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Increased frequency of participation in civic associations and reduced depressive symptoms: Prospective study of older Japanese survivors of the Great Eastern Japan Earthquake

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ABSTRACT

Rationale: Few studies have examined whether changes in participation in civic associations can mitigate depressive symptoms among older disaster survivors.
Objectives: We examined prospectively the association between changes in participation in civic associations and changes in depressive symptoms among older survivors of the 2011 Great Eastern Japan Earthquake.
Methods: We analyzed questionnaire-based survey data on pre- and post-disaster participation in civic associations and depressive symptoms compiled for 3567 respondents aged 65 years and above. Changes in these symptoms were assessed using a 15-item Geriatric Depression Scale (GDS) as a continuous variable for 2010 and 2013. We investigated four types of civic associations: sports, hobby, voluntary groups, and senior citizens' clubs. Changes in participation were calculated by subtracting the participation frequency measured in 2010 from that measured in 2013. Applying 95% confidence intervals, we used linear regression models with imputation to estimate the age- and sex-adjusted and multivariate-adjusted standardized coefficients.
Results: The survivors' GDS scores increased by 0.13 points on average between the pre-disaster and post-disaster periods. Average changes in the participation frequencies of respondents in each group were respectively +0.36 days/year, −5.63 days/year, +0.51 days/year, and −1.45 days/year. Increased frequencies of participation in the sports and hobby groups were inversely associated with changes in GDS scores ($B = -0.003$, Cohen's $f^2 = 0.10$, $P = 0.01$ and $B = -0.002$, Cohen's $f^2 = 0.08$, $P = 0.04$, respectively). The associations did not differ depending on the experience of housing damage caused by the disaster. In addition, we did not observe a significant association between changes in participation frequencies for voluntary groups or senior citizens' clubs and changes in GDS scores after multivariable adjustment.
Conclusions: Depressive symptoms of older adults post-disaster may be mitigated through increased frequency of participation in sports and hobby groups; yet, civic participation did not mitigate the adverse impact of disaster experiences on mental health.

1. Introduction

In recent decades, the frequencies of natural disasters, such as earthquakes, tsunamis, and hurricanes, have been increasing in Japan as well as globally (https://www.ipcc.ch/; http://www.bousai.go.jp/data/data.html). The Great Eastern Japan Earthquake (2011 Disaster) and associated tsunami that battered Japan's northeastern coastline on March 11, 2011, resulted in approximately 18,500 fatalities or missing

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persons (Ishigaki et al., 2013; Yabe et al., 2018) and the displacement of over 300,000 persons due to widespread property loss (www.reconstruction.go.jp/topics/main-cat2/sub-cat2-1/2016_hinansha_suii.pdf).

There is a growing body of literature on mental health disorders that commonly follow disastrous events. These studies have shown that trauma, residential relocation, and job loss/income loss induced by disasters are linked to depression, post-traumatic stress disorder (PTSD), or other manifestations of deteriorating mental status among survivors (Galea et al., 2005; Lowe et al., 2019; Farooqui et al., 2017; Wilson--Genderson et al., 2018; Yabe et al., 2014; Harada et al., 2015; Horikoshi et al., 2016). Previous studies have also found that the duration of the effects of disasters on survivors' mental health can extend for several years following these events (Fukusawa et al., 2017; Zhang et al., 2015; Archibald et al., 1962; Qu et al., 2012).

In previous studies, social participation has been treated as a kind of modifiable factor or behavior that promotes mental wellbeing. A recent cross-sectional study on 12,132 Japanese community-dwelling elderly aged 65–70 years found that voluntary participation in sports groups and hobby clubs was associated with significantly better mental health levels (Tomioka et al., 2017). The findings of other studies have also suggested that social participation may play a protective role against stress or depressive symptoms among older adults (Lampinen et al., 2000; Douglas et al., 2017; Willie-Tyndale et al., 2016).

Besides the above-mentioned studies focused on the general population, a few other studies conducted under non-disaster conditions have also demonstrated the benefits of social participation for the mental health of post-disaster survivors (Wickrama et al., 2011; Rung et al., 2017; Watanabe et al., 2004). Yet, evidence relating to survivors' mental health status prior to disaster events is very sparse (Yamamura et al., 2015; Tsuji et al., 2017). Most researchers have documented the mental health status of survivors using the self-recall method that clearly entails bias. We recently reported that encouraging participation in groups that involved physical activity (e.g. walking) was beneficial for the mental health of older survivors affected by the earthquake and tsunami (Tsuji et al., 2017). Nonetheless, this study was focused on encouraging physically active forms of social participation and did not consider a broader set of activities involving participation in civic associations such as hobbies, informal socializing, or voluntary work. Another previous study showed pre-disaster social support is protective for post-disaster depression (Sasaki et al., 2019). Yet, that study was focused on informal socializing support only, and the evidence for participation in civic associations was not examined.

