

Beneficial Roles of Social Support for Mental Health Vary in the Japanese Population depending on Disaster Experience: A Nationwide Cross-Sectional Study

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The purpose of the present study was to assess the effects of social capital on mental health among the Japanese population with or without natural disaster experience. A nationwide cross-sectional study was performed in the population aged 15 to 79 years old. We collected data on psychological status, social capital, disaster experience in ten years prior to the survey, and socio-demographic information. We assessed cognitive social capital (perceptions of support, reciprocity and trust), social support (support from individuals in the community), and social participation (participation in social activities) as components of social capital. The study outcome was mild mood or anxiety disorder (hereafter mood/anxiety disorder), defined as the score of 5 or higher in the Kessler Psychological Distress Scale (K6). Using logistic regression models, we tested whether each component of social capital was associated with mood/anxiety disorder with or without disaster experience. Out of 1,200 participants, 1,183 had available K6 score data and were considered. Among three components of social capital, only social support significantly interacted with disaster experience ($p = 0.019$). In the population without disaster experience, those with high social support were less likely to have mood/anxiety disorder (OR 0.45, 95% CI 0.28-0.73); however, no such association was observed among those with disaster experience (OR 1.11, 95% CI 0.64-1.90). Thus, the protective effects of social support against mood/anxiety disorder vary in the Japanese population depending on disaster experience. The present study provides important insight into the role of social capital on mental health after natural disaster.

Keywords: disaster; Japan; mental health; social capital; social support

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Introduction

Social capital is defined as resources that can be accessed from network or a group individuals belong to (Kawachi and Berkman 2014). Numerous studies have been performed to test for associations between social capital and multiple health outcomes including physical health (Yamaoka 2008; Inoue et al. 2013), mental health (De Silva et al. 2007), and health-related behaviors (Aslund and Nilsson 2013). In such approaches, social cohesion is the most common way to define social capital for public health

studies (Kawachi and Berkman 2014). Through the social cohesion perspective, social capital is classified into cognitive (perceptions of support, reciprocity and trust) and structural components (participation in social activities and support from individuals in the community), based on their distinct effects on health outcomes (Harpham et al. 2002; De Silva et al. 2007). Further, individual-level social capital is reported to exert more significant protective effects on health outcomes compared with that as a property of group of individuals (e.g. neighborhood, community, or workplace), also known as community-level social capital (Inoue

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et al. 2013).

Mental health has become a major research topic in social capital studies (De Silva et al. 2005). Namely, natural disasters are important research contexts for these type of studies (Noel et al. 2018). In the aftermath of disasters, the mental health of affected residents can be severely impaired. Victims can develop posttraumatic stress disorder, major depressive disorder, substance use disorder, and other psychological symptoms (e.g., generalized anxiety disorder and prolonged grief disorder) both in short- and long-term disaster aftermath (McFarlane and Williams 2012; Goldmann and Galea 2014). Further, disruption of social networks and loss of communal and individual resources can occur in disasters (Goldmann and Galea 2014), possibly devastating existing social capital in the affected communities. With the progress of climate change and population expansion (McFarlane and Williams 2012), the potential for natural disasters has been consistently on the rise. Thus, it is increasingly imperative to decipher the associations between social capital and mental health in post-disaster context.

There is an accumulating evidence body for social capital and post-disaster mental health. Cognitive social capital is consistently suggested to exert protective effect on post-disaster mental health (Hikichi et al. 2016; Tsuchiya et al. 2017). However, the findings for structural social capital are rather inconsistent: while this component is protective in some settings (Matsubara et al. 2014; Nakamura et al. 2014), it may impair mental health in other settings (Wind et al. 2011). Several hypotheses for this phenomenon have been proposed, such as contagion of effect and inverse relationships (Wind et al. 2011; Noel et al. 2018). An unanswered question is whether the effects of social capital on mental health could differ with or without previous disaster experience. The majority of previous studies only assessed the population who went through disasters and did not include those not exposed to disasters (Noel et al. 2018). Given the likelihood of increased mental health burdens in post-disaster contexts, the role that social capital may have in post-disaster mental health, and potential differences in the relationship between social capital and mental health in disaster and non-disaster affected populations, are critical subjects to elucidate through further research.

