

Emergent Use of Twitter in the 2011 Tohoku Earthquake

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ICT: information and communication technology

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Abstract

Introduction: Social networks play an important role in disaster situations as they have become a new form of social convergence that provides collective information. The effect of social media on people who experienced disaster should be assessed.

Hypothesis: In this study, Twitter communication during the Great East Japan Earthquake of March 11, 2011 was assessed. The hypothesis of this study was that usage of Twitter had psychological effects on victims of the disaster.

Methods: A cross-sectional questionnaire survey was carried out in cooperation with a major Japanese newspaper three months after the disaster, and 1,144 volunteer participants responded. They were asked about their health, area of residence, property damage they had experienced, information sources they used at the time of the disaster, and their usage of Twitter. Further, the Twitter users were divided into two groups—with and without disaster experience. Their psychological effects relating to feelings of relief, stress or anxiety that they experienced in using Twitter were compared between two groups, and Twitter's psychological risk of disaster experience was estimated as an odds ratio.

Results: Twitter users in this study tended to reside in disaster-affected areas and thought Twitter was a credible information source during the time of the disaster. The psychological effect of Twitter differed based on participants' disaster experience and gender. Females with disaster experience reported more feelings of relief and stress as a result of using Twitter compared to females who did not experience the disaster. On the other hand, males with disaster experience only reported more stress experiences as a result of using Twitter compared to those without disaster experience.

Conclusion: Twitter users with disaster experience had a higher usage of Twitter than those without disaster experience. Social media might have had a material psychological influence on people who experienced disaster, and the effect differed by gender. Regardless of gender, negative feelings were transmitted easily among people who experienced the disaster. It was anticipated that the application of Twitter in a disaster situation will be expanded further by taking these findings into consideration.

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Introduction

The Great East Japan Earthquake was a magnitude 9.0 quake that occurred on March 11, 2011, near the northeastern coast of Japan. The earthquake (the "3.11 earthquake") was followed by a large tsunami and nuclear plant accidents. These events are considered to be the most destructive disaster in the nation's recent history. In addition, the countless aftershocks and infrastructure damage that followed the earthquake have affected the entire northeastern region and eastern Pacific coast, as well as the Tokyo metropolitan area. As of July 25, 2011, the number of people killed or missing exceeded 20,000, and the number of refugees reached more than 400,000 at its peak.¹

While the local telecom network was disrupted in the aftermath of the disaster, many people actively exchanged information via the Internet. In particular, social networking services, including Twitter, were utilized as a means of searching for people, calling for humanitarian support, and exchanging information on topics such as electrical outages, traffic, or the nuclear plant accidents.

Social media has been utilized in emergency situations in previous disasters. Some studies have reported that during the disasters of Hurricane Katrina in 2005² and Southern California Wildfires in 2007,³ several online communities were formed to

provide for topical needs, coordinate housing arrangements, and provide relief goods. In addition, empirical research shows that online distributed problem-solving activities have occurred during major crises.⁴ More recently, social media was used to reduce disaster-related morbidity and mortality during the Haiti earthquake of 2010.⁵

Disaster researchers have found that people's activity often helps ameliorate tragedy and recovery.⁶ Social networks supported by information and communication technology (ICT) may also offer potential psychological benefits for vulnerable people through their participation in social media communication.⁵ Reporting their situation online is one way for disaster victims to cope with the situation. By doing so, the vulnerable people may exhibit increased resilience by replacing their helplessness with dignity and control of the situation.⁵

Although social network on ICT may have a potential benefit in terms of the community's resilience, it may also easily spread misinformation and rumors. In addition, social media remains less accessible than traditional media for people who are not able to use the Internet, such as the elderly or economically disadvantaged.⁷

Among various social media, Twitter was expected to contribute to reducing disaster-related morbidity and mortality risk. According to the White Paper on Information and Communications published by Japan's Ministry of Internal Affairs and Communications,⁸ the number of tweets by local governments in disaster areas had increased rapidly. Twitter activity by local government peaked on March 18, 2011. Many affected local governments took actions to send out information, and at the same time, Twitter and internet users showed a high degree of attention to information from government sources.