In light of the above research gaps, we investigated associations between diverse types of participation in civic associations and depressive symptoms among older survivors, taking advantage of the availability of pre-disaster data. This study hypothesizes that participation in different types of civic associations protects older adults against depressive symptoms following a disaster. This protective role may differ by the damaging effect of the disaster.

2. Methods

2.1. Study design and participants

For this study, we used data from the Iwanuma study, which is part of an ongoing nationwide prospective cohort study known as the Japan Gerontological Evaluation Study (JAGES) (Kondo, 2016; Kondo et al., 2018). The baseline survey for this study, conducted in August 2010, comprised a self-administered questionnaire that was mailed to respondents aged 65 years and above who were residents of Iwanuma. Seven months after the baseline of the cohort was established, a Richter scale 9.0 earthquake struck the northeastern coastline of Japan. Given the proximity of Iwanuma City from the earthquake's epicenter (80 km), the tsunami killed 187 persons outright and destroyed 5428 houses. A follow-up mail survey was conducted in October 2013 (about 2.5 years after the disaster), in which eligible survivors were asked about their personal experiences of the disaster, including damage or loss of their homes or family members. Trained investigators also visited the survivors and gathered information about their socioeconomic conditions.

As shown in Fig. 1, at the baseline, 5058 residents agreed to participate in the study (participation rate: 59.0%). Of these residents, 4957 were valid respondents. In total, 4380 respondents were eligible to participate in the follow-up survey. After excluding 832 respondents because of non-responses or invalid consent forms, 3567 panel samples remained and were included in the present analysis.

The survey protocol applied in the present study was approved by the ethics review committees of the Harvard T.H. Chan School of Public Health, Tohoku University, Nihon Fukushi Univ qersity, and Chiba University. All of the individuals who answered this self-administered questionnaire provided their informed consent to participate in the study.

2.2. Measurements

2.2.1. Outcome: changes in depressive symptoms

We assessed depressive symptoms using the 15-item Geriatric Depression Scale (GDS) as a continuous variable in 2010 and 2013 (Wata et al., 2003; Burke et al., 1991). With a cutoff point of five on the scale, the 15-item scale has a sensitivity of 92% and a specificity of 81% to detect major depression as ascertained by a structured clinical interview (Lyness et al., 1997). A validity and reliability study has also shown the Japanese Version of the Geriatric Depression Scale 15 (GDS-15-J) was a clinically applicable screening instrument for depression (Sugishita et al., 2017). A higher GDS score reflected more severe depressive symptoms. A change in depressive symptoms, considered as this study's outcome, was defined as the difference between the scores in 2013 and 2010.

2.2.2. Exposures: changes in participation in civic associations

Both surveys conducted in 2010 and 2013 included the following items: "How often do you participate in sports/hobby/voluntary groups/the senior citizens' club?" Respondents chose one of the following responses: "4 days/week or more," "2–3 days/week," "once a week," "1–3 time(s) per month," "a few times per year," and "never." The responses were converted into the following continuous variables: 260, 130, 52, 24, 6, and 0 day(s) per year. Therefore, changes in each group's participation were calculated by subtracting the frequency measured in 2010 from that measured in 2013.

2.2.3. Covariates

Drawing on a previous study (Tsuji et al., 2017), we considered variables previously reported to be correlated with the participation of older adult survivors in sports groups as potential confounders.

2.2.3.1. Demographic characteristics. The following categories were used to assess changes in respondents' drinking and smoking habits: "current drinker/smoker," "ex-drinker/smoker," and "never been a drinker/smoker." We calculated changes in instrumental activities of daily living (IADL) by subtracting the score obtained for the Tokyo Metropolitan Institute of Gerontology Index of Competence (TMIG-IC) in 2010 from that obtained in 2013.

2.2.3.2. Socioeconomic variables. The socioeconomic variables included in the study were educational status and changes in housing condition, employment status, and equivalized household incomes. Respondents self-reported their educational status at the baseline by selecting one of the following options: "$<$ 6 years," "6–9 years," "10–12 years," "$\geq$ 13 years," "other," and "undergraduate and graduate education."

