Six-year follow-up study of residential displacement and health outcomes following the 2011 Japan Earthquake and Tsunami

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Studies examining the long-term health consequences of residential displacement following large-scale disasters remain sparse. Following the 2011 Japan Earthquake and Tsunami, victims who lost their homes were resettled by two primary means: 1) group relocation to public housing or 2) individual relocation, in which victims moved into public housing by lottery or arranged for their own accommodation. Little is known about how the specific method of residential relocation affects survivors' health. We examined the association between residential relocation and long-term changes in mental and physical well-being. Our baseline assessment predated the disaster by 7 mo. Two follow-up surveys were conducted ∼2.5 y and 5.5 y after the disaster to ascertain the long-term association between housing arrangement and health status. Group relocation was associated with increased body mass index and depressive symptoms at 2.5-y follow-up but was no longer significantly associated with these outcomes at 5.5-y follow-up. Individual relocation at each follow-up survey was associated with lower instrumental activities of daily living as well as higher risk of cognitive impairment. Our findings underscore the potential complexity of long-term outcomes associated with residential displacement, indicating both positive and negative impacts on mental versus physical dimensions of health.

natural disaster | residential displacement | depression | cognitive impairment | functional limitation

Large-scale disasters are associated with three broad categories of health threats: 1) traumatic stressors that occur during or immediately after the event (e.g., injury or loss of loved ones); 2) resource loss, including property damage and income loss; and 3) ongoing adversities, including relocation, displacement, and social isolation (1).

Relatively few studies have documented the lingering, long-term health consequences of relocation and residential displacement. Older survivors of disaster are particularly vulnerable to long-term health consequences due to their risks of being socially isolated (e.g., widowhood or family members moving away from the disaster area) or because of their preexisting frailty. Previously, we demonstrated that 2.5 y after the 2011 Japan Earthquake and Tsunami older survivors were at higher risk of functional disability (2), cognitive decline (3), depressive symptoms (4), and deteriorated cardiometabolic profiles (body mass index [BMI], waist circumference, high-density lipoprotein cholesterol level, and systolic blood pressure) (5).

Major disasters also cause involuntary relocation of residents owing to devastating damage to domiciles and communities, resulting in the fragmentation of social ties (6)—also referred to as "social capital" (7). Immediately after the disaster, survivors who lost their homes in the 2011 Earthquake and Tsunami were accommodated in crowded emergency shelters. Gradually, as local municipalities constructed temporary housing villages, survivors were given a choice about the method of relocation: 1) group relocation, in which whole communities were moved together into public prefabricated temporary housing villages (*kasetsu jutaku*, which resembled FEMA [Federal Emergency Management Agency]–style trailer parks in the United States) or 2) individual relocation, in which people could choose between moving into public housing via random lottery, elect to seek housing in the open rental market, or build new homes at their own expense. The random lottery offered the advantage that survivors could escape the crowded emergency shelters sooner, as compared to waiting for enough temporary homes to be built to allow whole communities to move together. However, the disadvantage (compared to group relocation) was increased risk of becoming detached from predisaster social relations with neighbors and being randomly resettled among strangers in the temporary housing village.

Previously, we demonstrated that group relocation helped to preserve social capital 3 y after the disaster, whereas individual relocation attenuated their social ties (8). Moreover, we showed that preserving social connections in the community strengthens the survivors' resilience to developing adverse mental and physical health outcomes (9–11).

In the present study, we document the 5.5-y postdisaster follow-up of a cohort of community-dwelling older adults who were

Significance

The long-term health consequences of residential relocation following large-scale natural disasters remain poorly understood. We implemented a longitudinal study following the 2011 Earthquake and Tsunami in which survivors were relocated to temporary housing by different means: group relocation versus individual relocation. Group relocation was adversely associated with weight gain and depressive symptoms. An implication of our findings is that moving survivors into a highly dense environment conducive to social gatherings may paradoxically promote unhealthy changes in behavior (e.g., drinking and snacking). By contrast, we found that individual relocation was associated with deteriorated instrumental activities of daily living and cognitive function. The resettlement of survivors can have complex effects on physical and mental well-being, depending on the method of relocation.