This paper analyzes the Twitter communication that occurred in the aftermath of the 3.11 Earthquake in Japan. The characteristics of Twitter users and other general internet users are defined, and Twitter use from the standpoint of disaster victims is assessed. Finally, the potential psychological benefit of Twitter use is discussed, in particular, the possibility of increased resilience to those affected by disasters.

Methods

Design

In order to assess the relationship between Twitter use and disaster, a cross-sectional questionnaire survey was carried out among people who accessed news online three months after the 3.11 Earthquake.¹ Prior to the survey, the Institutional Review Board of Hakuoh University approved the study.

Through the website of a major Japanese newspaper, *Yomiuri Shimbun*,⁹ (daily circulation of approximately 10 million), demographic information was gathered, together with information on health status, mood over the last month, and Twitter usage. The survey was available from June 10 through July 11, 2011. The questionnaire consisted of 34 questions, and the link to the questionnaire site was provided on the home page of "YomiDr" (<http://www.umiharajunko.com/medical/index.html>), a site that presents health information by professionals. The questionnaire was accessible to all users and did not require a subscription, nor were there restrictions on access to other pages.

Measurement

The questionnaire covered demographic information including gender, age, residential address, job status, and general subjective

health characteristics such as self-rated health and depression during the previous 30 days. For intensity of disaster experience, participants were asked if they, their family, or friends directly experienced the 3.11 disaster. Residential addresses were then divided into three categories according to the number of dead and missing persons by prefecture, resulting in three categories: (1) severely affected (more than 1,000: three prefectures); (2) near affected (fewer than 999: nine prefectures); and (3) others (no dead or missing persons).¹⁰

Participants then provided a self-rated health assessment. Those who answered the question "What is your current health status" with a response of "Not good," "Bad," or "Very bad" were classified as having poor self-rated health. Those who answered "Good" or "Very good" were classified as having good health. Previous studies have indicated that self-rated health is a highly valid predictive indicator of objective physical and mental health outcomes.^{11,12}

A participant's mental health condition was categorized as a Depressive mood if they answered "Always" or "Usually" in response to the statement "I'm depressed, and nothing seemed to make me feel better during the last month."¹³

All survey participants were asked "Do you use Twitter?," and those who answered "yes" were directed to Twitter-related survey questions regarding how long they have subscribed to Twitter, their regular usage patterns, disaster-related usage, and psychological responses such as feelings of relief, stress, or anxiety regarding Twitter use.

Data Analysis

The data were analyzed using STATA (Version 11.2, STATA Statistics/Data Analysis Special Edition, StataCorp LP, College Station, TX, USA), and a two-tailed *P* value of $<.05$ was considered significant. First, the demographics, general health status, disaster experience, and related information of Twitter users were compared with those of non-users. Second, Twitter use was analyzed among participants in the user group. The participants' residential addresses were mapped in order to confirm the geometric relationships of the effect of disaster on general internet users. The average number of Twitter users in each prefecture in 2011 was obtained from the website of User Local, Inc. in February, 2012.¹⁴

Population-based numbers of Twitter users, total participants, and general Twitter users were calculated using the estimated population of people aged 15 years or older according to each prefecture.¹⁵ Finally, gender-stratified logistic regression analysis adjusting for age, residential address, job, self-rated health, and depressive mood in the prior month was performed to evaluate the association between disaster experience and the psychological response to Twitter.

Results

Data was obtained from 1,144 participants. The Twitter user group included more females and younger participants than the non-user group (Table 1). The user group also contained more participants who were unmarried, divorced, or widowed, and the proportion of those living with families was significantly lower than that in the latter groups. However, more Twitter users than non-users had a "reliable person"—a relative or friend on whom they could depend for assistance and support. For subjective health, Twitter users had a tendency to estimate their health worse than non-users did, and a significantly greater number of

