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Original Article

Social Capital and Post-traumatic Stress Disorder among Heavy Rainfall and Flood Victims in Japan

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This study examined the relationship between cognitive/structural social capital and post-traumatic stress disorder (PTSD) among victims of heavy rain and flood. Participants were individuals aged ≥ 18 years affected by the July 2018 heavy rainfall in the cities of Kurashiki and Soja, Japan, and living in temporary housing. We distributed five copies of a questionnaire to 1,991 households and received responses from 1,927 individuals (907 men, 1,008 women, 12 respondents of unspecified sex) in 1,029 households (51.7%). We estimated odds ratios (ORs) and 95% confidence intervals (CIs) for associations between high (vs. low) social capital and PTSD or other outcomes. After covariate adjustment, the odds of having PTSD were lower in participants with high cognitive social capital than those with low cognitive social capital (OR = 0.346, 95%CI: 0.263-0.456). Elderly women with higher structural social capital tended to have lower PTSD odds than those with lower structural social capital (OR = 0.671, 95%CI: 0.431-1.046). The opposite pattern was observed for elderly men (OR = 1.315, 95%CI: 0.792-2.183). Cognitive social capital is a protective factor that may reduce PTSD or promote a favorable PTSD prognosis after heavy rainfall and flood events. The associations between structural social capital and PTSD differ by age and sex.

Key words: social capital, post-traumatic stress disorder, disaster, flooding

In late June and early July 2018, extreme rainfall occurred in western Japan, including Okayama Prefecture, causing flooding and associated damage. The city of Kurashiki, in southwestern Okayama Prefecture, has a population of approximately 480,000. The city of Soja, adjacent to the north side of Kurashiki, has a population of approximately 70,000. The heavy rain resulted in a total of 78 deaths in these two cities [1]. Natural disasters are potentially traumatic events that are acute, collectively experienced, and temporally localized [2]. Following a natural disaster, psychological distress and the incidence of mental illness increase [3]. A study of flood damage in the UK reported several adverse mental health effects among flood-affected people compared with nonaffected people, with adjusted odds ratios (ORs) of 5.91 (95% confidence interval [CI]: 3.17-10.99) for depression, 6.50 (95%CI: 3.77-11.24) for anxiety, and 7.19 (95%CI: 4.33-11.93) for post-traumatic stress disorder (PTSD) [4]. The prevalence of PTSD was 15.2% among participants who had experienced disruption (*e.g.*, evacuation) and 36.2% among participants whose homes had flooded in at least one livable room [4]. One study from Japan reported that 6.8% of social welfare council employees affected by the Great East Japan Earthquake showed a high risk of

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PTSD [5]. A study of responses to a tsunami and earthquake found that 11.4% of a population of residents aged ≥ 65 years had severe PTSD symptoms [6]. In addition, a meta-analysis of PTSD incidence after disasters reported a higher incidence in elderly people than in other age groups and a higher incidence in women [7]. PTSD symptoms include intrusive thoughts and images, nightmares, dissociative symptoms (*e.g.*, flashbacks), avoidance/paralysis, and hyperarousal (*e.g.*, persistent anxiety and catatonia) [8]. PTSD is associated with suicidal ideation and suicide attempts [9] and may accelerate cognitive decline in elderly people [10]. However, the 12-month prevalence (cumulative incidence) of PTSD varies considerably across countries [11]. Therefore, it is unclear whether findings from other countries are applicable to Japan.