Japan is well-known for the catastrophic damage of the 2011 triple disaster (earthquake, tsunami, and nuclear disaster) (Ishigaki et al. 2013). The country has been repeatedly affected by various types of major natural disasters, including typhoons, flooding, landslides, earthquakes, and volcano eruptions. Part of the population has thus experienced natural disasters, and mental health has been a major topic in post-disaster studies (Matsubara et al. 2014; Nakamura et al. 2014; Hikichi et al. 2016; Tsuchiya et al. 2017). The aim of the present study was to assess whether the effects of social capital on mental health could differ between those who had previously experienced disasters and those who had not.

Methods

Study design, setting, and participants

A nation-wide cross-sectional survey was conducted in Japan in the year 2015, four years after the Great East Japan Earthquake and the subsequent tsunami. The target of this study was people aged 15 to 79 years who lived in Japan as of the start of the survey. Multi-stage sampling was applied to select study participants. First, 200 areas were selected as sampling units by stratified random sampling from the whole nation, which was stratified into 9 geographical blocks and 4 urban scales based on official census data. In each of the selected areas, we selected six participants. To achieve representativeness of participants, we systematically extracted six households from each of the selected areas using a residential map database as sampling frame, and recruited one participant from each household. The recruitment of the participants continued until its total number reached 1,200, under the concept of quota sampling. Although an accurate response rate of the survey is not available because of the sampling method, approximately half of those who received the printed questionnaire agreed to participate in the survey.

A previous study reported that the prevalence of mood or anxiety disorder (hereafter mood/anxiety disorder) screened by the Kessler Psychological Distress Scale (K6) among Japanese was 31.1% (Sakurai et al. 2011). We expected to detect a 10% absolute difference in having mood/anxiety disorder among those who had high social capital compared to those who had low social capital among 1,000 participants with 5% significance level (two tailed) and 80% power.

Data collection

The data were collected by the drop-off pick-up method. Participants filled in the printed structured questionnaire. The questionnaire was developed to collect data on psychological status, social capital, disaster experience, socio-demographic information, and trust toward governmental and private organizations and media.

The presence of mood/anxiety disorder was assessed through the self-administered Japanese version of the K6. The K6 consists of six questions that assess depressive mood and anxiety over the past month. Each of the K6 questions is rated from 0 (= "none of the time") to 4 (= "all of the time"), and the total score ranges from 0 (no psychological distress) to 24 (severe psychological distress). Disasters can impair mental health (McFarlane and Williams 2012; Goldmann and Galea 2014), and we estimated that the K6 could indicate mental distress following previous disasters. As we were interested in mild mood/anxiety disorder among the general population, a score of 5 was used as a cut-off value for this study, following the threshold generally used for the mild mood/anxiety disorder (Prochaska et al. 2012).

Social capital consists of cognitive and structural components, and the structural component can be measured by social participation and social support (De Silva et al. 2007). In the present study, cognitive social capital was measured by asking about perception of fairness, trust and reciprocity toward the community a participant belonged to (De Silva et al. 2007). It was categorized as low for those who had a positive perception in none or only one of fairness, trust and reciprocity, middle for those who had a positive perception in two of these three factors, and high for those who had positive perception in all three. Social support was measured by asking if a participant had anyone who would give him/her physical or financial

support, who would understand his/her feelings, who would casually meet and talk, who would respect him/her and who would give him/her advice and information. Social support was categorized as high if a participant had someone who would support him/her in all five areas, and otherwise categorized low. Social participation was measured by asking the number of informal and formal organizations a participant belonged to, when participants answered the survey.

Disaster experience was measured by asking whether participants experienced any natural disasters in the past ten years, regardless of the type and severity of disasters. We restricted the type of disasters to natural disasters, as natural disasters have been a predominant focus in previous studies for social capital and mental health (Noel et al. 2018).