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exposed to the 2011 Great East Japan Earthquake and Tsunami. During the follow-up period, we had the opportunity to observe two waves of mass relocation. In the first wave of relocation (occurring months after the disaster), survivors who lost their homes were relocated to temporary housing. In the second wave of relocation, which occurred at the end of April 2016, the local government closed down temporary houses (and terminated exemption from payment of rent for people in rental housing) and opened a permanent housing community comprising a mix of new private housing and government-provided rental housing. Survivors were again given two choices to choose from: 1) group relocation to the permanent housing community or 2) individual relocation to private housing.

Results

Comparing our analytic sample with data from the local census at baseline (*SI Appendix*, Table S1), we can see that women made up 55.8% of our analytic sample, which is quite comparable to the actual census of older residents conducted in the city of Iwanuma in October 2010 (male 42.8%, female 57.2%) (12). The age distribution of our sample is younger than the local census data (respondents 66.7%, census data 51.8%, for groups aged 65 to 74 y) (12). A higher proportion of respondents in our sample were married (75.6%) compared to the census data (64.7%) (12). The proportion of working people in our data (19.5%) is also close to the census data (17.2%) (12). These comparisons support the representativeness of our data relative to Iwanuma as a whole.

Table 1 presents the characteristics of respondents at baseline (before the disaster), at follow-up 2.5 y after the disaster, and at follow-up 5.5 y after the disaster. The average number of depressive symptoms increased slightly over time (3.35 at the first wave, 3.46 by the third wave). We also observed changes consistent with aging of the sample; the IADL (instrumental activities of daily living) scores decreased over the same 6-y period (12.02 at the first wave, 10.43 by the third wave). Average level of cognitive impairment also increased during follow-up (0.08 at the second survey, 0.23 at the third survey). Mean BMI slightly fell during the follow-up term (23.58 at the first wave, 23.45 by the third wave).

Among respondents who did not report relocation at either follow-up survey wave (n = 2,495), 87.6% of them had no damage or only minor damage to their houses stemming from the disaster (*SI Appendix*, Table S2). By contrast, 83 respondents experienced relocation twice during the follow-up period (*SI Appendix*, Fig. S1 *B* and *C*).

As shown in *SI Appendix*, Table S3, those who avoided relocation during the follow-up had higher educational attainment and equivalized income compared to respondents who selected individual or group relocation.

Among respondents who moved into the public temporary housing together with community residents prior to the disaster (the 15-item Geriatric Depression Scale [GDS-15] mean score 5.65 in 2013 survey), people who bought a new private housing by 2016 reported fewer depressive symptoms (GDS-15 mean score 2.84) than people who moved into government-provided collective or individual housing in a permanent housing village (GDS-15 mean scores 5.00 and 4.14, respectively) (*SI Appendix*, Fig. S1*C*).

As shown in Table 2, the random effect model showed that group relocation to public temporary housing (compared to no relocation) was associated with increased BMI and depressive symptoms at 2.5-y postdisaster follow-up (coefficient 0.79, 95% CI 0.32 to 1.27 for BMI; coefficient 1.50, 95% CI 0.78 to 2.21 for depressive symptoms). However, group relocation to the permanent housing village was no longer significantly associated with these outcomes at 5.5-y follow-up. As shown in *SI Appendix*, Table S4, group relocation to temporary housing was associated with risk of being obese (25 and over BMI) (odds 7.59, 95% CI 1.83 to 31.47).

On the other hand, individual relocation to public temporary housing, rental housing on the open market, or building new private housing was associated with lower IADL scores (coefficient −0.49, 95% CI −0.91 to −0.07) as well as higher cognitive impairment (coefficient 0.16, 95% CI 0.04 to 0.26).

Informal socializing and social participation partly explained the associations between both types of relocation and health outcomes except for depressive symptoms (model 2 in Table 2).

We also examined whether the two occasions of relocation were associated with survivors' social capital. Group relocation to public temporary housing was associated with improved informal socializing and social participation (coefficient 0.24, 95% CI 0.04 to 0.44), while individual relocation was associated with deteriorated social cohesion (coefficient −0.19, 95% CI −0.31 to −0.07) (*SI Appendix*, Table S5). Loss of loved ones during the disaster was not associated with any of the four health outcomes or social capital.

Discussion

Our study showed that group relocation to public temporary housing after the disaster is adversely associated with weight status and depressive symptoms, while group relocation to a permanent housing village did not affect these parameters. Meanwhile, individual relocation at both survey times was associated with deteriorating IADL scores and cognitive function. Informal socializing and social participation partly explained the associations between both types of relocation and health outcomes except for depressive symptoms.