		Twitter (-) Group n (%) (n = 846)	Twitter (+) Group n (%) (n = 298)	P ^a
Gender (Female)		299 (35)	157 (53)	<.0001
Age:	≤ 19	4 (0.5)	7 (2)	<.001
	20-29	12 (1)	16 (5)	
	30-39	43 (5)	60 (20)	
	40-49	133 (16)	96 (32)	
	50-59	157 (19)	70 (24)	
	≥60	497 (59)	49 (16)	
Employed (Yes)		407 (48)	204 (68)	<.001
Marital status:	Single	86 (10)	100 (33)	<.001
	Married	694 (82)	178 (60)	
	Divorced or Widowed	66 (8)	20 (7)	
Living with family (Yes)		740 (87)	240 (81)	.003
Has reliable person (Yes)		493 (58)	197 (66)	.017
Self-rated health:	Very bad	35 (4)	8 (3)	
	Bad	154 (18)	73 (24)	.091 ^b
	Enough	344 (41)	110 (37)	
	Good	170 (20)	60 (20)	
	Very Good	143 (17)	47 (16)	
Depressive mood in month:	Always	40 (5)	19 (6)	
	Usually	42 (5)	24 (8)	.024 ^c
	Sometimes	276 (32)	123 (41)	
	Rarely	303 (36)	92 (31)	
	Never	185 (22)	40 (14)	

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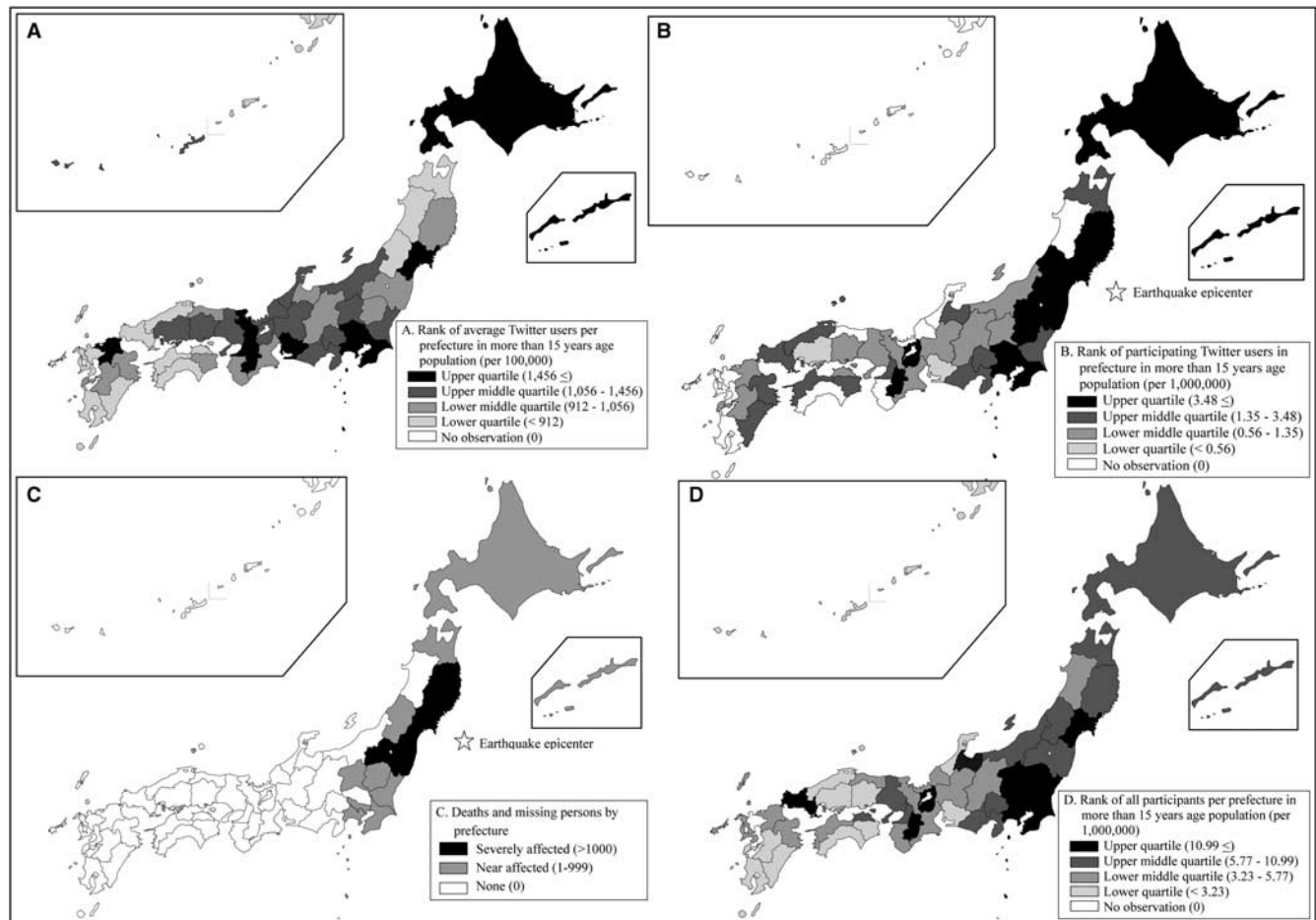
Table 1. Sociodemographic Characteristics and Subjective Health of Twitter Users and Non-users^aChi-square test was used for comparison of the two groups.^bComparison for the proportion of worse than “Bad.”^cComparison for the proportion more than “Usually.”