Data analysis

First, we conducted a confirmatory factor analysis and calculated Cronbach's alpha to confirm the validity of pre-determined definitions for social capital (social support and cognitive social capital) and trusting organizations (Table 1). We then examined the distribution of each variable among study participants. Using univariate and multivariate logistic regression models, we calculated the association between the outcome and social capital, and that between the outcome and disaster experience. Moreover, to examine whether any association between types of social capital (cognitive social capital, social support and social participation) and mood/anxiety disorder differed between those who had experienced disasters and those who had not, we further tested the interaction between social capital and disaster experience. We thereby estimated the stratum specific odds ratios of having mood/anxiety disorder with and without disaster experience. Stepwise method with inclusion and exclusion criteria of 0.2 respectively was used for variable selection. Effects of missing data were examined using multiple imputation method under the missing at random assumption as a sensitivity analysis. Sensitivity analysis using K6 score cut-off values of 9 and 13 were also performed to examine moderate and severe mood/anxiety disorder, respectively. Confirmatory factor analysis was performed using SAS/STAT 9.4 (SAS Institute Inc., NC, USA). All other analyses were done using STATA/IC 14.0 (StataCorp LLC, TX, USA).

Ethics approval

We conducted this study as a part of omnibus survey performed by the Nippon Research Center. The Nippon Research Center is a research agency that complies with "ISO 20252 Market • Public Opinion, Social Survey - Terms and Service Requirements", which is an international standard dedicated to survey established by ISO (International Organization for Standardization). This organization is also a member of the Japan Marketing Research Association, and all surveys including the present one were planned and conducted following the General Principle of Marketing Research, published by Japan Marketing Research Association (Japan Marketing Research

Association 2017). This Code establishes ethical and professional behavioral guidelines and complies with the Personal Information Protection Law and the marketing research policy. For these reasons, the authors' affiliations withdrew the review of the study, and as such, the authors did not obtain ethical approval from their individual affiliations. The General Principle of Marketing Research is available only in Japanese. Instead, the ICC (International Chamber of Commerce) /ESOMAR (European Society for Opinion and Marketing Research) Code (International Chamber of Commerce and European Society for Opinion and Marketing Research 2016), which the Nippon Research Center follows and became the foundation of the General Principle of Marketing Research, is available in English.

Results

In total, 1,200 participants answered the questionnaire. Data on K6 were available for 1,183 (98.6%) people, who were included in analyses. Among the 1,183 respondents, 313 (26.5%) were categorized as having mild mood/anxiety disorder (Table 2), a prevalence which was similar to a previous report (Sakurai et al. 2011). With respect to variables related to social capital, 209 (17.7%) were categorized as having high cognitive social capital, 474 (40.1%) as having high social support, and 444 (37.5%) belonged to at least one formal or informal organization. Among the 1,183 respondents, 367 (31.0%) people experienced at least one natural disaster in ten years prior to the survey. With respect to sociodemographic factors, the mean age of participants was 48.2 years (standard deviation (SD) 17.8 years), and about half of the participants were female (50.4%). Among the 900 participants who reported their annual income, 583 participants (64.8%) had an annual income of less than 5 million yen, an amount which was approximately in the same range as the national average salary in Japan (4 million yen in 2013) (National Tax Agency of Japan 2016).

In results of the univariate logistic model for mild mood/anxiety disorder (Table 3), participants with high (odds ratio (OR) 0.55, 95% confidence interval (CI) 0.37-0.81) or middle (OR 0.56, 95% CI 0.42-0.75) cognitive social capital were less likely to have mild mood/anxiety disorder compared to those with low cognitive social capital. Those with high social support appeared to be less likely to have mild mood/anxiety disorder compared with those with low social support, but it was not statistically significant (OR 0.79, 95% CI 0.57-1.10). Participants were slightly more likely to have mild mood/anxiety disorder when the value of social participation increased from none

Table 1. Findings of confirmatory factor analysis (comparative factor index and adjusted goodness of fit index) and Cronbach's alpha for social capital (social support and cognitive social capital) and trusting organizations.