We originally hypothesized that group relocation would be associated with better health conditions, since this method of relocation helps to preserve community social capital (8). Against our expectation, however, people who opted for group relocation to public temporary housing reported weight gain and deteriorated depressive symptoms. Interestingly, group relocation was no longer associated with either weight status or depressive symptoms by the second postdisaster follow-up wave, that is, 5.5 y after the disaster when temporary houses were closed down and survivors were moved into permanent accommodation.

There are several plausible reasons to explain weight gain and increased depressive symptoms when respondents experienced group relocation to public temporary housing. First, residents of public temporary housing had frequent social gatherings, resulting in weight gain. After the disaster, the residents who moved together with their neighbors to the temporary trailer housing continued to organize a variety of communal activities—for example, meeting regularly with local officials to improve the delivery of services and connecting residents to nonprofits (13). We also showed that social participation and informal socializing was increased among respondents who moved into public temporary housing (*SI Appendix*, Table S5). During these community activities, they might have shared refreshments and alcohol. Therefore, frequent social gatherings may also be a cause of increasing body weight. Results shown in *SI Appendix*, Table S4 supported this hypothesis, since informal socializing and social participation partly explained the association between relocation to public temporary housing and risk of being obese. Second, residual confounding of socioeconomic status may link to increased depressive symptoms among respondents who relocated to public temporary housing. Among them (GDS-15 mean score 5.65 in 2013 survey), people who bought new private housing by 2016 reported fewer depressive symptoms (GDS-15 mean score 2.84) than people who moved into government-provided collective or individual housing in a permanent housing village (GDS-15 mean scores 5.00 and 4.14, respectively) (*SI Appendix*, Fig. S1*C*). Respondents who could afford to purchase new private housing moved into more comfortable places, resulting in improved

Table 1. Characteristics of analytic sample at baseline and second and third waves (n = 2,664)

	Baseline: 7 mo before the disaster				Second wave: 2.5 y after the disaster				Third wave: 5.5 y after the disaster			
	Mean	SD	n	%	Mean	SD	n	%	Mean	SD	n	%
BMI	23.58	3.02			23.50	3.12			23.45	3.31		
Missing			129	4.8			60	2.3			192	7.2
Depressive symptoms (GDS-15)	3.35	3.25			3.43	3.16			3.46	3.40		
Missing			328	12.3			312	11.7			688	25.8
Higher-level IADL (TMIG index)	12.02	1.59			11.63	2.07			10.43	2.96		
Missing			138	5.2			121	4.5			394	14.8
Cognitive impairment level*					0.08	0.45			0.23	0.75		
The first relocation†												
No relocation							2,458	92.2				
Individual relocation							71	2.7				
Public temporary housing (group relocation)							51	1.9				
Missing							84	3.2				
The second relocation†												
No relocation											2,417	90.7
Individual relocation											48	1.8
Permanent housing village (group relocation)											63	2.4
Missing											136	5.1
Loss of loved ones†												
No							1,623	60.9				
Yes							1,041	39.1				
Age	72.50	5.53			75.70	5.54			78.83	5.54		
Sex‡												
Male			1,178	44.2								
Female			1,486	55.8								
Equivalized income (10,000 JPY)	231.93	137.56			220.45	134.63			216.94	139.85		
Missing			426	16.0			373	14.0			715	26.8
Education‡												
1: <6 y to 4: ≥13 y	2.88	0.75										
Missing			75	2.8								
Living alone												
No			2,391	89.8			2,343	88.0			2,066	77.6
Yes			213	8.0			273	10.2			328	12.3
Missing			60	2.2			48	1.8			270	10.1
Working												
No			1,909	71.7			2,218	83.3			1,765	66.3
Yes			462	17.3			372	14.0			282	10.6
Missing			293	11.0			74	2.7			617	23.1
Divorce or bereavement												
No			1,989	74.6			1,909	71.6			1,737	65.2
Yes			599	22.5			719	27.0			807	30.3
Missing			76	2.9			36	1.4			120	4.5

*Ranging from 0: independent to 7: Needs constant treatment in a specialized medical facility.
†Measured at only the second/third wave.
‡Empty cells due to time-invariant variables.
TMIG, Tokyo Metropolitan Institute of Gerontology; JPY, Japanese yen.

depressive symptoms, while affected people relocated to government-provided housing carried over their depressive symptoms until the third-wave survey. From this trajectory of depressive symptoms among temporary housing residents, economic deprivation could cause increased depressive symptoms for them, besides their disaster experiences.