Twitter users reported experiencing a depressive mood in the last month than did non-users.

A higher proportion of Twitter users had disaster experience compared with non-users (Table 2). Furthermore, friends and relatives of Twitter users also had been more affected by the disaster than those of non-users. Although general Twitter users are concentrated in prefectures with major cities such as Tokyo, Osaka, Kyoto, Aichi, Fukuoka, etc., (Figure 1A), more Twitter users in this study lived in prefectures that were severely affected by or are close to the disaster area (Figures 1B and 1C). Twitter users thought Twitter sites were useful sources of information during and after the disaster, and they relied more on the Internet in the same time period. In contrast, non-users thought that traditional media, such as television and newspapers, were

more useful. However, three-quarters of each group thought not enough information was available at the time of the disaster. Compared to non-Twitter users, Twitter users were more likely to consider that there was a shortage of information on topics such as medical treatment, family welfare, and availability of food and daily necessities.

Table 3 details Twitter use and compares Twitter use between users with and without disaster experience. No differences were found between the groups in terms of when the users first started using Twitter or their frequency of tweeting. Twitter users who had been affected by the disaster were significantly more likely to follow Twitter sites related to the crisis. However, tweeting or re-tweeting experiences and obtaining useful information via Twitter sites showed no significant difference between those with



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Figure 1. Geographical Relationship Among General Twitter Users, Study Participating Twitter Users, Deaths and Missing Persons, All Study Participants, and the Center of 2011 Tohoku Earthquake

- A. Rank of average Twitter users >15 years of age per prefecture (per 100,000)
 B. Rank of participating Twitter users >15 years of age in prefecture (per 1,000,000)
 C. Deaths and missing persons by prefecture
 D. Rank of all participants >15 years of age per prefecture (per 1,000,000)

direct disaster experience and those without disaster experience. In the overall evaluation of Twitter use during and after the disaster, there was no significant difference between the two groups of users.

In Table 4, the relationship between disaster experience level and the psychological reaction of Twitter use is shown using odds ratio considering gender and mental status. Among female participants, Twitter users with disaster experience felt relief by using Twitter at a ratio of 2.81 to their counterparts without disaster experience. For negative feelings associated with Twitter, both genders who experienced disaster reported more stress or anxiety experiences from Twitter use than those with no disaster experience: Female Twitter users with disaster experience reported these feelings at a ratio of 2.33, and male users at a ratio of 3.10 compared to their respective gender group without disaster experience.

Discussion

Among the participants, Twitter users tended to be young, employed, and had a reliable person on whom they could depend. The gender proportion of Twitter users was comparable to the general population of Japan (women were 51.2% of Japan's total

population in 2009).¹⁵ Although the proportions of participants who were married and living with family were lower than those of non-users, the former's health status had been expected to be better than that of the latter because of their age and gender distribution. However, the observed fact was the opposite. Because more Twitter users had disaster experience and tended to reside in affected prefectures, they may have continued to experience the effects of the disaster.

In fact, on the basis of the observed Twitter use, disaster experience affected participants' mental experience from Twitter use. The psychological effects of Twitter use at the time of the disaster seemed to be different. More Twitter users with disaster experience reported feeling relieved, anxious, or stressed through Twitter use than those who had not been affected by the disaster. On the other hand, male Twitter users may have been less affected by positive feelings from using Twitter, but they were strongly affected by the negative feelings caused by Twitter use, especially among those who had experienced the disaster.

