Tohoku J. Exp. Med., 2024, **262**, 143-155

Gender Differences in the Association between Psychological Distress and Sociability among Older Adult Survivors: Cross-Sectional Survey Four Years after the 2016 Kumamoto Earthquake in Japan

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Mental health deterioration after a disaster is a concern. Individuals' sociability is expected to relate to the risk of this deterioration; however, research focusing on older adults is lacking. We aimed to investigate the relationship between psychological distress and sociability in older adults who survived the 2016 Kumamoto earthquake. We conducted a self-reported questionnaire survey in 2020. Data on 3,588 people aged 65 years and over (2,024 women and 1,564 men, mean age 74.6 ± 7.2, mean ± standard deviation) were analyzed. The overall prevalence of psychological distress (the Kessler psychological distress scale: K6 ≧ 10) was 10.5%; by gender, it was 11.2% in women and 9.5% in men. Logistic regression analysis revealed that, in the total sample, age, gender, public housing, reduction in income resulting from the coronavirus disease 2019 pandemic, self-rated unhealthy conditions, subjective social isolation, and a lack of awareness of community events were positively associated with psychological distress. For women, a lack of community participation was positively related to psychological distress. For men, not knowing the change in school district after relocation was negatively associated with psychological distress, probably due to men's scarce community participation and reliance on friendships, compared to women's stronger dependence on community. Moreover, having a family member or friend to consult with was associated with a lower risk of psychological distress, regardless of gender. Gender differences were related to different conditions of social participation and types of social relationships. Enhancing community participation and family relationships among women and social contact with friends among men is essential.

Keywords: disaster; gender difference; mental health; social cohesion; social participation
Tohoku J. Exp. Med., 2024 March, **262** (3), 143-155.
doi:10.1620/tjem.2024.J003

Introduction

Mental health generally deteriorates after disasters such as earthquakes and tsunamis (Akerkar and Fordham 2017; Sato et al. 2020; Fu et al. 2021). During the Kumamoto earthquake (EQ-2016-000033-JPN), seven earthquakes of magnitude 5.4 or greater occurred between April 14 and 16, 2016 (Cabinet Office Government of Japan 2016). A total of 267 people died, with 50 direct and 217 indirect deaths, including a toll from heavy rain afterwards; 1,185 were seriously injured, and 1,150 were slightly injured in Kumamoto Prefecture alone (Cabinet Office

Received October 3, 2023; revised and accepted January 7, 2024; J-STAGE Advance online publication January 18, 2024
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Government of Japan 2018). Furthermore, more than 4,000 aftershocks of intensity 1 or higher were observed in the six months following the Kumamoto earthquakes (Japan Meteorological Agency 2016). These repeated earthquakes resulted in residents' continued exposure to trauma, which may have evoked ruminations about past experiences and subsequent cumulative mental health risks (Bryant et al. 2013).

Post-earthquake mental health studies worldwide have identified women as being at risk of negative health factors (Yokoyama et al. 2014; Hosseinnejad et al. 2022). The prevalence of both posttraumatic stress symptoms (PTSS) (Fu et al. 2021; Yazawa et al. 2022) and posttraumatic stress disorders (Sato et al. 2020) has been reported to be higher in women compared to men. High-risk groups for the treatment of mood and anxiety symptoms after the 2011 Christchurch, New Zealand earthquake (EQ-2011-000024-NZL) included women, older adults, and those with a history of mental illness (Hogg et al. 2016). In a follow-up study conducted over eight years after the 2008 Wenchuan earthquake in China (EQ-2008-000062-CHN), the prevalence of depressive symptoms was higher in women (Fu et al. 2021). A meta-analysis on depression after disasters found that being a woman was a risk factor among adults (Tang et al. 2014). While it has been established that women may be more prone to post-earthquake mental health crises, gender differences at mid- to long-term periods have not been clarified in Japan.

Up to 110,000 people were evacuated owing to the Kumamoto earthquake in Kumamoto City, the prefectural capital (Kumamoto Earthquake Museum 2020). Subsequently, most survivors chose to move into private flats rather than community units (Abe 2020). However, among the survivors in the Great East Japan Earthquake (GEJE) (EQ-2011-000028-JPN), those who relocated individually experienced reduced informal socializing and social participation than those who relocated as a group (Hikichi et al. 2017). Therefore, there are concerns about the long-term mental health effects experienced by earthquake survivors who did not participate in community-based relocation after the Kumamoto earthquake. Particularly, there is a concern about the long-term decline in the mental health of women, whose regular daily lives often involve socializing with neighbors.

Sociability may act as a buffer against a post-disaster deterioration in mental health. The risk of depression among survivors of the Black Saturday fires in Australia (WF-2009-000035-AUS) was higher among those with fewer social ties (Bryant et al. 2017). Furthermore, community-level social cohesion before the Kumamoto earthquake was found to significantly reduce the risk of post-earthquake major depressive episodes among older women in a rural town (Sato et al. 2020). On the contrary, in the same study, informal socializing and community-level social participation before the earthquake significantly increased the risk of depression in women (Sato et al. 2020). In addition, among younger older adult (65-74 years old) Japanese women, those who participated in sports organizations and hobby clubs had better mental health than non-participants, while forced participation in sports organizations resulted in worse mental health than among non-participants (Tomioka et al. 2017). Thus, sociability, depending on surrounding social factors, can be both a risk factor for and a buffer against post-disaster mental health deterioration among women. However, the differences in the association between mental health status and sociability among Kumamoto earthquake survivors in non-rural areas have not been thoroughly investigated.