Recent public health research has identified social capital as an important resource in disaster-resilient communities. Social capital can be defined as those attributes of social groups that facilitate cooperation to achieve common goals, and is a particularly useful resource during and after a disaster [12]. Social capital subcategories include a cognitive dimension, which comprises a subjective sense of shared values such as trust and reciprocity, and a structural dimension, which comprises connections and social networks and involves aspects such as participation in community activities [13]. Some studies on the relationships between social capital and mental health have been conducted in the context of natural disasters. A study of social capital and mental health after heavy rainfall and flooding in the UK suggested that cognitive social capital is consistently associated with lower prevalence of depression, anxiety, and PTSD, whereas structural social capital is associated only with anxiety [14]. A study of elderly people in Japan during the Great East Japan Earthquake showed that older survivors with strong social cohesion after the disaster had a lower risk of depressive symptoms than those with weak social cohesion before and after the disaster, even after adjustment for the disaster-related damage experienced by participants [15]. A study on social cohesion as a preventive factor for PTSD after the Great East Japan Earthquake found that individual- and community-level social cohesion before the disaster were associated with a lower risk of PTSD symptoms [6]. Despite the high risk of natural disasters in Japan [16], there has been little research on social capital and PTSD associated with natural disasters there. Given that PTSD prevalence varies greatly across countries, that little research has been conducted on how PTSD differs according to disaster type, and that PTSD can have negative effects on the lives of disaster victims, more information is needed about the factors that prevent PTSD onset and contribute to recovery from PTSD symptoms after natural disasters.

In this study, we focused on social capital as a factor that may prevent PTSD and promote recovery from PTSD symptoms among victims of heavy rainfall and flooding, and examined the relationship between cognitive/structural social capital and PTSD. We hypothesized that higher cognitive social capital would be associated with lower odds of PTSD among disaster victims. The results of previous studies on the relationship between structural social capital and mental health have been inconsistent [17]. Therefore, in this study we described the relationship between structural social capital and PTSD without using any *a priori* hypotheses. To enable the comparison of our findings with those of previous studies, we also examined self-rated health and depression/anxiety outcomes and their relationships with social capital.

Materials and Methods

Participants. A questionnaire survey was conducted by the local government of Okayama between January 16 and February 14, 2020. The recipients were individuals aged 18 years or older (as of November 30, 2019) who had been affected by the July 2018 heavy rainfall in the cities of Kurashiki and Soja and were living in publicly supported temporary housing after the disaster. A total of 1,991 households were selected, and five questionnaires were distributed to each household. Recipients were asked to make the required number of copies of the questionnaire if their household comprised six or more members. We received responses from 1,029 households (response rate: 51.7%). The total number of respondents was 1,927: 907 men, 1,008 women, and 12 respondents of unspecified sex. The return of a completed questionnaire was considered to constitute informed consent. The ethics review committee of Okayama University Graduate School of Medicine, Dentistry, and Pharmaceutical Sciences approved the study (approval number: 2006-015).

Social capital. Cognitive social capital was

assessed using two items: "Would you say that people in your neighborhood can be trusted?" (trust) and "Would you say that people in your neighborhood mutually aid others?" (reciprocity). Both items were rated on a five-point Likert scale; trust was rated from 1 "can be trusted" to 5 "cannot be trusted," and reciprocity was rated from 1 "try to be helpful" to 5 "just look out for themselves" [18]. For analysis, the trust and reciprocity scores were reversed, summed, and divided into two categories based on the mean: ≤7 (low) and >7 (high).

Structural social capital was assessed by asking respondents whether they participated in any of the following community groups (yes=1, no=0): senior citizens' associations, women's groups, parent-child associations, community groups, sports clubs, hobby and cultural groups, religious groups, day care and day services, and others. For the analysis, participants were divided into two categories (0 and ≥1) according to whether they participated in any of the groups.

PTSD. PTSD was assessed using the PTSD-3 [19], a simple self-report scale used in epidemiological studies and for screening after large-scale disasters. The PTSD-3 consists of three items, each rated on a four-point Likert scale: 0 "never," 1 "sometimes," 2 "almost half the time," and 3 "almost always." Higher total scores for the three items indicate a higher risk of PTSD. For the analysis, cutoff points (<3, ≥3) were used based on previous studies, and participants were divided into two categories.

Self-rated health. Self-rated health was assessed using a single item. Self-rated health has been widely investigated in epidemiological studies because of its high predictive power for subsequent death [20]. In this study, we asked participants, "Would you say your health in general is excellent, very good, good, fair, or poor?" Responses were on a five-point Likert scale from 1 "excellent" to 5 "poor" [21]. For analysis, poor self-rated health was used as an outcome and divided into two categories: "good/normal" (<4) and "poor" (≥4).