Most other aspects of Twitter use at the time of the disaster showed no significant difference between those with and without

		Twitter (-) Group n (%) (n = 846)	Twitter (+) Group n (%) (n = 298)	P ^a
Experience of disaster		242 (29)	118 (40)	<.001
Victims:	Myself	29 (3)	16 (5)	.138
	Family	32 (4)	8 (3)	.375
	Relatives	62 (7)	28 (9)	.254
	Friends	50 (6)	32 (11)	.005
	Others	69 (8)	34 (11)	.092
Home Prefecture:	Severely affected	35 (4)	19 (6)	.016
	Near affected	453 (54)	179 (60)	
	Others	358 (42)	100 (34)	
Top two sources of useful information for disaster (multiple):	TV	712 (84)	178 (60)	<.001
	News paper	491 (58)	72 (24)	<.001
	Web site	263 (31)	157 (53)	<.001
	Radio	187 (22)	63 (21)	.729
	Twitter	44 (5)	144 (48)	<.001
Disaster information:	(Not enough)	642 (76)	224 (75)	.804
For (multiple):	Evacuation center's safety	251 (30)	98 (33)	.300
	Evacuation route	132 (16)	56 (19)	.201
	Medical information	130 (15)	64 (21)	.016
	Family welfare	163 (19)	75 (25)	.031
	Food and Daily Necessities	196 (23)	104 (35)	<.001
	Others	62 (7)	44 (15)	<.001

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Table 2. Disaster Experience and Related Information for Twitter Users and Non-users^aChi-square test was used for comparison between two groups.

disaster experience and as compared to Internet users in general. Many Twitter users seemed to seek specific information according to their individual requirements, such as family welfare and availability of consumer goods, at the time of the disaster. Therefore, the mental state of vulnerable Twitter users may have been affected easily by the real time flow of available information pertinent to their greatest concerns.

In this study, it was observed that there were both potential psychological benefits from and disadvantages to using Twitter. There are several possible reasons for these psychological responses to Twitter use. People with disaster experience tended to use Twitter and social networking services to obtain useful information. Twitter was able to provide these people information without time lags. However, there were several cases of misinformation through Twitter at the time of the disaster. People with disaster experience were easily affected by this misinformation. On the other hand, the possibility of misinformation made

people aware that they needed to select reliable information sources. This step might have enabled vulnerable people to maintain a critical viewpoint.

Another mental benefit of using Twitter was derived from the typical method of social networking communication using ICT. Information created by Twitter-enabled victims to replace their helpless situations with a more proactive one by becoming information senders. Several studies have reported that peer to peer communication through social media in disasters provides people the opportunity to create information rather than to be passive consumers.^{3,4} Consequently, people gain control over their situation and are better able to stay organized.^{3,4}

In addition, cultural factors influence Japanese Twitter users differently from Western users. Typically, Japanese do not communicate just through words, but also convey their feelings non-verbally, for example, by smiling, changing their speed of speech, and pausing. This communication style is called high

	Total Twitter Users (N = 298)	Disaster experience		P ^a
		No (n = 180)	Yes (n = 118)	
Regular usage:				
Subscribed to Twitter use after disaster	51 (18)	27 (15)	24 (21)	.192
Regular use of Twitter ^b	80 (27)	52 (29)	28 (24)	.326
Disaster-related usage:				
More than one following to Twitter-site-related disaster	191 (64)	105 (58)	86 (73)	.010
Experience tweeting or re-tweeting about disaster topics	200 (69)	121 (68)	79 (70)	.781
Experience obtaining useful information from Twitter site	193 (65)	113 (63)	80 (68)	.375
Subjective total evaluation of Twitter use at the time of the disaster:	Negative	18 (6)	10 (6)	.333
	Zero	103 (35)	68 (38)	
	Positive	176 (59)	101 (56)	
Psychological Response to Twitter of usage:				
Experienced relief by Twitter use (Positive feelings)	173 (60)	97 (55)	76 (67)	.040
Experienced stress or anxiety from Twitter use (Negative feelings)	110 (37)	53 (30)	57 (48)	.001

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Table 3. Twitter Use by Disaster Experience^aComparison of disaster experienced and non-experienced among Twitter users.^bRegular users include participants who reported using Twitter “A few per week” or “everyday.”

context communication, and is quite the opposite of the Western communication style.¹⁶ Therefore, when Japanese users send information on Twitter, they have to think and select appropriate words to tweet more than they do in daily communication.¹⁷ This extra step of using Twitter enables them to keep control of their feelings during the disaster.