While some types of social participation are thought to be associated with better mental health among older women, findings regarding the association between social support and mental health problems have also been reported. In a cohort study of older adults affected by GEJE, women showed greater deterioration in instrumental support from non-relatives, which significantly mediated the association between gender and PTSS (Yazawa et al. 2022). In another study after GEJE, social relationships with friends were associated with reduced psychological distress, particularly among women aged 65 years and older (Teramoto et al. 2015). In addition, among South Korean adults, directly or indirectly exposed to a disaster, social support partially mediated the relationship between disaster distress and depressive symptoms (Park et al. 2021). In the aforementioned study in Mifune-town, Kumamoto Prefecture, pre-earthquake community-level social cohesion and socialization were strongly associated with the risk of post-earthquake major depressive episodes among women, while pre-earthquake individual-level social cohesion was only moderately associated ($P = 0.07$) among men (Sato et al. 2020). Thus, social factors associated with mental health problems among older women are diverse, with social ties and support from friends and the community. Additionally, the types of social factors associated with PTSS, distress, and depression may differ between men and women. However, studies of older adults after the disaster are lacking, and few have been conducted on the Kumamoto earthquake. Therefore, regarding the association between sociability and mental health problems among survivors, further research on gender differences is required.

Among the types of social supports, emotional support is mainly provided by a confidant (Berkman et al. 2000) and is said to influence mental health (Thoits 2011). Confidant relationships have also been shown to help relieve stress and have been suggested to be particularly beneficial for women (Cohen and Wills 1985). For older adults, family as confidants have been shown to be helpful for stress relief (Robertson and Mosher-Ashley 2003), while other studies have shown that friends and neighbors can also be helpful as confidants for older women because they have more diverse networks (Chipperfield 1994; Antonucci et al. 2001; York Cornwell and Goldman 2021). However, among the urban elderly in Japan, an association

between the availability of someone to consult with and depressive symptoms was found, particularly among men, regardless of the type of emotional and instrumental support (Koizumi et al. 2004). Furthermore, in a recent study, confidant support was helpful for problem solving and effective parenting in both post-divorce men and women (Degarmo and Forgatch 2012). Thus, associations between confidants and mental health may vary across genders and individuals, necessitating more in-depth research on these relationships post-disaster.

Considering these factors, we aimed to clarify the reality of and risk factors for psychological distress among older survivors (≧65 years old) four years after the Kumamoto earthquake, focusing on gender differences. We hypothesized that: 1) even four years after the earthquake, a considerable proportion of survivors suffer psychological distress, with a higher prevalence found in women than in men and 2) risk factors for psychological distress differ between women and men, and the risk of psychological distress is increased in women owing to a lack of sociability, such as community participation and connectedness.

Materials and Methods

Participants

The participants were older adults who were affected by the 2016 Kumamoto earthquake and had moved from temporary to permanent housing by the end of December 2019 (Fig. 1). The total population of Kumamoto City was 740,822 (348,470 males and 392,352 females), with the rate of aging (≧65) of 24.2% as of 2015 (Kumamoto City 2015).

Data were collected from July to December 2020. The data collection period was during the second (July-October 2020) and third (October 2020-February 2021) waves of the coronavirus disease 2019 (COVID-19) pandemic in Japan (Furukawa et al. 2021). Questionnaires were mailed to all (N = 19,212) adult residents registered on a list of survivors who utilized temporary housing in Kumamoto City. Respondents completed the self-administered questionnaire and returned it individually by mail. In this study, out of all the respondents, only data from those aged 65 years and over were extracted.

Ethical considerations

This study was conducted in accordance with the Declaration of Helsinki and approved by the Institutional Review Board of Kumamoto University (approval no. 1940, June 4, 2020). In our explanatory letter, we briefed the participants regarding voluntary participation, saying that there would be no disadvantages owing to refusal to participate, protection of personal information, the burden of participation, future publication of the results, and joint research between Kumamoto City and the university. It was also explained that returning the questionnaire would be considered consenting to participate in the study.

Outcome variables

The Kessler psychological distress scale, K6 (Kessler et al. 2002), was developed to screen for mental health problems, such as psychological distress and anxiety, in the general population. The Japanese version (Furukawa et al. 2008) has been confirmed to be sufficiently reliable and valid (Sakurai et al. 2011). It is a six-item instrument measuring psychological distress during the past 30 days. Responses are given using a 5-point scale ranging from "always" to "never," scored on a scale of 0-4 (total score 0-24). A K6 score of ≧10 has been used as a cutoff in past studies of survivors of GEJE (Suzuki et al. 2014; Murakami et al. 2017). Similarly, in this study, a K6 score of ≧10 was defined as having psychological distress.