A unique implication of our findings is that moving affected people into a highly dense environment conducive to strengthening social ties can paradoxically lead to changes in behavior (drinking and communal dining) that promote weight gain. By contrast, we found individual relocation was a cause of deteriorated IADL and cognitive function (Table 2). Health-care authorities should work to prevent the isolation of affected older survivors, but they also should pay attention to the negative side of group relocation when the living environment is radically changed after the disaster.

A major strength of this study was the length of follow-up that enabled us to observe two occasions when survivors were moved into new housing arrangements. These events provided us two opportunities to observe the effects of changes in residential environment on health outcomes. Another strength was the availability of information predating the disaster about health conditions. Our design was therefore able to effectively address the problem of recall bias that besets most studies conducted in postdisaster settings.

A limitation of this study was the possibility of selection bias due to 59% response rate at baseline survey. Nonetheless, this response rate is quite comparable to similar surveys involving community-dwelling residents (14). In addition, we confirmed that the demographic profile of our participants at baseline was similar to the rest of Iwanuma residents aged 65 y or older (*SI Appendix*,

Table 2. Relocation to public temporary housing, relocation to permanent housing, and health outcomes

	Outcome: BMI		Outcome: Depressive symptoms		Outcome: Higher-level IADL		Outcome: Cognitive decline	
	Model1: Exposures and covariates	Model2: Added social capital	Model1: Exposures and covariates	Model2: Added social capital	Model1: Exposures and covariates	Model2: Added social capital	Model1: Exposures and covariates	Model2: Added social capital
	Coef (95% CI)	Coef (95% CI)	Coef (95% CI)	Coef (95% CI)	Coef (95% CI)	Coef (95% CI)	Coef (95% CI)	Coef (95% CI)
The first relocation								
Individual relocation	−0.13 (−0.51, 0.26)	−0.13 (−0.51, 0.26)	0.27 (−0.31, 0.85)	0.07 (−0.50, 0.63)	−0.49 (−0.91, −0.07)	−0.37 (−0.78, 0.03)	0.16 (0.04, 0.27)	0.15 (0.04, 0.26)
Public temporary housing (group relocation)	0.79 (0.32, 1.27)	0.76 (0.28, 1.24)	1.50 (0.78, 2.21)	1.56 (0.86, 2.25)	−0.33 (−0.83, 0.17)	−0.44 (−0.91, 0.04)	0.13 (0.01, 0.26)	0.14 (0.02, 0.27)
The second relocation								
Individual relocation	−0.29 (−0.80, 0.22)	−0.28 (−0.79, 0.23)	0.12 (−0.71, 0.96)	−0.12 (-0.94, 0.71)	−0.52 (−1.07, 0.04)	−0.33 (−0.87, 0.20)	0.18 (0.03, 0.33)	0.16 (0.02, 0.31)
Permanent housing community (group relocation)	0.19 (−0.26, 0.64)	0.18 (−0.27, 0.63)	−0.10 (−0.77, 0.58)	0.01 (−0.65, 0.68)	−0.01 (−0.50, 0.48)	−0.07 (−0.56, 0.41)	0.16 (0.04, 0.28)	0.17 (0.05, 0.28)
Loss of loved ones	0.05 (−0.08, 0.18)	0.06 (−0.07, 0.19)	0.03 (−0.17, 0.22)	0.05 (−0.14, 0.23)	0.06 (−0.08, 0.20)	0.05 (−0.08, 0.18)	0.01 (−0.03, 0.04)	0.01 (−0.03, 0.05)
Age	−0.03 (−0.05, −0.01)	−0.03 (−0.05, −0.01)	0.05 (0.03, 0.07)	0.04 (0.02, 0.06)	−0.12 (−0.13, −0.11)	−0.10 (−0.11, −0.09)	0.02 (0.01, 0.02)	0.02 (0.01, 0.02)
Female	−0.07 (−0.30, 0.17)	−0.10 (−0.34, 0.13)	0.03 (−0.20, 0.26)	0.19 (−0.02, 0.40)	0.51 (0.37, 0.66)	0.30 (0.17, 0.43)	0.03 (0.01, 0.06)	0.05 (0.02, 0.08)
Equivalized income	0.01 (−0.01, 0.01)	0.01 (−0.01, 0.01)	−0.01 (−0.02, −0.01)	−0.01 (−0.02, -0.01)	0.01 (−0.01, 0.01)	0.01 (−0.01, 0.01)	0.01 (−0.01, 0.01)	0.01 (−0.01, 0.01)
Educational attainment	−0.34 (−0.49, −0.18)	−0.35 (−0.51, −0.20)	−0.34 (−0.49, −0.19)	−0.23 (−0.37, −0.09)	0.34 (0.25, 0.44)	0.24 (0.15, 0.33)	−0.02 (−0.04, 0.01)	−0.01 (−0.03, 0.01)
Living alone	0.10 (−0.15, 0.35)	0.09 (−0.16, 0.34)	0.53 (0.22, 0.83)	0.55 (0.26, 0.84)	0.45 (0.25, 0.66)	0.42 (0.23, 0.61)	0.01 (−0.04, 0.05)	0.01 (-0.03, 0.05)
Employment	−0.08 (−0.24, 0.08)	−0.07 (-0.23, 0.09)	−0.27 (−0.50, −0.04)	−0.28 (−0.50, −0.06)	0.03 (−0.12, 0.18)	0.06 (−0.08, 0.20)	−0.01 (−0.04, 0.02)	−0.01 (−0.05, 0.02)
Divorce or bereavement	−0.15 (−0.33, 0.03)	−0.15 (−0.33, 0.03)	0.21 (−0.03, 0.44)	0.21 (−0.01, 0.43)	−0.40 (−0.56, −0.24)	−0.39 (−0.53, −0.24)	0.05 (0.01, 0.08)	0.05 (0.01, 0.08)
Survey year								
2013 (second)	−0.02 (−0.13, 0.09)	−0.02 (−0.13, 0.09)	−0.18 (−0.34, −0.03)	−0.22 (−0.37, −0.07)	0.01 (−0.10, 0.11)	0.03 (−0.07, 0.13)	0.01 (−0.02, 0.04)	0.01 (−0.02, 0.03)
2016 (third)	0.06 (−0.09, 0.21)	0.05 (−0.10, 0.20)	−0.24 (−0.42, −0.06)	−0.24 (−0.41, −0.07)	−0.85 (−0.97, −0.73)	−0.90 (−1.01, −0.78)	0.10 (0.07, 0.13)	0.11 (0.08, 0.14)
Informal socializing		0.11 (0.05, 0.17)		−0.66 (−0.74, −0.59)		0.70 (0.65, 0.75)		−0.06 (−0.07, −0.05)
Social cohesion		−0.05 (−0.14, 0.03)		−0.84 (−0.96, −0.72)		0.25 (0.18, 0.33)		0.01 (−0.01, 0.02)
Constant	26.92 (25.22, 28.63)	26.66 (24.92, 28.40)	1.16 (−0.51, 2.84)	6.35 (4.73, 7.96)	18.81 (17.77, 19.85)	15.33 (14.34, 16.32)	−0.35 (−0.55, −0.14)	−0.13 (−0.34, 0.08)