Over the past decades, researchers have found several trauma-specific variables to be associated with the development of psychological distress after a disaster. The variables include being a female victim, personal loss, separation from family or community, lack of community support, physical illness, and strong fear after the disaster.¹⁸ In our study, females with disaster experience were more likely to be affected by Twitter use. This indicates that Twitter, which can provide peer to peer communication, has a potential benefit for female victims who feel isolated from society by providing a support network. It can be anticipated that Twitter will serve important functions during disasters not only as an information dissemination tool, but also as a means to improve the resilience of the victims.

The Floating Doctors program, which has served Central American coastal communities since 2008, demonstrates how social media, such as Facebook or Twitter, can be used to build a worldwide network among medical specialists to help patients in remote areas.¹⁹ Additionally, through a recently launched project, emergency medical doctors in Taiwan use social media to exchange medical information with other doctors and to establish a cooperative framework with the government.²⁰ Notwithstanding these successes, the application of Twitter to medical practice has not been thoroughly developed. Future studies might further

explore the potential of social media as a means for providing mental health care to the public during times of disaster. Doctors should also consider appropriate ways to use Twitter to support people who have experienced disasters and to provide them with high-quality health information.

This study is unique in that it captured the disaster victims' tendencies in a relatively timely manner, and showed that they appeared to be sensitive to the obtained information. This was achieved using the Internet as the survey venue and by examining the victims' communication experience within three months of the disaster. In addition, answering the questions about their Twitter use and experience through the survey, the participants were able to provide an objective view on their own communication. This is because people usually remember their communication in Twitter more clearly than in other forms of communication that do not linger.²¹

Limitations

There were several limitations to this study. One was a possible selection bias because the data were obtained through an online survey. This study may have failed to catch more vulnerable people who could not use ICT during the survey period, such as those more severely affected by the disaster, the elderly, or those who had economic constraints. Furthermore, the targeted online users were all readers of Yomiuri Shimbun, who may have some different group characteristics from those of the general population. Therefore, it is necessary to be careful in interpreting the effect of Twitter communication during this emergency. The effect of resilience of Twitter should be discussed in terms of ICT availability in the community.

		Total Disaster Experience		Female Disaster Experience		Male Disaster Experience	
		No (n = 176)	Yes (n = 118)	No (n = 97)	Yes (n = 60)	No (n = 83)	Yes (n = 58)
Experienced feelings of relief from Twitter use (positive feelings)	(n of Yes) Crude OR Adjusted OR	97 (55) Ref. Ref.	76 (67) 1.67 (1.02-2.74) 1.67 (0.99-2.82)	56 (60) Ref. Ref.	47 (81) 2.90 (1.34-6.29) 2.81 (1.21-6.53)	41 (50) Ref. Ref.	29 (53) 1.12 (0.56-2.21) 1.16 (0.57-2.34)
Experienced feeling of stress or anxiety from Twitter use (negative feelings)	(n of Yes) Crude OR Adjusted OR	53 (30) Ref. Ref.	57 (48) 2.22 (1.37-3.60) 2.54 (1.46-4.41)	33 (34) Ref. Ref.	31 (52) 2.04 (1.06-3.94) 2.33 (1.11-4.90)	20 (24) Ref. Ref.	26 (45) 2.56 (1.24-5.27) 3.10 (1.33-7.24)

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Table 4. Relationship Between Disaster Experience and Psychological Response to Twitter Use by Gender,^a Odds Ratio and 95% Confidence Interval^b

^aAdjusted by age, address, self-rated health, and depressive mood experience.

^bBold text indicates statistical significance.

A second limitation was the generalization of study participants. The survey participants tended to live near disaster areas (Figure 1D). However, this tendency would not detract from the observed relationship between disaster experience and the mental effect of Twitter use. Finally, this study was cross sectional in nature. The possible resilient effect of Twitter and other social networks should be monitored longitudinally in a cohort study; this may be a topic for further study.

Conclusion

This study showed that the effect of social media at the time of disaster is affected by gender difference, and suggested that social media might have had a material psychological influence on people who experienced disaster. People who experienced disaster received both positive and negative feelings by using Twitter, and for both genders, negative feelings were transmitted easily among users.

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