Explanatory variables

The key variable was sociability. We considered sociability in terms of the availability of someone to consult with and participation in local activities. Regarding the

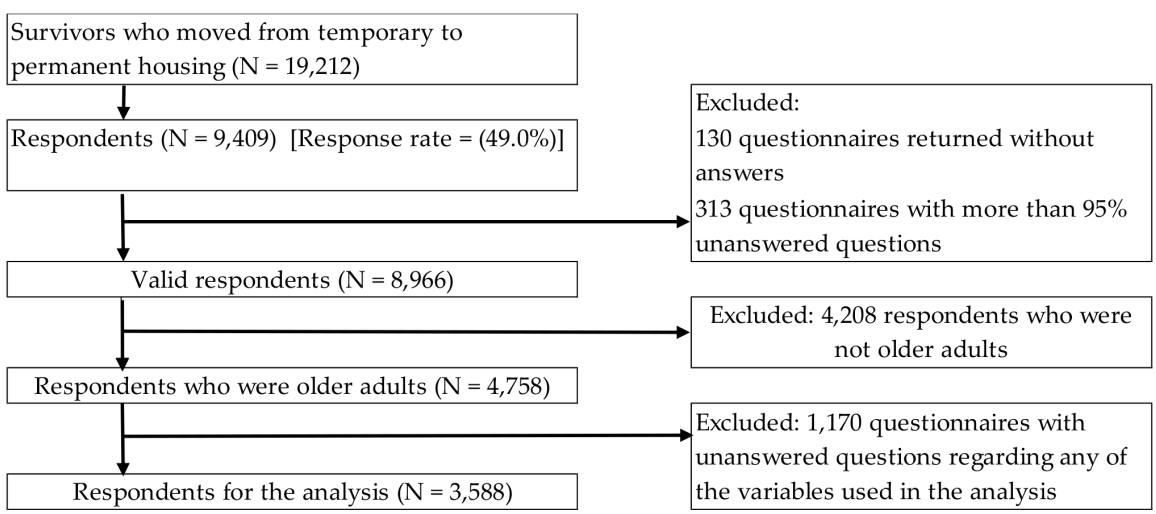

Fig. 1. The extraction process of the analysed respondents.

former, the participants were asked whether they could consult with their family, friends, or neighbors. As previous studies have addressed spouses, boyfriends, and romantic partners as confidants (Cohen and Wills 1985; Degarmo and Forgatch 2012), this study asked about relationship with a family's confidant. We also considered the fact that a buffering effect on mental health when using friends and neighbors as a confidant has been shown in women (Cohen and Wills 1985), and that in older men, trusting relationships with friends may have a weak influence on depression after the Kumamoto earthquake (Sato et al. 2020). Concerning the latter, the participants were asked whether they engaged in events and social activities held in the community on three levels: (1) "Yes, I participate in them;" (2) "No, I do not participate in them;" and (3) "I do not have information on these events." Among older survivors in Mifune-town after the Kumamoto earthquake, pre-earthquake informal socializing and community-level social participation, which represent structural social capital, significantly increased women's risk of depression (Sato et al. 2020). High community participation was also independently associated with a lower risk of psychological distress among women in a five-year cohort study of older Japanese (Amagasa et al. 2017). Referring to these previous studies, this study used consultants and community participation as explanatory variables.

Participants were asked about their category of temporary housing: prefabricated temporary housing; deemed temporary housing (private); and deemed temporary housing (public). After the Kumamoto earthquake, the government rented private apartments and operated them as deemed temporary housing.

Participants were asked on a 4-point scale (not at all, hardly ever, sometimes, and always) whether they sometimes felt isolated from other people. As we asked respondents about their perceptions of their relationships with members of social networks and perceived integration in social networks (Taylor et al. 2018), in this analysis, "never" and "hardly ever" were defined as "no subjective social isolation," while "sometimes" and "always" were defined as "experiencing subjective social isolation."

Self-rated health is an indicator of an individual's overall health status. In the National Survey of Living Conditions and the National Health and Nutrition Survey, the question, "How is your current health condition?" was answered using the options: 1 = very good, 2 = good, 3 = somewhat good, 4 = somewhat bad, 5 = bad, and 6 = very bad (Wada et al. 2015). In the analysis, "very good," "good" and "somewhat good" were categorized as healthy and "somewhat bad," "bad" and "very bad" were categorized as not healthy.

Participants were asked to indicate, on a 3-point scale, the changes in their current social activities and opportunities for physical activity as compared to before the COVID-19 pandemic began. "Increased" and "unchanged" were defined as "no decrease in opportunities," and "decreased" as "decreased opportunities." Participants were also asked whether their income had decreased because of COVID-19. "Greatly decreased" and "slightly decreased" were defined as "income decreased," while "no decrease" was defined as "income did not decrease."