Changes in employment were recorded using one of the following options: "lost job temporally, but resumed again after the disaster," "lost job permanently," "was not employed prior to the disaster,"

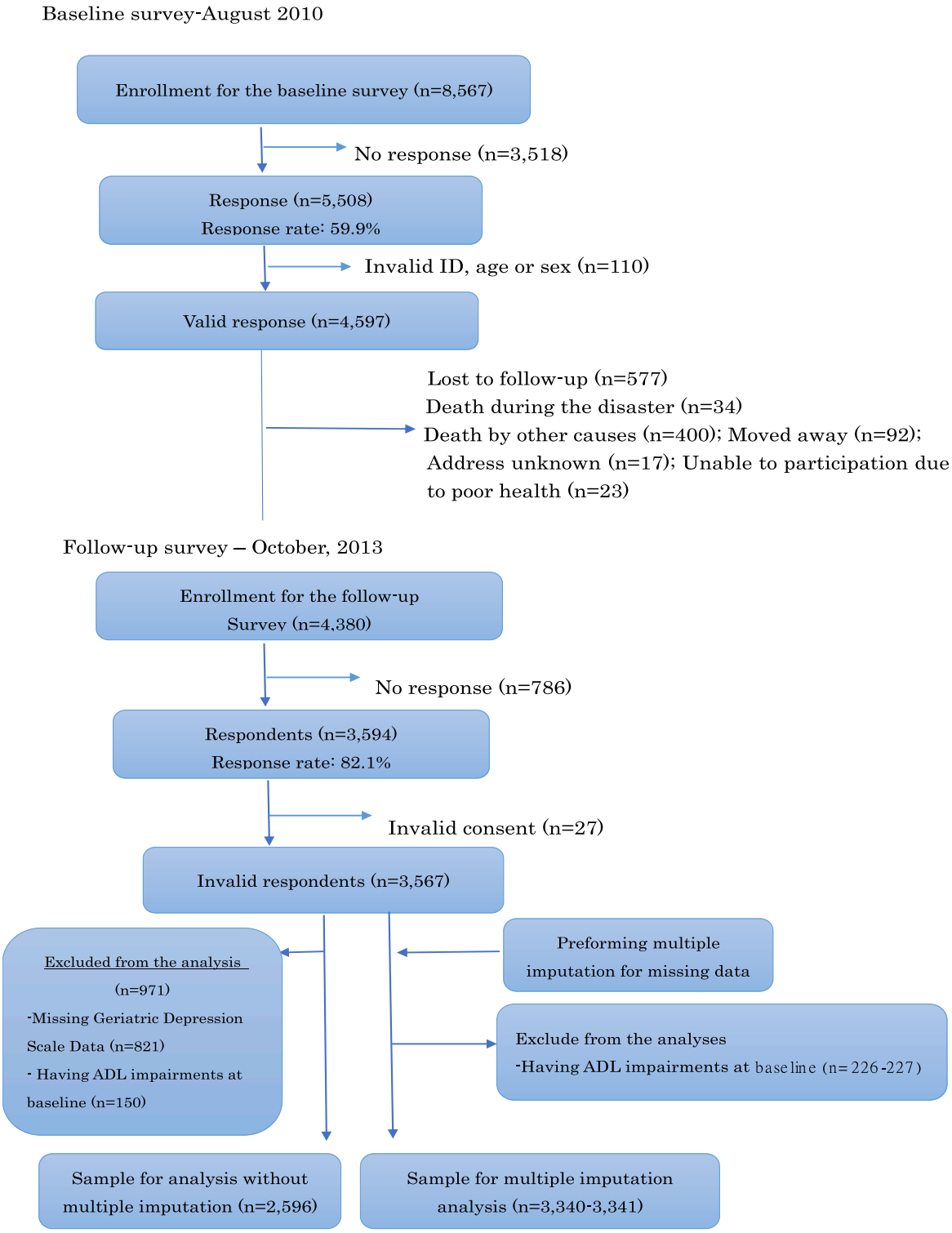

Fig. 1. Flow of participants into study.

"continuously employed without interruption," and "found new employment after the disaster". Income changes were calculated by subtracting self-reported equivalent household income in 2010 from that in 2013.

2.2.3.3. Assessment of disaster-related experiences. Damage to housing caused by the disaster was decided based on objectively established criteria for compensation of victims. The properties were surveyed by at least two technical officers and classified the damage into five options: 1 = "no damage," 2 = "partial damage," 3 = "minor damage," 4 = "major damage," and 5 = "destroyed." (Hikichi et al., 2016). Loss of family members/relatives and friends caused by the disaster was indicated by

"yes" or "no" responses.

2.3. Statistical analyses

We excluded 971 subjects from the 3567 panel samples because of missing GDS data (n = 821) or ADL impairment at the baseline (n = 150). Chi-squared tests were performed to compare the prevalence of changes in GDS scores for different demographic, socioeconomic, and post-disaster characteristics of individuals in the remaining 2596 samples. To mitigate any attrition bias emerging from the participants, we conducted a comparative analysis of participant characteristics, excluding those whose data were incomplete and who did not report ADL impairment at the baseline ($n = 1431$) and those whose data were missing or had ADL impairments at the baseline ($n = 2136$) (see Table A1 in the online Appendix).