	Social Support	Cognitive social capital	Trusting organizations
Comparative factor index	0.99	1.00	0.75
Adjusted goodness of fit index	0.98	Not applicable	0.74
Cronbach's alpha	0.86	0.66	0.89

Table 2. Participant characteristics (N = 1,183).

	Number (%)
Presence of mild mood/anxiety disorder (K6 score 5 or more)	
Yes	313 (26.5)
No	870 (73.5)
Cognitive social capital	
Low	363 (30.7)
Middle	605 (51.1)
High	209 (17.7)
Missing	6 (0.5)
Social support	
Low	300 (25.4)
High	474 (40.1)
Missing	409 (34.5)
Social participation (No. of organizations)	
None	736 (62.2)
One	282 (23.8)
Two or more	162 (13.7)
Missing	3 (0.3)
Disaster experience	
Yes	367 (31.0)
No	810 (68.5)
Missing	6 (0.5)
Age (years), mean [standard deviation]	
	48.2 [17.8]
Less than 35	291 (24.6)
35-44	237 (20.0)
45-64	371 (31.4)
65 or more	284 (24.0)
Sex	
Male	587 (49.6)
Female	596 (50.4)
Educational attainment	
Primary/Secondary school	613 (51.8)
High school/Vocational training school	258 (21.8)
University and above	302 (25.5)
Missing	10 (0.9)
Annual income (JPY)	
Less than 3.0 million	209 (17.7)
3.0-4.9 million	374 (31.6)
5.0-6.9 million	181 (15.3)
7.0 million or more	136 (11.5)
Missing	283 (23.9)
Number of trusted organizations	
Less than 5	175 (14.8)
5-8	255 (21.6)
9 or more	753 (63.7)

K6, Kessler Psychological Distress Scale; JPY, Japanese Yen.

to one (OR 1.17, 95% CI 0.86-1.58) and from none to two or more (OR 1.01, 95% CI 0.69-1.49). Further, disaster experience was significantly associated with mild mood/anxiety disorder (OR 1.55, 95% CI 1.18-2.04).

We fit all variables in a logistic regression model among the 590 participants with complete data (Table 3). Between them and the rest of the population (593), no significant differences were observed in the proportion of mild mood/anxiety disorder, high social support, or disaster experience (Table 4). In the model, compared to those with low cognitive social capital, those with middle (OR 0.49, 95% CI 0.31-0.75) and high (OR 0.58, 95% CI 0.33-1.02) cognitive social capital were less likely to have mild mood/anxiety disorder, respectively. Similarly, those with high social support were less likely to have mild mood/anxiety disorder compared to those with low social support (OR 0.62, 95% CI 0.42-0.93). Those who had previously experienced disasters were more likely to have mild mood/anxiety disorder compared to those who had not (OR 1.66, 95% CI 1.10-2.48). Variation inflation factor of the covariates was acceptable, ranging from 1 to 2. Similar results were observed by the analysis using multiple imputation method (Table 3) and in the models for moderate and severe mood/anxiety disorder (Table 5).

Among cognitive social capital, social support, and social participation, social support was the only factor which interacted with disaster experience in the effect on the likelihood of having mild mood/anxiety disorder ($p = 0.019$, the likelihood ratio test for interaction) (Table 6). Among participants without disaster experience, those with high social support were less likely to have mild mood/anxiety disorder compared with those with low social support (OR 0.45, 95% CI 0.28-0.73). However, among those with disaster experience, it appeared that those with high social support were not less likely to have mild mood/anxiety disorder, compared with those with low social support (OR 1.11, 95% CI 0.64-1.90). This suggests that disaster experience may work as a potential effect modifier for the association between social support and mood/anxiety disorder. The estimates were almost the same with results of multivariate analyses with imputed data (Table 6). In the model for moderate and severe mood/anxiety disorder (Table 7), social support appeared to be protective against the condition among both disaster-affected and non-affected populations.