Depression/anxiety. Depression and anxiety were assessed using the Japanese version of the Kessler K6 scale [22], which screens for mental disorders such as depression and anxiety. The K6 comprises six items scored on a five-point Likert scale of 0 "never," 1 "a little," 2 "sometimes," 3 "usually," and 4 "always." A higher total score indicates a higher risk of mental health problems. For analysis, the score on each item were summed and divided into two categories based on the existing cutoff criteria (<9, ≥9) for mood and anxiety disorders.

Covariates. The following covariates were used: sex (male, female), age, socioeconomic status (occupation), magnitude of residential destruction (all/half/partial destruction, and other), and type of housing after evacuation (rented housing [fixed-term (up to 2 year) rent subsidy specifically related to the disaster], emergency housing, and other). For socioeconomic status, we used occupation to classify respondents into five categories: full-time (self-employed, company employee, public servant), part-time (part-time worker), agriculture/other, unemployed, and housewife/student.

Statistical analysis. The continuous variable of age was represented by medians and quartiles; the other variables were represented by means and standard deviations. Frequencies and percentages were used for categorical variables. To examine the relationships between social capital and each of PTSD, poor self-rated health, and depression/anxiety, we conducted multiple logistic regression analyses. The exposure variables were cognitive social capital and structural social capital. The outcome variables were PTSD, poor self-rated health, and depression/anxiety. As covariates, we adjusted for sex and age in Model 1. In Model 2 we adjusted for the covariates in Model 1, plus occupation. In Model 3, we adjusted for the covariates in Model 1, plus type of housing and magnitude of destruction of the residence. We calculated ORs and 95% CIs. We conducted a stratified analysis of social capital and PTSD by sex and age (<65 years, ≥65 years) because a previous study suggested that the effects of social ties on mental health differ by sex [23]; additionally, many studies included only participants older than 65 years, so it is unclear whether the effects identified are the same as those found for younger people [for example, see 6,15,24]. We used STATA/SE17.0 (StataCorp, College Station, TX, USA) for all statistical analyses, with statistical significance set at $p<0.05$.

Results

Demographic characteristics of participants. The demographic data are shown in Table 1. Of the participants, 47.1% were men and 52.3% were women. The median age was 62 years. After evacuation, 80.4% of

Table 1 Characteristics of the Analytic Sample (n=1927)

	No.	%	Mean	SD
Sex				
male	907	47.1		
female	1,008	52.3		
missing	12	0.6		
Age[a]			62	[44–72]
Type of housing after evacuation				
rented (subsidized) housing	1,550	80.4		
emergency housing	160	8.3		
other	153	7.9		
missing	64	3.3		
Magnitude of residential destruction				
all destruction	1,763	91.5		
half destruction	119	6.2		
partial destruction	2	0.1		
other	13	0.7		
missing	30	1.6		
Occupation				
full-time[b]	626	32.5		
part-time	257	13.3		
housewife/student	269	14.0		
other[c]	85	4.4		
without an occupation	651	33.8		
Cognitive social capital				
continuous (2–10)	1,814	94.1	6.97	(1.947)
missing	113	5.9		
Participations in organized activities[d]				
senior citizens' associations	63	3.3		
women's groups	22	1.1		
parent-child associations	13	0.7		
community salons	91	4.7		
sports clubs	104	5.4		
hobby and cultural circles	114	5.9		
religious groups	39	2.0		
day care and day service	65	3.4		
others	156	8.1		
missing	2	0.1		
Structual social capital (number of participations in organized activities)			0.35	(0.616)
0	1,371	71.2		
1≦	554	28.8		
missing	2	0.1		
PTSD				
<3	1,439	74.7		
3≦	394	20.5		
missing	94	4.9		
Self-related health				
excellent, very good, good (<4)	1,380	71.6		
fair, poor (4≦)	499	25.9		
missing	48	2.5		
Depression/anxiety				
<9	1,338	69.4		
9≦	459	23.8		
missing	130	6.8		

[a]Age: median, p25, p75, $n=1,903$ [b]full time: self-employed, company employee and public servant
[c]other: agriculture and other [d]Participations in organized activities: participants in organized activities /all participants

participants lived in rented (subsidized) housing, 8.3% in emergency housing, and 7.9% in other types of housing. Regarding residential damage, the homes of 91.5% of participants had been completely destroyed. Regarding occupation, 32.5% of participants worked full time, 13.3% worked part time, 14.0% were housewives or students, 4.4% had other occupations, and 33.8% were unemployed.