Participants were asked their age at the time of completing the questionnaire. Older adults are individuals aged 65 years and older, but this was further divided into the categories of younger older adults (65-74 years old) and senior older adults (75+ years). Participants were also asked whether they lived with someone and whether they had changed their primary school district because of relocation after the Kumamoto earthquake. In Japan, primary school districts are treated as neighborhood community units (Kanamori et al. 2021). Therefore, a change in primary school district implies separation from one's community. Information on gender was obtained from the registry of the earthquake survivors in Kumamoto City. In recent years, municipalities' efforts not to provide a gender statement unless there is a recognized reasonable cause has been spreading out of consideration for the LGBTQ+ community (Akashi City 2023). The same approach is applied in Kumamoto City (Kumamoto City 2023), and since gender can be confirmed in the survivor's ledger, we did not ask a new question in this survey form.

Data analysis

As research generally shows that women experience poor mental health after disasters, all analyses were stratified by gender. To examine the association between psychological distress and participants' demographics, tests of independence (χ-square test) were conducted for the full sample and thereafter separately for men and women. To examine the factors associated with psychological distress, multivariate logistic regression analyses were conducted separately for men and women, with the presence or absence of psychological distress as the dependent variable. The independent variables were age group, presence of cohabitants, temporary housing category, change in residential school district, subjective social isolation, self-rated health, community participation, types of people to consult with, reduced activity owing to COVID-19, and reduced income owing to COVID-19. Adjusted odds ratios (AORs) and 95% confidence intervals (95% CI) were used to examine the results. Variance inflation factor values were checked to confirm multicollinearity between the independent variables entered. Variable selection was by the forced entry method, and statistical significance was set at 5% two-sided. Hosmer–Lemeshow tests were conducted to assess the goodness of fit of the model. Missing values for each variable were excluded. SPSS Statistics 28.0 (IBM Corp., Armonk, NY, USA) was used for statistical analysis.

Results

From the 8,966 valid responses, 3,588 were analyzed

Table 1. The demographic characteristics of the analyzed respondents.

(N = 3,588)

	All		Men		Women	
	N	%	N	%	N	%
Gender						
Men	1,564	43.6	1,564	100.0	0	0.0
Women	2,024	56.4	0	0.0	2,024	100.0
Psychological distress (K6 ≧ 10)						
None	3,213	89.5	1,415	90.5	1,798	88.8
Yes	375	10.5	149	9.5	226	11.2
Age						
65-74	2,050	57.1	939	60.0	1,111	54.9
75+	1,538	42.9	625	40.0	913	45.1
Temporary housing						
Prefabricated housing	253	7.1	132	8.4	121	6.0
Deemed temporary housing in the private sector	3,109	86.6	1,341	85.7	1,768	87.4
Deemed temporary housing in the public sector	226	6.3	91	5.8	135	6.7
Current residence						
Owned house	2,123	59.2	958	61.3	1,165	57.6
Houses for rent	766	21.3	318	20.3	448	22.1
Public housing	541	15.1	226	14.5	315	15.6
Public housing for disaster	49	1.4	23	1.5	26	1.3
Hospitals and facilities	109	3.0	39	2.5	70	3.5
Change of school district						
None	2,350	65.5	1,038	66.4	1,312	64.8
Yes	1,135	31.6	483	30.9	652	32.2
I don’t know	103	2.9	43	2.7	60	3.0
Cohabitant						
Yes	2,717	75.7	1,251	80.0	1,466	72.4
None	871	24.3	313	20.0	558	27.6
Self-rated health						
Healthy	2,704	75.4	1,169	74.7	1,535	75.8
Not healthy	884	24.6	395	25.3	489	24.2
Community participation						
Yes	1,022	28.5	457	29.2	565	27.9
None	2,253	62.8	952	60.9	1,301	64.3
No information of such events	313	8.7	155	9.9	158	7.8
Subjective social isolation						
None	2,837	79.1	1,238	79.2	1,599	79.0
Yes	751	20.9	326	20.8	425	21.0
A family member as someone to consult with						
None	721	20.1	323	20.7	398	19.7
Yes	2,867	79.9	1,241	79.3	1,626	80.3
A friend as someone to consult with						
None	2,266	63.2	1,166	74.6	1,100	54.3
Yes	1,322	36.8	398	25.4	924	45.7
A neighbor as someone to consult with						
None	3,292	91.8	1,485	94.9	1,807	89.3
Yes	296	8.2	79	5.1	217	10.7
Decrease in activity opportunities owing to COVID-19 pandemic						
None	1,783	49.7	853	54.5	930	45.9
Yes	1,805	50.3	711	45.5	1,094	54.1
Decrease in income owing to COVID-19 pandemic						
None	2,633	73.4	1,066	68.2	1,567	77.4
Yes	955	26.6	498	31.8	457	22.6

K6, the Kessler psychological distress scale; COVID-19, coronavirus disease 2019.

(Fig. 1). The excluded 4,208 responses were from individuals who were not older adults and 1,170 responses that did not correspond to any of the variables used in the analysis. The participants' demographics are presented in Table 1. There were 1,564 (43.6%) men and 2,024 (56.4%) women, with a mean age of 74.61 ± 7.19 years (mean ± standard deviation, SD) (range 65-102 years).