Prior to conducting the main analyses, we conducted multiple imputations, applying the missing-at-random (MAR) assumption to handle missing values for all of the covariates in the 2010/2013 surveys. We created a total of 20 imputed datasets and combined the estimated parameters using Rubin's combination method (Rubin, 2004) (see Table 1).

In the main analysis, we applied a linear regression model to examine the association between changes in respondents' frequency of participation in sports/hobby/voluntary groups/the senior citizens' club and changes in depressive symptoms. Changes in the participation of individuals in each group as well as changes in GDS scores were entered as continuous variables. Table 2 shows the age- and sex-adjusted results and the multivariate-adjusted results expressed as coefficients. We also computed a regression model with an interaction term between the damaging effects (damage to homes) and changes in participation in sports/hobby/voluntary groups/the senior citizens' club. Table 3 presents the results. We also conducted a sub-analysis (see Table 7 in the online Appendix) to examine the associations between changes in sports or hobby group participation and changes in depressive symptoms stratified by housing damage (with or without housing damage).

Additionally, we conducted a multiple logistic regression analysis to identify the associations between change in frequency in participation in sports/hobby/voluntary groups/the senior citizens' club and incidence of depressive symptoms (GDS score<5 in 2010 but≥5 in 2013). Odds ratios (OR) and 95% CIs for increased GDS appear in Table A8 in the online Appendix.

Statistical significance of all the above analyses was defined as a 2-sided P-value < 0.05 and the marginal significance as P-value < 0.10. All the analyses were performed using the SAS software suite, version 9.4 (SAS Institute Inc., Cary, NC, USA).

3. Results

The mean change in survivors' GDS scores between the pre-disaster and post-disaster periods was +0.13 (SD = 2.88). Between 2010 and 2013, average changes in the frequency of social participation of individuals in the sports, hobby, and voluntary groups and the senior citizens' clubs were +0.36 (SD = 47.95) days/year, −5.63 (SD = 50.45) days/year, 0.51 (SD = 32.16) days/year, and −1.45 (SD = 23.44) days/year, respectively.

Table 1 shows the characteristics of participants without missing GDS data in either 2010 or 2013 (2596) or those with ADL impairments at the baseline. Of these participants, 1557 (60.0%) showed decreased or unchanged GDS scores while 1039 (40.0%) showed increased GDS scores during this period.

The participants whose GDS scores decreased or did not change were more likely to be those whose participation in the sports or hobby groups (65.2% and 67.6%, respectively) increased during the three-year period. They were also more likely to be under 75 years of age, with impaired ADL or decreased IADL scores during this period.

Compared with the participants whose GDS scores increased, those

Table 1
Baseline characteristics of participants ($n = 2596$).

		Decreased or non-change in GDS score	Increased in GDS score	*P*
Frequency of participation in Sports Group	Decreased or non-change	1345 (59.2%)	926 (40.8%)	0.039
	Increased	212 (65.2%)	113 (34.8%)	
Frequency of participation in Hobby Group	Decreased or non-change	1334 (58.9%)	932 (41.1%)	0.003
	Increased	223 (67.6%)	107 (32.4%)	
Frequency of participation in Volunteer Group	Decreased or non-change	1404 (59.6%)	953 (40.4%)	0.181
	Increased	153 (64.0%)	86 (36.0%)	
Frequency of participation in Senior citizens' club	Decreased or non-change	1455 (59.8%)	978 (40.2%)	0.484
	Increased	102 (62.6%)	61 (37.4%)	
Sex	Men	732 (58.5)	519 (41.5)	0.142
	Women	825 (61.3)	520 (38.7)	
Age (years)	≤75	868 (63.5%)	499 (36.5%)	<0.001
	>75	689 (56.1%)	540 (43.9%)	
Educational attainment	<6 years	11 (44.0%)	14 (56.0%)	0.012
	6–9 years	469 (56.7%)	358 (43.3%)	
	10–12 years	723 (61.4%)	455 (38.6%)	
	≥13 years	339 (63.3%)	197 (36.8%)	
	Others	4 (36.4%)	7 (63.6)	
Impaired ADL	No	1503 (61.3%)	948 (38.7%)	<0.001
	Impaired	54 (37.2%)	91 (62.8%)	
Drinking habits	Current drinker	557 (61.3%)	351 (38.7%)	0.678
	Ex-Drinker	75 (51.4%)	71 (48.6%)	
	Never-drinker	918 (60.0%)	611 (40.0%)	
Smoking status	Current smoker	145 (63.9%)	82 (36.1%)	0.839
	Ex-smoker	228 (54.8%)	188 (45.2%)	
	Never-smoker	1175 (60.5%)	766 (39.5%)	
Damage to house	No damage,	658 (63.1%)	385 (36.9%)	<0.001
	Partial damage	688 (61.1%)	439 (39.0%)	
	Minor damage	91 (48.2%)	98 (51.9%)	
	Major damage	56 (60.9%)	36 (39.1%)	
	Destroyed	36 (36.0%)	64 (64.0%)	
Loss of family members or relatives	No	1143 (60.4%)	749 (39.6%)	0.458
	Yes	414 (58.8%)	290 (41.2%)	
Loss of friends	No	1310 (59.8%)	882 (40.2%)	0.604
	Yes	247 (61.1%)	157 (38.9%)	
Change of living arrangement due to earthquake	No change	1463 (60.8%)	942 (39.2%)	0.042
	Deliver to temporary housing with community	16 (32.7%)	33 (67.4%)	
	Deliver to temporary housing by other ways	4 (57.1%)	3 (42.9%)	
	Rental accommodation	11 (44.0%)	14 (56.0%)	
	New bought	22 (52.4%)	20 (47.6%)	
	Others	9 (64.3%)	5 (35.7%)	
Change of job	Lost job temporally, but	20 (50.0%)	20 (50.0%)	0.070