Exposure variables. Descriptive data for cognitive social capital and structural social capital are shown in Table 1. The mean scores for cognitive and structural social capital were 6.97 and 0.35 (standard deviation = 1.95 and 0.62), respectively.

Outcome variables. Of participants, 20.5% had PTSD, 25.9% had poor self-rated health, and 23.8% had mood/anxiety disorders.

Relationship between social capital and each outcome variable.

PTSD.

After adjusting for all covariates, the prevalence of PTSD was still significantly lower in participants with high cognitive social capital than in those with low cognitive social capital (Table 2, OR = 0.346, 95% CI: 0.263-0.456). Elderly women with higher structural social capital tended to have lower odds of PTSD than those with lower structural social capital (OR = 0.671, 95% CI: 0.431-1.046). The opposite pattern was observed for elderly men (OR = 1.315, 95% CI: 0.792-2.183) (Table 3).

Self-rated health and depression/anxiety. The associations between social capital and self-rated health and depression/anxiety are shown in Table 4. For self-rated health, after adjustment for all variables, participants with high cognitive social capital were significantly less likely to be in poor health than those with low cognitive social capital (OR = 0.412, 95% CI: 0.323-0.526). The results were similar for structural social capital (OR = 0.667, 95% CI: 0.519-0.856).

For depression/anxiety, after adjustment for all variables, participants with high cognitive social capital had

Table 2 The odds ratios of PTSD by cognitive social capital

	PTSD					
	Model 1		Model 2		Model 3	
	OR	[95%CI]	OR	[95%CI]	OR	[95%CI]
Cognitive social capital						
low	1.000	(ref.)	1.000	(ref.)	1.000	(ref.)
high	0.325	[0.248, 0.427]	0.327	[0.248, 0.430]	0.346	[0.263, 0.456]
n	1,745		1,724		1,681	

Model 1 sex, age.
Model 2 sex, age, occupation.
Model 3 sex, age, type of housing after evacuation, magnitude of residential destruction.
OR, Adjusted odds ratio; 95% CI, 95% confidence interval.

Table 3 The odds ratios of structual social capital associated with PTSD (stratified by age and sex)

	score			adjusted		
	n	Mean	SD	n	Δ OR	[95%CI]
High structual social capital (vs low)						
male, <65 yo	485	0.98	± 1.635	469	0.764	[0.373, 1.565]
male, 65 yo+	373	1.39	± 1.850	359	1.315	[0.792, 2.183]
female, <65 yo	548	1.01	± 1.490	535	1.015	[0.580, 1.775]
female, 65 yo+	412	1.76	± 2.137	388	0.671	[0.431, 1.046]

adjusted by type of housing after evacuation, magnitude of residential destruction.
Δ OR, Adjusted odds ratio; 95% CI, 95% confidence interval.
Structual social capital low = 0, high = 1, 2, 3, 4, 5

Table 4 The odds ratios of Self-related health, Depression/Anxiety by Social capital

	Self-related health						Depression/anxiety					
	Model 1		Model 2		Model 3		Model 1		Model 2		Model 3	
	OR	[95%CI]	OR	[95%CI]	OR	[95%CI]	OR	[95%CI]	OR	[95%CI]	OR	[95%CI]
Cognitive social capital												
low	1.000	(ref.)	1.000	(ref.)	1.000	(ref.)	1.000	(ref.)	1.000	(ref.)	1.000	(ref.)
high	0.401	[0.315, 0.510]	0.388	[0.304, 0.495]	0.412	[0.323, 0.526]	0.231	[0.176, 0.304]	0.225	[0.170, 0.296]	0.227	[0.171, 0.302]
n		1,774		1,753		1,706		1,718		1,700		1,655
Structual social capital												
low	1.000	(ref.)	1.000	(ref.)	1.000	(ref.)	1.000	(ref.)	1.000	(ref.)	1.000	(ref.)
high	0.672	[0.526, 0.858]	0.632	[0.492, 0.810]	0.667	[0.519, 0.856]	0.718	[0.558, 0.923]	0.688	[0.532, 0.888]	0.700	[0.540, 0.907]
n		1,865		1,842		1,794		1,782		1,762		1,716