The results of the cross-tabulation between the independent variables and psychological distress are presented in Table 2. Differences in the proportion of people with psychological distress according to gender were not statistically significant. Overall, the proportion of individuals with psychological distress was significantly higher in the late-aged population (men and women).

The results of the dichotomous logistic regression analysis are presented in Tables 3, 4 and 5. The Hosmer–Lemeshow test results were P ≧ 0.05; all variance inflation factor values were < 10. Logistic regression analysis revealed that age, female, residing in public housing, lower self-rated health, a lack of awareness of community events, subjective social isolation and decreased income owing to the COVID-19 pandemic were risk factors of psychological distress in the total sample in Table 3. Inversely, having a family member or a friend as someone to consult was identified as the buffering factors with the Adjusted Odds Ratio (AOR) less than 1. For men, a lack of awareness of school district change, lower self-rated health, subjective social isolation, having a friend as someone to consult with, and decreased income owing to the COVID-19 pandemic were significantly associated with psychological distress (Table 4). For women, older age group, public housing, lower self-rated health, no community participation, subjective social isolation, having a family member as someone to consult with, and decrease in income resulting from the COVID-19 pandemic were significantly associated with psychological distress (Table 5). Only in men, not knowing the change in school district was significantly associated with psychological distress: 0.27 [95% confidence interval (CI) = 0.08-0.89], as well as having a friend as someone to consult with was 0.50 (95% CI = 0.28-0.89). Only among women, the older age group, public housing, no community participation, and family member as a confidant were significantly associated with psychological distress. Among these associated factors, the existence of a family member as a confidant was identified as the buffering factor and AOR was 0.61 (95% CI = 0.42-0.88).

Discussion

To the best of our knowledge, this study is one of the few to identify gender differences in psychological distress and related factors in the older adult population four years after the Kumamoto earthquake in Japan. Overall, 10.5% of the participants experienced psychological distress. In the coastal town of Shichigahama in Miyagi Prefecture, 8% of residents whose houses were more than half destroyed by the tsunami experienced psychological distress (K6 ≧

Table 2. Univariate analysis of factors associated with psychological distress (K6 ≧ 10) in participants.

N = 3,588

	All (N = 3,588)					Men (N = 1,564)					Women (N = 2,024)				
	K6 < 10 (N = 3,213)		K6 ≧ 10 (N = 375)		P	K6 < 10 (N = 1,415)		K6 ≧ 10 (N = 149)		P	K6 < 10 (N = 1,798)		K6 ≧ 10 (N = 226)		P
	N	%	N	%		N	%	N	%		N	%	N	%	
Gender					0.112										
Men	1,415	90.5	149	9.5											
Women	1,798	88.8	226	11.2											
Age					< 0.001					0.007					< 0.001
65-74	1,879	91.7	171	8.3		865	92.1	74	7.9		1,014	91.3	97	8.7	
75+	1,334	86.7	204	13.3		550	88.0	75	12.0		784	85.9	129	14.1	
Temporary housing					< 0.001					< 0.001					0.078
Prefabricated housing	225	88.9	28	11.1		118	89.4	14	10.6		107	88.4	14	11.6	
Deemed temporary housing in the private sector	2,806	90.3	303	9.7		1,227	91.5	114	8.5		1,579	89.3	189	10.7	
Deemed temporary housing in the public sector	182	80.5	44	19.5		70	76.9	21	23.1		112	83	23	17.0	
Current residence					< 0.001					< 0.001					< 0.001
Owned house	1,957	92.2	166	7.8		890	92.9	68	7.1		1,067	91.6	98	8.4	

