR (95% CI)**	***P* value**	**OR (95% CI)**	***P* value**
Age	0.99 (0.97-1.02)	0.65	0.99 (0.96-1.01)	0.26	0.98 (0.96-1.01)	0.23
Gender						
Male (vs Female)	2.14 (0.95-4.82)	0.07	2.26 (0.97-5.26)	0.06	2.07 (0.90-4.80)	0.09
Evacuees due to a nuclear disaster						
Evacuees (vs Non-evacuees)	1.08 (0.94-1.24)	0.31	1.07 (0.92-1.23)	0.38	1.06 (0.92-1.23)	0.39
Changes in workplace and domestic life						
Burdensome on their work						
Increased (vs No change/Decrease)	**0.85 (0.73-0.99)**	**0.04**	0.86 (0.74-1.01)	0.07	**0.85 (0.73-0.99)**	**0.05**
Time of overtime-working						
Increased (vs No change/Decrease)	0.90 (0.72-1.11)	0.30	0.92 (0.74-1.14)	0.45	0.90 (0.73-1.12)	0.36
Having meals in irregular time						
Increased (vs No change/Decrease)	0.93 (0.81-1.07)	0.32	0.95 (0.82-1.10)	0.51	0.92 (0.79-1.06)	0.26
Workplace communication						
Superior, Manager						
Do you feel that you can talk freely with them?						
Very much and Quite (vs Somewhat and None)			**1.21 (1.01-1.45)**	**0.04**	—	
Can you consult with them when having troubles?						
Very much and Quite (vs Somewhat and None)			**1.30 (1.09-1.55)**	**<0.01**	—	
Colleagues						
Do you feel that you can talk freely with them?						
Very much and Quite (vs Somewhat and None)			—		1.15 (0.98-1.35)	0.08
Can you consult with them when having troubles?						
Very much and Quite (vs Somewhat and None)			—		1.13 (0.96-1.34)	0.15

Note: Bold: $P < 0.05$; CI, confidence interval; OR, odds ratio.

as the questionnaire did not address workers' mental status after communication with superiors, managers, or colleagues. It was hypothesized that communication with superiors or managers could resolve business/personal issues with greater ease than through communication with colleagues. Following disasters, workers would inevitably encounter more complicated business or personal issues, but the questionnaire did not address the reason for their perceived psychological distress. Therefore, further studies including such questions will be required in future studies.

Despite these limitations, this study has several strengths. It included a large number of subjects that were sufficient to evaluate the association between workplace communication and workers' psychological distress. In addition, there has not been any previous report regarding workplace communication and general workers' psychological distress after a disaster based on workers' rank (eg, superior, manager and colleagues).

5 | CONCLUSION

The study findings showed that only workplace communication with superiors or managers was associated with low-psychological distress after this nuclear disaster among workers who experienced an increased work burden, increased frequency of working overtime and having irregular meals. Therefore, for workers with perceived psychological distress, superiors or managers should take the initiative to engage in open communication and active consultations might be needed after a disaster. These findings have implications for developing work health management measures for workplace administrators, especially after a disaster.

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DISCLOSURE

Approval of the research protocol: Approved by the ethical review committee of Fukushima Medical University on July 29, 2016. *Informed consent:* Not applicable due to a survey conducted by an anonymous, self-reporting questionnaire. *Registry and the registration no. of the study/trial:* N/A. *Animal studies:* N/A. *Conflict of interest:* None declared.

AUTHOR CONTRIBUTIONS

MO conceived the ideas, collected and analyzed the data, and wrote the manuscript. SY reviewed the writing.

ORCID

Masatsugu Orui https://orcid.org/0000-0002-4871-8455

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