(continued on next page)

Table 1 (*continued*)

		Decreased or non-change in GDS score	Increased in GDS score	*P*
	resumed again after the disaster			
	Lost job permanently	48 (46.2%)	56 (53.9%)	
	Was not employed prior to the disaster	651 (40.7%)	952 (59.4%)	
	Continuously employed without interruption	351 (65.7%)	183 (34.3%)	
Found new employment after the disaster	13 (52.0%)	12 (48.0%)		
Change of economic status due to earthquake	Worse	80 (49.7%)	81 (50.3%)	<0.001
	A little worse	237 (55.4%)	191 (44.6%)	
	No change	1218 (62.1%)	743 (37.9%)	
	Better	4 (50%)	4 (50%)	
Mean IADL score (SD)	Pre-disaster	12.34 (0.04)	12.11 (0.05)	<0.001
	Post-disaster	12.06 (0.07)	11.34 (0.08)	<0.001
Change in mean IADL Score (SD)		−0.261 (0.06)	−0.760 (0.06)	<0.001
Mean equivalent income (SD) (million JPY)	Pre-disaster	256.36 (4.78)	239.86 (5.38)	0.022
	Post-disaster	244.12 (4.52)	225.76 (5.09)	0.007
Change in mean equivalent income (SD) (million JPY)		−7.52 (4.15)	−14.41 (4.72)	0.273

GDS: Geriatric Depression Scale.
ADL: activities of daily living.
IADL: instrumental activities of daily living.

with decreased or unchanged GDS scores were more likely to have educational backgrounds spanning 10–12 years (61.4% vs. 38.6%) or higher (63.3% vs. 36.8%). They were also less likely to experience decreased incomes during this period. In addition, the participants with decreased or unchanged GDS scores were more likely to have experienced no damage to their homes (63.1%) or less than 50% damage to their homes (61.1%). Consequently, they not only had higher IADL scores both pre-disaster and post-disaster, but also had less decline in mean IADL scores during the three years ($P < 0.01$).

Table A1 in the online Appendix presents the results of the comparative analysis. We observed significant differences in the mean GDS scores and the frequencies of social group participation between both groups. Yet, changes in these variables did not differ significantly between the two groups. Participants with missing data or ADL impairments at the baseline were more likely to be older and female and report higher educational qualifications, decreased income levels, and lower IADL scores.

Table 2 shows the association between changes in the frequency of diverse types of group participation and changes in depressive symptoms. These results were obtained using multiple imputed datasets within linear regression models. Increases in the frequency of participation in the sports and hobby groups ($B = -0.003$, $P < 0.01$ and $B = -0.003$, $P = 0.01$, respectively) were associated with significantly decreases in depressive symptoms. The results remained statistically significant after adjusting for all covariates ($B = -0.003$, $P = 0.01$ and $B = = 0.002$, $P = 0.04$, respectively). Cohen's f^2 of B was 0.10 and 0.08, respectively, which indicated modest effect sizes. We observed that increases in the frequency of participation of the voluntary group and senior citizens' clubs were associated with significantly decreased levels of depressive symptoms in the age- and sex-adjusted models. Yet, this relationship was attenuated to statistical non-significance in the multivariate-adjusted model. In addition, we conducted a sub-analysis of 1431 participants, excluding those whose data were incomplete. The results are similar to those obtained for the main analysis (Table A9 in the online Appendix).

In the model incorporating the interaction terms, the change in sports or hobby group participation * housing damage is not significant. This finding indicates no significant difference in change in GDS according to change in participation between individuals affected by a disaster and those who were not (Table 3). In other words, participation is similarly protective irrespective of disaster trauma.