Houses for rent	669	87.3	97	12.7		280	88.1	38	11.9		389	86.8	59	13.2	
Public housing	449	83.0	92	17.0		190	84.1	36	15.9		259	82.2	56	17.8	
Public housing for disaster	39	79.6	10	20.4		18	78.3	5	21.7		21	80.8	5	19.2	
Hospitals and facilities	99	90.8	10	9.2		37	94.9	2	5.1		62	88.6	8	11.4	
Change of school district					< 0.001					0.025					0.001
None	2,143	91.2	207	8.8		954	91.9	84	8.1		1,189	90.6	123	9.4	
Yes	983	86.6	152	13.4		423	87.6	60	12.4		560	85.9	92	14.1	
I don't know	87	84.5	16	15.5		38	88.4	5	11.6		49	81.7	11	18.3	
Cohabitant					< 0.001					< 0.001					0.002
Yes	2,472	91.0	245	9.0		1150	91.9	101	8.1		1,322	90.2	144	9.8	
None	741	85.1	130	14.9		265	84.7	48	15.3		476	85.3	82	14.7	
Self-rated health					< 0.001					< 0.001					< 0.001
Healthy	2,590	95.8	114	4.2		1130	96.7	39	3.3		1,460	95.1	75	4.9	
Not healthy	623	70.5	261	29.5		285	72.2	110	27.8		338	69.1	151	30.9	
Community participation					< 0.001					< 0.001					< 0.001
Yes	958	93.7	64	6.3		433	94.7	24	5.3		525	92.9	40	7.1	
None	1,998	88.7	255	11.3		855	89.8	97	10.2		1,143	87.9	158	12.1	
No information of such events	257	82.1	56	17.9		127	81.9	28	18.1		130	82.3	28	17.7	
Subjective social isolation					< 0.001					< 0.001					< 0.001
None	2,702	95.2	135	4.8		1,196	96.6	42	3.4		1,506	94.2	93	5.8	
Yes	511	68.0	240	32.0		219	67.2	107	32.8		292	68.7	133	31.3	
A family member as someone to consult with					< 0.001					< 0.001					< 0.001
None	591	82.0	130	18.0		271	83.9	52	16.1		320	80.4	78	19.6	
Yes	2,622	91.5	245	8.5		1,144	92.2	97	7.8		1,478	90.9	148	9.1	
A friend as someone to consult with					< 0.001					< 0.001					< 0.001
None	1,988	87.7	278	12.3		1,037	88.9	129	11.1		951	86.5	149	13.5	
Yes	1,225	92.7	97	7.3		378	95.0	20	5.0		847	91.7	77	8.3	
A neighbor as someone to consult with					0.701					0.32					0.958
None	2,946	89.5	346	10.5		1341	90.3	144	9.7		1,605	88.8	202	11.2	
Yes	267	90.2	29	9.8		74	93.7	5	6.3		193	88.9	24	11.1	
Decrease in activity opportunities owing to COVID-19 pandemic					< 0.001					0.003					0.003
None	1,636	91.8	147	8.2		789	92.5	64	7.5		847	91.1	83	8.9	
Yes	1,577	87.4	228	12.6		626	88.0	85	12.0		951	86.9	143	13.1	
Decrease in income owing to COVID-19 pandemic					< 0.001					< 0.001					< 0.001
None	2,397	91.0	236	9.0		985	92.4	81	7.6		1,412	90.1	155	9.9	
Yes	816	85.4	139	14.6		430	86.3	68	13.7		386	84.5	71	15.5	

K6, the Kessler psychological distress scale; COVID-19, coronavirus disease 2019.

Table 3. Multivariate analysis of factors associated with psychological distress (K6 ≧ 10) in all participants.
(N = 3,588)

	All		
	AOR	95% CI	P
Age (ref: 65–74 years old)			
75+	1.46	1.13-1.90	0.004
Gender (ref: Men)			
Women	1.44	1.11-1.87	0.006
Temporary housing (ref: Deemed temporary housing in the public sector)			
Prefabricated housing	0.83	0.44-1.54	0.551
Deemed temporary housing in the private sector	0.82	0.53-1.26	0.359
Current residence (ref: owned house)			
Houses for rent	1.17	0.80-1.70	0.429
Public housing	1.55	1.01-2.37	0.046
Public housing for disaster	2.14	0.88-5.20	0.092
Hospitals and facilities	1.03	0.48-2.23	0.932
Change of school district (ref: none)			
Yes	0.77	0.55-1.08	0.131
I don't know	0.65	0.33-1.30	0.225
Cohabitant (ref: yes)			
None	0.81	0.59-1.12	0.204
Self-rated health (ref: healthy)			
Not healthy	5.45	4.20-7.07	< 0.001
Community participation (ref: yes)			
None	1.37	0.99-1.90	0.061
No information of such events	1.63	1.02-2.60	0.040
Subjective social isolation (ref: none)			
Yes	5.30	4.07-6.90	< 0.001
A family member as someone to consult with (ref: none)			
Yes	0.63	0.47-0.85	0.003
A friend as someone to consult with (ref: none)			
Yes	0.65	0.48-0.87	0.004
A neighbor as someone to consult with (ref: none)			
Yes	1.48	0.92-2.39	0.105
Decrease in activity opportunities owing to COVID-19 pandemic (ref: none)			
Yes	1.16	0.89-1.50	0.267
Decrease in income owing to COVID-19 pandemic (ref: none)			
Yes	1.81	1.38-2.38	< 0.001

K6, the Kessler psychological distress scale; AOR, Adjusted Odds Ratio; COVID-19, coronavirus disease 2019.

10) in 2015 (Kunii et al. 2022). The participants were residents who could not return to their homes from evacuation centers and were forced to move into temporary housing, and most of their homes were considered to have been more than half destroyed. Therefore, it is likely that the prevalence of psychological distress in the present study was equally high compared to residents who experienced tsunami damage (Kunii et al. 2022). According to the Comprehensive Survey of Living Conditions conducted in 2020 by the Ministry of Health, Labour and Welfare, the proportion of persons with K6 ≧ 10 was 6.6% among adults aged 65 years and older (Ministry of Health, Labour and Welfare 2023). The proportion of people with psychological distress in this study is assumed to be substantial compared to the unaffected peer group. Moreover, among the analyzed population, women had a higher prevalence of psychological distress than men; however, though a univariate analysis did not reveal statistical significance, a multivariate analysis yielded significance for gender. We inferred that this was probably due to the lower prevalence for both men and women compared to previous studies (Wang et al. 2017; Fu et al. 2021), and that the extent and trajectory of mental health recovery after disasters did not differ between men and women (Akerkar and Fordham