Discussion

In this nationwide cross-sectional analysis, we found that the association between social support and mild mood/anxiety disorder among the general Japanese population may differ by experience or lack of experience of a natural disaster in the prior decade. In the population without disaster experience, those with high social support were less likely to have mild mood/anxiety disorder compared with their counterpart. However, no such association was observed among those with disaster experience.

Given the inconsistent results between mild and moderate or worse mood/anxiety disorders, an interpretation of the observed findings warrants some caution. However, the cut-off value of 5 for K6 scores is reported to be more sensitive in the detection of mild mood/anxiety disorder among the Japanese general population, compared with that of 9 (Sakurai et al. 2011). Thus, results obtained using the cut-off values of 9 or higher may not have been able to fully reflect any effect of disasters on protective effects of social capital on mild mood/anxiety disorder, a primary aim of the present study. Further, the observed findings for mild mood/anxiety disorder were consistent with the previous evidence, which indicated how the extent of disaster damage (e.g., house destruction, and loss of property or important others) could alter the effects of social capital on post-disaster mental health within victims (Wind et al. 2011; Matsubara et al. 2014; Nakamura et al. 2014; Hikichi et al. 2016; Tsuchiya et al. 2017). As such, we assume that it is reasonable to carry out the discussion based on the results of our main analyses for mild mood/anxiety disorder.

The primary novelty of this study is the inclusion of a population who did not previously experience natural disasters. Previous studies were performed only in disaster-affected communities (Noel et al. 2018), and did not include non-affected populations as a control. As such, it has been difficult to understand any variation in relationships between social capital and mental health between those with or without disaster experience. In contrast, our nationwide survey included both a population who had experienced disasters in the past ten years (regardless of type or severity) and those who had not. As a result, the study enabled us to address previously-unanswered, but important questions.

Three explanations could be possible for a decline in the protective effects of social capital on mild mood/anxiety disorder in post-disaster contexts. The first explanation for this would be contagions of stress (Wind et al. 2011). When one individual is exposed to stressful events, negative feelings could easily spread among those who are in close social networks, and increase their feeling of anxiety (Wind et al. 2011). It has been previously suggested that such a phenomenon could be more widely observed in disaster settings compared with non-disaster setting (Wind et al. 2011). One reason for a spread of anxiety in disaster settings could be worsened anxiety among disaster victims (Goldmann and Galea 2014). Disasters are unpredictable, and are difficult to prevent or control, a situation that could deliver a sense of helplessness among the affected population. Indeed, in our study, participants with disaster experience were more likely to experience mood/anxiety disorder compared to those without such experience. Second, the nature of social support may have changed among disaster victims. The main sources of social support may have been families and neighbors, yet disasters could have changed disaster victims' relationships with families and neighbors, as a result of evacuation and/or relocation (Koyama et al.

Table 3. Unadjusted and adjusted odds ratios of mild mood/anxiety disorder related to social capital, disaster experience and socio-economic factors.