Table A8 in the online Appendix reports the odds ratios (OR) and 95% CIs for newly identified depressive symptoms ranging from mild to severe (GDS score < 5 in 2010 but ≥ 5 in 2013) per unit change in the frequency of participation in civic associations obtained from multiple logistic regression analyses. We observed trends similar to those in the multiple linear regression models. The risk of exhibiting depressive symptoms significantly decreased in those who recorded increased frequency in sports group participation (OR = 0.66; 95% CI: 0.46–0.95; $p < 0.01$) compared with participants who reported decreased or unchanged frequency. This relationship did not change in the multivariable-adjusted model (OR = 0.80; 95% CI: 0.65–0.99; $p = 0.04$). Changes in other forms of civic associations were also inversely associated with the risk of exhibiting depressive symptoms, but these associations were not significant.

4. Discussion

We found that the increased frequency of participation in sports and hobby groups had a protective effect against worsening depressive symptoms among older adults in a post-disaster context. The preventive effects may not differ depending on the experience of housing damage caused by the disaster.

In the present study, survivors' GDS scores increased on average by

Table 2
The results of multiple linear regression performed to assess associations between changes in frequency of participation in civic associations and changes in depressive symptoms (*Ns* = 3340–3341).

	Model 1[a]			Model 2[b]			
	B	t	Pr > |t|	B	Effect Size (Cohen's f^2)	t	Pr > |t|
Change in frequency of sports group participation	−0.003	−2.82	<0.01	−0.003	0.10	−2.52	0.01
Change in frequency of hobby group participation	−0.003	−2.56	0.01	−0.002	0.08	−2.06	0.04
Change in frequency of volunteer group participation	−0.002	−4.53	<0.01	−0.001	0.08	−0.65	0.51
Change in frequency of senior citizens' club participation	−0.004	−8.18	<0.01	−0.003	0.08	−0.98	0.33

[a] Adjusted for age and sex.
[b] Further Adjusted for educational attainment, impaired ADL, change in drinking habits, change in smoking status, change in job status, dwelling house damage, death of family members, change in equivalent income, change in IADL score.

Table 3
Results of multiple linear regressions performed to assess associations between changes in frequency of participation in sports/hobby group and changes in depressive symptoms (*Ns* = 3340–3341).

	B	t	Pr > |t|		B	t	Pr > |t|
Change in frequency of sports group participation	−0.006	−2.11	0.04	**Change in frequency of hobby group participation**	−0.004	−1.94	0.05
Age (year)	0.002	0.25	0.80	**Age (year)**	0.004	0.43	0.67
Sex (1 men, 2 women)	−0.12	−0.94	0.35	**Sex (1 men, 2 women)**	−0.13	−1.04	0.30
Educational attainment	0.12	1.79	0.07	**Educational attainment**	0.12	1.79	0.07
Impaired ADL (0 no, 1 impaired)	0.64	2.30	0.02	**Impaired ADL (0 no, 1 impaired)**	0.65	2.35	0.02
Changes in drinking habits				**Changes in drinking habits**			
Drink-non	−0.50	−1.46	0.14	Drink-non	−0.53	−1.57	0.12
Non-non	0.24	1.08	0.28	Non-non	0.25	1.12	0.26
Non-drink	−0.04	−0.27	0.79	Non-drink	−0.03	−0.23	0.82
Changes in smoking habits				**Changes in smoking habits**			
Smoke-non	0.99	3.01	<0.01	Smoke-non	0.96	2.90	<0.01
Non-non	1.75	2.13	0.03	Non-non	1.75	2.12	0.03
Non-smoke	0.19	1.01	0.31	Non-smoke	0.17	0.93	0.35
Changes in job status				**Changes in job status**			
Work-new work	0.51	1.82	0.07	Work-new work	0.53	1.90	0.06
Non-non	0.17	1.41	0.16	Non-non	0.16	1.35	0.18
Work-non	0.52	0.88	0.38	Work-non	0.53	0.90	0.37
Dwelling house damage				**Dwelling house damage**			
(1 no damage; 5 complete destruction)	0.20	3.66	<0.01	(1 no damage; 5 complete destruction)	0.20	3.64	<0.01
Death of family members				**Death of family members**			
(0 no; 1 yes)	−0.05	−0.53	0.60	(0 no; 1 yes)	−0.06	−0.59	0.56
Change in equivalent income	−0.001	−1.41	0.16	**Change in equivalent income**	−0.001	−1.38	0.17
Change in IDAL score	−0.29	−7.76	<0.01	**Change in IDAL score**	−0.29	−7.69	<0.01
Interaction				**Interaction**			
Change in frequency of sports group participation * house damage	0.002	1.24	0.21	Change in frequency of hobby group participation * house damage	0.001	1.11	0.27

GDS: Geriatric Depression Scale; ADL: activities of daily living; IADL: instrumental activities of daily living.