Table 4. Multivariate analysis of factors associated with psychological distress (K6 ≧ 10) in male participants.
(N = 1,564)

	Men		
	AOR	95% CI	P
Age (ref: 65-74 years old)			
75+	1.48	0.97-2.26	0.068
Temporary housing (ref: Deemed temporary housing in the public sector)			
Prefabricated housing	0.59	0.23-1.53	0.275
Deemed temporary housing in the private sector	0.52	0.26-1.03	0.059
Current residence (ref: owned house)			
Houses for rent	1.10	0.57-2.09	0.781
Public housing	1.14	0.55-2.34	0.731
Public housing for disaster	2.47	0.68-8.99	0.170
Hospitals and facilities	0.51	0.10-2.74	0.432
Change of school district (ref: none)			
Yes	0.71	0.41-1.24	0.226
I don't know	0.27	0.08-0.89	0.031
Cohabitant (ref: yes)			
None	0.93	0.53-1.63	0.796
Self-rated health (ref: healthy)			
Not healthy	6.45	4.16-10.00	< 0.001
Community participation (ref: yes)			
None	1.08	0.62-1.87	0.785
No information of such events	1.69	0.82-3.51	0.157
Subjective social isolation (ref: none)			
Yes	7.90	5.09-12.25	< 0.001
A family member as someone to consult with (ref: none)			
Yes	0.62	0.38-1.04	0.069
A friend as someone to consult with (ref: none)			
Yes	0.50	0.28-0.89	0.019
A neighbor as someone to consult with (ref: none)			
Yes	1.12	0.37-3.34	0.842
Decrease in activity opportunities owing to COVID-19 pandemic (ref: none)			
Yes	1.15	0.76-1.73	0.513
Decrease in income owing to COVID-19 pandemic (ref: none)			
Yes	2.07	1.35-3.17	0.001

K6, the Kessler psychological distress scale; AOR, Adjusted Odds Ratio; COVID-19, coronavirus disease 2019.

2017; Fu et al. 2021), as gender differences tend to shrink in older age (Kiely 2019).

The odds ratio for subjective social isolation was high for all respondents. The impact of objective isolation on mental health has been addressed in disaster survivors. Two years after GEJE, objective social isolation measured using the Luben Social Network Scale 6 (LSNS6) was significantly associated with depressive symptoms measured using the Center for Epidemiologic Studies Depression Scale (CES-D) (Kotozaki et al. 2021). However, this study showed that subjective social isolation was also associated with psychological distress among disaster survivors. A national survey of older people across the US and in Japan found that subjective social isolation was significantly associated with psychological distress as measured by the K6 in both men and women (Sakurai et al. 2010; Taylor et al. 2018). After moving from temporary housing, where communication with neighbors was easier, to permanent apartment-type housing, survivors of GEJE complained more about loneliness and showed worsening mental health (Kunii et al. 2022). Moreover, there are concerns that deemed temporary housing could have easily isolated the survivors of the Kumamoto earthquake, as they moved in through individual relocation rather than community unit relocation (Nihon Keizai Shimbun 2019). In this study, participants living in general public housing and public housing for disasters were also more likely to feel isolated as they were cut off from their pre-earthquake and tempo-

Table 5. Multivariate analysis of factors associated with psychological distress (K6 ≧ 10) in female participants. (N = 2,024)

	Women		
	AOR	95% CI	P
Age (ref: 65-74 years old)			
75+	1.46	1.04-2.05	0.029
Temporary housing (ref: Deemed temporary housing in the public sector)			
Prefabricated housing	1.00	0.44-2.37	0.933
Deemed temporary housing in the private sector	1.09	0.62-1.94	0.762
Current residence (ref: owned house)			
Houses for rent	1.14	0.70-1.84	0.601
Public housing	1.79	1.04-3.06	0.034
Public housing for disaster	1.82	0.55-6.04	0.325
Hospitals and facilities	1.29	0.54-3.12	0.569
Change of school district (ref: none)			
Yes	0.83	0.54-1.27	0.387
I don't know	1.09	0.47-2.53	0.848
Cohabitant (ref: yes)			
None	0.78	0.53-1.15	0.209
Self-rated health (ref: healthy)			
Not healthy	5.26	3.79-7.32	< 0.001
Community participation (ref: yes)			
None	1.52	1.00-2.30	0.048
No information of such events	1.47	0.79-2.74	0.226
Subjective social isolation (ref: none)			
Yes	4.24	3.03-5.95	< 0.001
A family member as someone to consult with (ref: none)			
Yes	0.61	0.42-0.88	0.009
A friend as someone to consult with (ref: none)			
Yes	0.72	0.51-1.03	0.068
A neighbor as someone to consult with (ref: none)			
Yes	1.65	0.97-2.81	0.065
Decrease in activity opportunities owing to COVID-19 pandemic (ref: none)			
Yes	1.15	0.82-1.61	0.417
Decrease in income owing to COVID-19 pandemic (ref: none)			
Yes	1.65	1.15-2.38	0.007

K6, the Kessler psychological distress scale; AOR, the Adjusted Odds Ratio; COVID-19, coronavirus disease 2019.

rary communities, which may have been associated with worsening mental health. More attention needs to be paid to the link between survivors' subjective social isolation and psychological distress.