Model 1 sex, age.
Model 2 sex, age, occupation.
Model 3 sex, age, type of housing after evacuation, magnitude of residential destruction.
OR, Adjusted odds ratio; 95% CI, 95% confidence interval.

significantly fewer symptoms related to mood and anxiety disorders than those with low cognitive social capital (OR = 0.227, 95% CI: 0.171-0.302). The results were similar for structural social capital (OR = 0.700, 95% CI: 0.540-0.907).

Discussion

The study findings demonstrated that individuals with high cognitive social capital had lower odds of PTSD after experiencing heavy rain and flooding. Patterns of association between structural social capital and PTSD differed by sex, especially among elderly participants, suggesting that structural social capital might protect women but not men from PTSD. The observed relationships between cognitive/structural social capital and self-rated health and depression/anxiety were similar to those identified in previous studies.

The results support our hypothesis that high cognitive social capital is associated with lower odds of PTSD after a heavy rainfall and flooding event. This relationship remained consistent even after the analysis of the association between cognitive social capital and PTSD was stratified by sex and age. Two possible pathways link social capital to health (*i.e.*, prevent PTSD) at the individual level: (1) the acquisition of useful information (*e.g.*, notifications regarding where to apply for housing reconstruction subsidies) and (2) the receipt of social support (*e.g.*, loans for living expenses). However, an important distinction between social capital and social support is that social support derives from close, strong ties whereas social capital can also be obtained from weak acquaintance ties (*e.g.*, weak ties with local government employees).

The association between structural social capital and PTSD was not uniform. Sex- and age-stratified analyses showed different patterns across sex and age. In recent years, it has been pointed out that social capital does not promote health uniformly for all individuals [25]. Our analysis suggests that there may be adverse health effects of social capital, especially among elderly men (often referred to as the "dark side" of social capital). A possible explanation for this negative effect is that elderly men tend to engage in less spontaneous social participation than women, even in regular social situations. In addition, structural social capital was measured after participants had been relocated to temporary housing. It is possible that they were required to participate in groups they would rather not be involved with, especially among individuals who had lost social participation due to the disaster. In short, requiring elderly men to participate in social groups after a disaster may not necessarily improve their health. Therefore, we do not recommend building structural social capital by simply increasing the opportunities of social participation.

This study had several limitations. First, it was cross-sectional, so we cannot assume that the relationships between social capital and PTSD were causal. In addition, the survey was conducted 1.5 years after the disaster. Social capital after the disaster may have differed from that before the disaster; regarding structural

social capital, for example, many participants experienced a loss of social participation owing to forced relocation to temporary housing. However, although it takes time to build social capital, the characteristics of structural social capital are such that individuals who had high capital before the disaster also had relatively high capital at the time of the study. Second, the study target was not the entire population of disaster victims, *i.e.*, it did not include those who had moved to private housing (*e.g.*, relatives house). Therefore, the study was limited to victims who had experienced considerable damage to their homes. Thus, we should be cautious about generalizing the results to all flood victims. However, these findings could make an important contribution to knowledge about high-risk populations that may require appropriate measures to cope with relocation after heavy rainfall and flood disasters. Third, common method bias may have been a problem. Because both social capital and PTSD were measured using subjective questionnaire responses, it is possible that the association between them was overestimated. However, the assessment of structural social capital was not based purely on subjective responses, but also partly reflected the objective situation. Future research needs to clarify these relationships using longitudinal surveys.

In conclusion, high cognitive social capital was associated with lower odds of PTSD among victims of heavy rainfall and flood. This result is consistent with the findings of previous studies. However, the relationship between structural social capital and PTSD differed by sex and age. Among elderly women, higher levels of structural social capital tended to be associated with lower odds of PTSD, whereas elderly men showed the opposite pattern.

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