0.126 points between the pre-disaster and post-disaster periods. In the 2010 survey, there were 1026 participants (30.7%) in total who could be considered to have mild to severe depressive symptoms. In our post-disaster survey, the prevalence of depressive symptoms among all of the participants was 32.1%. Being consistent with previous studies (Wada et al., 2003; Wada et al., 2004; Sasaki et al., 2015), the prevalence of depression comparing pre and post-disaster surveys was relatively stable. Yet, during this 2.5-year follow-up period, mild to severe depressive symptoms (GDS ≥5) were newly identified in 15.3% of those without depressive symptoms at the baseline survey. A previous study has reported the same incidence among the older survivors in Iwanuma Study (Tsuji et al., 2017). The same depressive symptoms were assessed in a concurrent study covering 37,193 adults dispersed across Japan, most of whom were not directly affected by the 2011 disaster. The incidence of the onset of mild to severe depressive symptoms reported in this study was 11.8% (Tani et al., 2015). It suggests that the disaster may have imposed a considerable psychological burden following the tsunami among old adults living in disaster areas.

The present study is also the first to demonstrate the protective role of participation in a hobby group against worsening scores for depressive symptoms among older adults in a post-disaster context. Several previous studies have shown that engagement in hobbies plays a beneficial role in subjective life quality and other indicators of mental health status, such as depressive symptoms and the frequency of laughter exhibited by older adults Japanese adults (Onishi et al., 2006; Hirosaki et al., 2009). A recent cohort study conducted in 8780 English adults aged 50+ years found that engagement in hobby activities was associated with lower odds of developing depression or an improvement in depressive symptoms amongst both men and women (Fancourt et al., 2020). Another recent study in 5094 Japanese older adults whose mean age was 75.9 years also reported that promoting community activities, including hobby groups may protect against depressive mood in this population (Okura et al., 2017). According to the findings of a previous study conducted in Japan, hobby-related activities in which the participants engaged not only comprised fancywork, pottery making, technical art, painting, and group singing but they also included traditional Japanese arts and rituals, such as tea ceremonies, flower arrangements, and calligraphy (Tomioka et al., 2017). Participation in hobby groups may be beneficial for individuals' mental health in the following ways. First, frequent participation in hobby-related activities may help to relieve psychological distress and provide recreation (Bannai A, Tamakoshi A, 2014). Second, similar to other types of groups, hobby groups may provide social connections and opportunities to interact with others that could contribute to exchanges of instrumental and emotional support among members. In a post-disaster context, social support is especially important for coping with memories of the disaster and facilitating the recovery of survivors who underwent traumatic experiences.

Many studies have demonstrated that physical activities or exercises contribute to reducing depressive symptoms in older people (Catalan-Matamoros et al., 2016; Park et al., 2014). Physical activities may alleviate depressive symptoms through their thermogenic effects, the release of endorphins, the enhancement of aminergic synaptic transmissions within the central nervous system (Ransdord et al., 1982), and by stimulating the growth of new nerve cells (van Praag et al., 1999). Furthermore, although both group and individual exercise programs have been shown to be effective in lowering the symptoms of depression (Stanton et al., 2014), some other studies suggest that compared with exercising alone, exercising with others in a socially engaged manner may augment health benefits by providing social connections, social support, peer bonding, and improved self-esteem (Eime et al., 2013; Emie et al., 2010). A recent cross-sectional study conducted among 21, 684 older adults Japanese adults reported that the subjective health status of individuals who exercised with others was better than that of individuals who exercised alone (Kanamori et al., 2016). Another recent panel study conducted as part of the Iwanuma project similarly found that participation in group exercise programs or regular walking may have a protective effect against the worsening of depressive symptoms among 2011 disaster survivors (Tsuji et al., 2017). The findings of this study support those of earlier studies. The combination of physical activity and civic association participation may relieve stress or depressive feelings among older adults 2011 disaster survivors.

This study also suggests that the inverse relationship between sports or hobby group participation and depressive symptoms may not differ according to the experience of housing damage caused by the disaster.

This result is inconsistent with a previous study, which found that the protective role of walking or exercise tends to be attenuated among those who reported more housing damage (Tsuji et al., 2017). Yet, the reasons for this finding are unclear. It is possible that survivors with greater housing damage walked out of compulsion and not voluntarily (Tsuji et al., 2017). Nevertheless, both the previous and present studies suggest the need to increase the frequency of sports group participation among older survivors following a disaster.