	Univariate analysis (N = 1,183) ¹	Multivariate analysis with complete data (N = 590) ^{1,2,3}	Multivariate analysis with imputed data (N = 1,200) ²
	Unadjusted OR (95% CI)	Adjusted OR (95% CI)	Adjusted OR (95% CI)
Cognitive social capital			
Low	1.00	1.00	1.00
Middle	0.56 (0.42-0.75)	0.49 (0.31-0.75)	0.58 (0.43-0.78)
High	0.55 (0.37-0.81)	0.58 (0.33-1.02)	0.61 (0.40-0.92)
Social support			
Low	1.00	1.00	1.00
High	0.79 (0.57-1.10)	0.62 (0.42-0.93)	0.77 (0.53-1.13)
Social participation (No. of organizations)			
No	1.00	1.00	1.00
One	1.17 (0.86-1.58)	1.31 (0.83-2.04)	1.30 (0.95-1.80)
Two or more	1.01 (0.69-1.49)	1.70 (0.94-3.08)	1.32 (0.86-2.02)
Disaster experience			
No	1.00	1.00	1.00
Yes	1.55 (1.18-2.04)	1.66 (1.10-2.48)	1.51 (1.14-2.00)
Age (years)			
Less than 35	1.00	1.00	1.00
35-44	0.84 (0.58-1.23)	1.39 (0.77-2.51)	0.89 (0.60-1.32)
45-64	0.62 (0.44-0.88)	0.63 (0.36-1.09)	0.65 (0.45-0.93)
65 or more	0.63 (0.44-0.92)	0.68 (0.37-1.23)	0.65 (0.44-0.98)
Sex			
Male	1.00	1.00	1.00
Female	1.10 (0.85-1.42)	1.28 (0.81-2.01)	1.02 (0.73-1.43)
Annual income (JPY)			
Less than 3.0 million	1.00	1.00	1.00
3.0-4.9 million	0.74 (0.51-1.07)	0.95 (0.57-1.57)	0.77 (0.51-1.16)
5-6.9 million	0.63 (0.40-0.99)	0.68 (0.34-1.33)	0.61 (0.35-1.06)
7.0 million or more	0.70 (0.43-1.14)	0.80 (0.39-1.66)	0.67 (0.37-1.22)
Number of trusted organizations			
Less than 5	1.00	1.00	1.00
5-8	0.66 (0.43-1.00)	0.76 (0.42-1.37)	0.74 (0.48-1.15)
9 or more	0.64 (0.45-0.91)	0.79 (0.47-1.32)	0.69 (0.47-0.99)

OR, odds ratio; CI: confidence interval; JPY, Japanese Yen.

¹Missing data were excluded.

²Adjusted for all other variables in the table.

³Log likelihood = -321.63.

Table 4. Participants' characteristics with or without inclusion in the complete case analysis.

	Participants included in complete cases analysis (N = 590) number (%)	Participants not included in complete case analyses (N = 593) number (%)	p-value
Presence of mild mood/anxiety disorder (K6 score 5 or more)			0.989
Yes	156 (26.4)	157 (26.5)	
No	434 (73.6)	436 (73.5)	
Cognitive social capital			< 0.001
Low	157 (26.6)	206 (35.1)	
Middle	307 (52.0)	298 (50.8)	
High	126 (21.4)	83 (14.1)	
Social support			0.688
Low	231 (39.2)	69 (37.5)	
High	359 (60.9)	115 (62.5)	
Social participation (No. of organizations)			0.028
None	346 (58.6)	390 (66.1)	
One	157 (26.6)	125 (21.2)	
Two or more	87 (14.8)	75 (12.7)	
Disaster experience			0.316
Yes	176 (29.8)	191 (32.5)	
No	414 (70.2)	396 (67.5)	
Age (years), mean [standard deviation]	49.3 [16.6]	47.1 [18.8]	0.0330
Less than 35	121 (20.5)	170 (28.7)	0.005
35-44	121 (20.5)	116 (19.6)	
45-64	206 (34.9)	165 (27.8)	
65 or more	142 (24.1)	142 (24.0)	
Sex			< 0.001
Male	329 (55.8)	258 (43.5)	
Female	261 (44.2)	335 (56.5)	
Educational attainment			0.029
Primary/Secondary school	290 (49.2)	323 (55.3)	
High school/Vocational training school	128 (21.7)	130 (22.3)	
University and above	171 (29.0)	131 (22.4)	
Annual income (JPY)			0.044
Less than 3.0 million	126 (21.4)	83 (26.8)	
3.0-4.9 million	246 (41.7)	128 (41.3)	
5.0-6.9 million	116 (19.7)	65 (21.0)	
7.0 million or more	102 (17.3)	34 (11.0)	
Number of trusted organizations			< 0.001
Less than 5	103 (17.5)	72 (12.1)	
5-8	156 (26.4)	99 (16.7)	
9 or more	331 (56.1)	422 (71.2)	

K6, Kessler Psychological Distress Scale; JPY, Japanese Yen.

Table 5. Adjusted odds ratios of moderate and severe mood/anxiety disorder related to social capital, disaster experience and socio-economic factors.