Lack of community involvement was significantly associated with a higher risk of psychological distress only among women. In a study conducted in Mifune-town, higher social cohesion measured before the Kumamoto earthquake, which represents cognitive social capital, was associated with a lower risk of depression among older women immediately after the disaster (Sato et al. 2020). In addition, among women in flood-affected areas in the UK, a sense of emotional well-being through caring relationships with neighbors predicted mental health recovery (Akerkar and Fordham 2017). Inadequate involvement in neighborhood activities among middle-aged and older people in Germany was associated with perceptions of social isolation only among women (Hajek et al. 2023). In the present study, it is likely that women who did not participate in neighborhood activities after a disaster were at higher risk of psychological distress owing to the lack of a buffer effect through communication and mutual help with neighbors. Furthermore, the risk of psychological distress was lower among women whose family members were their advisers. This is supported by the finding that in older people, family cohesion acts as a buffer and lowers psychological distress (Park et al. 2022). The current study suggests that participation in community activities and

caring relationships with family members may be factors that lower post-disaster psychological distress among older women.

In contrast, for men, not knowing whether the school district had changed and having a friend to talk to were associated with a lower risk of psychological distress after the disaster in Table 4. Compared to women's wider neighborhood associations and social networks (Akerkar and Fordham 2017), men tend to be connected mainly with friends, such as colleagues (Moore 1990), and participate less in community activities than women (DiBello et al. 2020). While women have been reported to increase their contact with neighbors to help each other after a disaster, the same is not the case with men, who are reported to be content with their friends from before the disaster and stabilizing their mental health mainly through self-control rather than social relationships (Akerkar and Fordham 2017). Moreover, the men's community-neighborhood boundaries are considered to be smaller including a block in the very proximity of their home, compared to women's larger boundaries, which includes several avenues and streets (Akerkar and Fordham 2017). The men in this study may have responded similarly to the aforementioned strategies of male survivors, perhaps caring less about the change in social relationships and neighborhoods as long as they sustain control of their lives. This study highlights new factors regarding the buffers of post-disaster psychological distress in older adults and reinforces previous findings on gender differences.

Finally, reduced income owing to COVID-19 was associated with a higher risk of psychological distress in both men (2.07) in Table 4 and women (1.65) in Table 5. The experience of job loss and lower subjective economic status appear to have a lingering effect on the risk of sleep disturbance and the persistence of PTSS (Katayanagi et al. 2020; Kikuchi et al. 2020). This study confirms previous findings of an association between perceived economic deterioration in individuals and poor mental health in affected older adults.

Based on these findings in relation to social factors for post-disaster psychological distress, it is necessary to design measures based on gender differences in the future. As participation in community activities may prevent post-disaster psychological distress among older women, it is important to encourage community participation with the help of the government and volunteers. Furthermore, as communication in the community may be limited by age and residence, it is necessary to design programs that take diversity among older women into account. Among older men, maintaining friendships, even if community relations are weak, may buffer psychological distress after a disaster. Therefore, to enable groups to continue their activities in the community through work or hobbies after a disaster, the government should provide inexpensive space to rent and information on how to obtain funding for activities.

There are some limitations to this study. First, this study was limited to survivors of the Kumamoto earthquake, and the results may not be applicable to all earthquake survivors. Second, as this was a cross-sectional study, it was not possible to make causal inferences. With regard to psychological distress, no baseline measurements were taken before the Kumamoto earthquake. In addition, the survey did not determine the presence or absence of past trauma. Longitudinal studies are required to explain these causal relationships. Third, there may be other important determinants in addition to the variables incorporated in the model used in this study. Fourth, our measurement of sociability does not provide sufficient insights in comparison with previous studies, as it does not measure objective social participation using scales such as the LSNS-6. Lastly, our study revealed the explanatory variables that were statistically significantly associated with lower K6, "friends to talk to" for men, "family members to talk to" and "community participation" for women, which is generally associated with mental health even if they are not disaster survivors. Therefore, the design of this study does not allow us to determine whether these variables are protective for older people in general or specifically protective for those who have experienced a disaster. Owing to these limitations, the results should be interpreted with caution.

In conclusion, despite the limitations cited above, we clarified gender differences in psychological distress and related factors among Kumamoto earthquake survivors four years after the disaster. The study provides basic knowledge for planning future support after disasters.

Acknowledgments

This study was supported by the FY2022 Kumamoto University Academic English Paper Editing Support (6090ru2022) and FY2022 Kumamoto University SDGs Grants (21801510).

Author Contributions

A.I.O., S.T. and K.T. conceived the research questions. A.I.O. and S.T. contributed to the design of the research protocol and the development of the questionnaire. A.I.O., M.H. and Y.K. conducted the statistical analysis. A.I.O. drafted the initial manuscript in collaboration with H.M. All authors revised and approved the final manuscript.

Conflict of Interest

The authors declare no conflict of interest.

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