In this study, we could not find psychological benefits from voluntary group participation among older people. There are several reasons why participation in voluntary groups would yield mental health benefits, especially for older adults. Volunteering improves access to social networks and psychological resources that may help lift depression (Musick et al., 2003). Moreover, volunteering induces positive feelings among participants, invoking a feeling of being useful and helping others (Morrow-Howell et al., 2010). Several previous studies on this topic have suggested that participation in voluntary groups is associated with improved psychological well-being among older adults (Tomioka et al., 2017; Musick et al., 2003, 2004, Morrow-Howell et al., 2010, Iwasaki et al., 2017). Our findings were inconsistent with those of some previous studies. Two points are noteworthy here. First, individuals participating in voluntary groups care more about those who need help and/or support from volunteers than about themselves. Consequently, volunteering may induce feelings of self-sacrifice (Morrow-Howell et al., 2010). A previous study also demonstrated the positive effect of a moderate level of volunteering on older adults (<40 h/year), but not of frequent participation (≥40 h/year) (Musick et al., 2004). Yet, this information on the duration of volunteering was not available at the time of our study. Therefore, a comparison of "moderate participation," as defined in the two studies is difficult. Additionally, the types of volunteering activities have not been identified. Because the present study was conducted prior to and after the 2011 disaster, we assumed that most of the volunteering activities were related to disaster recovery. Consequently, volunteering may induce a heavier psychological burden and pressure by reinforcing memories of the disaster.

Very few studies have focused on the effect of senior citizens' clubs, and their results have been inconsistent. A previous study discussed the potential difference in the relationship between bonding versus bridging social capital and health outcomes. Bonding social capital refers to connections forged among people who share similar social-demographic characteristics such as age or ethnicity. Bridging social capital is derived from connections between people from diverse backgrounds. The above study reported that whereas bridging social capital is inversely associated with poor self-rated health for both sexes, bonding social capital is not associated with better health for either sex (Iwase et al., 2012). Similarly, we did not find benefits from bonding social capital (participation in senior citizens' clubs) for mental health status. By contrast, another study conducted among older Japanese adults suggested that bonding social capital, for example, through clubs for older adults, is associated with better self-reported health in men but not in women (Kishimoto et al., 2013). It is difficult to explain the inconsistent effects of senior citizens' clubs. As a type of social connection or social capital, senior citizens' clubs appear to help older adults by alleviating mental stress to some extent. Yet, unlike other open social or hobby groups, senior citizens' clubs are more likely to include a limited sample of participants (65 years and above) within a limited area (neighborhood). As previously mentioned, stronger bonding within disadvantaged communities may be detrimental to the health of residents (Kawachi, 2006). Participation in senior citizens' clubs is not necessarily associated with protection against depressive symptoms.

4.1. Strengths and limitations

A major strength of this study lies in its methodological design. The problem of recall bias, which is common in post-disaster studies, was effectively minimized using available pre-disaster information about the participation of distinct types of social groups and the scoring of depressive symptoms as well as other health conditions. Yet, the study had several limitations. First, as also noted in a previous study (Tsuji et al., 2017), the assessment of the frequency of social participation was entirely based on self-reporting, which may have led to information bias. Depressed individuals may be more likely to under-report the frequency of their social participation. Second, because the present study only included the participants who provided invalid answers in both the 2010 and 2013 surveys, selection bias may have occurred. Third, because a standardized questionnaire was not available, assessments of participation in each social group were solely based on frequency. Therefore, future studies should include assessments of the intensity, participation time, and precise types of activities of the groups. Fourth, the effect sizes (as indicated by Cohen's f^2 statistics) were modest. In contrast, our effect sizes were constrained by the relatively short period of follow-up. More sustained social participation over longer follow-up periods may result in larger cumulative benefits for mental health. Finally, we cannot discount the possibility that individuals' deteriorating mental status could result in the decreased frequency of their participation in sports/hobby groups. Alternatively, they could be more likely to increase the frequency of their participation in sports/hobby groups, as their GDS scores showed an improvement (Tsuji et al., 2017). Still, the results of our sub-analyses suggest that higher frequencies of participation in pre-disaster social groups were significantly associated with lower post-disaster depressive symptoms (online Appendix Table A9). Therefore, we concluded that an increase in the frequency of participation in sports/hobby groups was predictive of decreases in depressive symptoms among older adult survivors.

5. Conclusions

The current study found that the increase in the frequency of participation in civic associations after a disastrous event could be independently protective against worsening depressive symptoms in older survivors. Yet, participating civic associations may not mitigate the adverse impact of disaster experience on mental health. Findings suggest that early improvements in the provision of opportunities for engaging in group exercises and hobby-related activities among survivors would be an effective strategy for preventing depression following natural disasters.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.socscimed.2021.113827.

Credit author statement

Wen Zhang Designed and conducted the study, did the analysis and wrote the paper. Ichiro Kawachi and Katsunori Kondo contributed to the conception of the study. Jun Aida, Taishi Tsuji, Meiko Yokoyama and Kazushige Ide helped perform the analysis with constructive discussions.

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