	Moderate mood/anxiety disorder Multivariate analysis with complete data (N = 590) ^{1,2,3} OR (95% CI)	Severe mood/anxiety disorder Multivariate analysis with complete data (N = 590) ^{1,2,4} OR (95% CI)
Cognitive social capital		
Low	1.00	1.00
Middle	0.51 (0.27-0.96)	0.46 (0.15-1.38)
High	0.62 (0.26-1.45)	0.47 (0.08-2.67)
Social support		
Low	1.00	1.00
High	0.59 (0.33-1.08)	0.43 (0.15-1.20)
Social participation (No. of organizations)		
None	1.00	1.00
One	1.54 (0.81-2.92)	1.75 (0.58-5.27)
Two or more	1.15 (0.43-3.02)	2.35 (0.47-11.67)
Disaster experience		
No	1.00	1.00
Yes	3.64 (2.04-6.51)	3.42 (1.25-9.35)
Age (years)		
Less than 35	1.00	1.00
35-44	0.63 (0.27-1.46)	0.52 (0.11-2.44)
45-64	0.35 (0.15-0.77)	0.63 (0.18-2.23)
65 or more	0.52 (0.22-1.22)	0.34 (0.07-1.65)
Sex		
Male	1.00	1.00
Female	0.89 (0.46-1.71)	0.68 (0.23-1.98)
Annual income (JPY)		
Less than 3.0 million	1.00	1.00
3.0-4.9 million	0.93 (0.45-1.92)	0.61 (0.19-1.88)
5-6.9 million	0.42 (0.14-1.20)	0.22 (0.04-1.30)
7 million or more	0.69 (0.24-1.98)	Not applicable
Number of trusted organizations		
Less than 5	1.00	1.00
5-8	0.69 (0.29-1.64)	0.28 (0.06-1.25)
9 or more	0.78 (0.37-1.63)	0.32 (0.10-1.02)

¹Missing data were excluded.

²Adjusted for all other variables in the table.

³Log likelihood = -170.37.

⁴Log likelihood = -65.39.

2014). Such post-disaster changes could have impaired the protective effects of social support on mental health. Third, those with severe disaster experience may have been more likely to receive higher social support compared with those with less severe disaster experience, yet could have had

mood/anxiety disorder even with such social support, although we were not able to assess severity of disaster experience in the present study.

The association between cognitive social capital and mood/anxiety disorder did not differ with or without disas-

Table 6. Stratum specific odds ratio of mild mood/anxiety disorder related to social support with or without disaster experience in complete data (N = 590) and imputed data (N = 1,200).

Disaster experience	Social support	Complete data (N = 590) ^{1,2}	Imputed data (N = 1,200) ^{1,3}
		OR (95% CI)	OR (95% CI)
No	Low	1.00	1.00
	High	0.45 (0.28-0.73)	0.64 (0.41-1.00)
Yes	Low	0.90 (0.47-1.74)	1.07 (0.66-1.73)
	High	1.11 (0.64-1.90)	1.22 (0.78-1.89)

OR, odds ratio; CI, confidence interval.

¹Used the same model as the multivariable analysis in Table 2 adjusting for cognitive social capital, social participation, age, sex, annual income and number of trusting organizations.

²Log likelihood of the model = -318.83. The likelihood ratio test for interaction (potential effect modifier) between disaster experience and social support on mood disorder/anxiety produced a p value of 0.019.

³The likelihood ratio test for interaction (potential effect modifier) between disaster experience and social support on mild mood/anxiety disorder produced a p value of 0.080.

Table 7. Stratum specific odds ratio of moderate and severe mood/anxiety disorders related to social support with or without disaster experience in complete data (N = 590).

Disaster experience	Social support	Moderate mood/anxiety disorder	Severe mood/anxiety disorder
		Complete data (N = 590) ^{1,2}	Complete data (N = 590) ^{1,3}
		OR (95% CI)	OR (95% CI)
No	Low	1.00	1.00
	High	0.55 (0.24-1.25)	0.45 (0.10-2.02)
Yes	Low	3.33 (1.41-7.83)	3.56 (0.93-13.65)
	High	2.15 (0.97-4.77)	1.46 (0.37-5.80)

OR, odds ratio; CI: confidence interval.

¹Used the same model as the multivariable analysis in Table 2 adjusting for cognitive social capital, social participation, age, sex, annual income and number of trusting organizations.

²Log likelihood of the model = -170.33. The likelihood ratio test for interaction (potential effect modifier) between disaster experience and social support on mood disorder/anxiety produced a p value of 0.778.

³Log likelihood of the model = -65.38. The likelihood ratio test for interaction (potential effect modifier) between disaster experience and social support on mood disorder/anxiety produced a p value of 0.931.

ter experience. It has been previously reported that the cognitive component is positively associated with better mental health both in disaster and non-disaster contexts (De Silva et al. 2005; Noel et al. 2018). In this respect, the present findings are in line with such previous evidence. Unlike structural social capital, cognitive social capital represents fundamental human emotions, and are thought not to vary between locations and contexts (De Silva et al. 2007). Our findings are consistent with this idea of universal relationships.

Given the unclear protective effect of social support in disaster aftermath and worsened mental health burden, it is imperative to build up effective mental health services for those who experience disasters. Emergency health workers could play key roles on these services in short-term disaster aftermath. Yet, given that mental health burdens could last persistently after disasters (Goldmann and Galea 2014), more organized support and services for mental health should be established in the long term (McFarlane and

Williams 2012). As post-disaster situations could differ from location to location, and different responses could be warranted in such situation, the role of local health workers must be quite large. In this respect, pre-disaster preparedness and post-disaster policy-level interventions supporting local health workers could be important to enable appropriate mental health services in short- and long-term disaster aftermath.

This study has five important limitations. First, this study incorporated a cross-sectional design, where causal inferences would be challenging for the observed finding (Noel et al. 2018). Although a longitudinal study would enable us to perform a more robust analysis of causal inference, such a design is not always possible in disaster aftermath (Murakami et al. 2018). At this stage, it appears realistic to accumulate evidence by using any feasible study design to assess protective effect of social capital on mental health in post-disaster settings.

Second, we did not consider geographical proximity in

the recruitment of the participants, which made it impossible for us to assess community-level social capital in the analysis. However, according to a previous systematic review (Noel et al. 2018), individual social capital was a predominant research focus in post-disaster mental health studies. Thus, we assume that we properly captured a major portion of the relationships between social capital and mental disorders in the present work, even though we could not look at community-level social capital.

Third, we did not consider the severity of disasters experienced by the participants. Among those considered in the analysis (N = 1,183), only a small proportion of the participants with disaster experience experienced major house destruction or loss of property and/or important others (17.7%, 65/367), and 70.3% (45/64) of them reportedly recovered from such disaster impacts. Thus, the findings observed based on this definition of disaster experience may need some caution. However, as we suggested in the discussion, the difference in the associations between social support and post-disaster mood/anxiety may have related not to direct disaster damage, but through possible changes in the relationships with important others.

Fourth, we only assessed mood/anxiety disorder, and did not examine other important mental health outcomes including posttraumatic stress disorders and depression. This restricts the generalizability of our study findings.

Fifth, there were many participants with missing values, namely in income and social support. As a result, less than half of the original population was considered in multivariate logistic regression (49.2%, 590/1,200). However, the analyses using multiple imputation method yielded similar results, and as such we assume that the outcomes did not significantly differ with or without missing values.

In conclusion, the protective effects of social support against mood/anxiety disorder vary in the Japanese population depending on disaster experience. In contrast, cognitive social capital is protective against mild mood/anxiety disorder in both populations, irrespective of disaster experience. To our knowledge, this is the first study to suggest that associations between social capital and mental health outcomes may differ between those who have experienced disasters, and those who have not. Notwithstanding the inherent limitations and a lack of robustness in the findings, this study provides important insight into the role of social capital on mental health after disaster. The present findings could be considered in disaster-resilient community building and associated policy planning.

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Conflict of Interest

The authors declare no conflict of interest.

Among the authors, however, Akihiko Ozaki receives personal fees from MNES Inc., outside the submitted work.

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