Coef, coefficient.

Table S1). Furthermore, the participation rates of our follow-up surveys were quite high (82.1% for wave 2, 84.6% for wave 3). Also, affected people voluntarily chose a type of relocation (individual vs. group relocation) that also caused selection bias. Healthier or more socioeconomically advantaged people could buy new private housing, while the other people had no choice but to move into public temporary housing or government-provided housing. We could not exclude the potential residual confounding, although we controlled for multiple covariates in analyses. There are additional variables that we did not measure in the study, such as level of noise inside the temporary houses and changes in nutrition and physical activity. We plan to measure some of these characteristics in future studies.

In conclusion, our study suggested that group relocation to temporary trailer housing caused short-term weight gain and aggravated depressive symptoms among displaced victims of the 2011 Japan Earthquake and Tsunami, whereas individual relocation at each follow-up survey was associated with lower instrumental activities of daily living as well as higher risk of cognitive impairment. Our findings underscore the potential complexity of long-term outcomes associated with residential displacement, indicating both positive and negative impacts on mental versus physical dimensions of health, as well as dynamic patterns of change according to duration of follow-up after the disaster. In the wake of the 2011 Earthquake and Tsunami, some pilot interventions have been implemented to strengthen community engagement as a way to mitigate the effects of social isolation. For example, the *Ibasho* café program and the Hamarassen Urban Farming project in Iwate Prefecture have shown promise in reestablishing social connections between disaster-affected residents (15). The Hamarassen Urban Farming project not only provides opportunities for social engagement via community

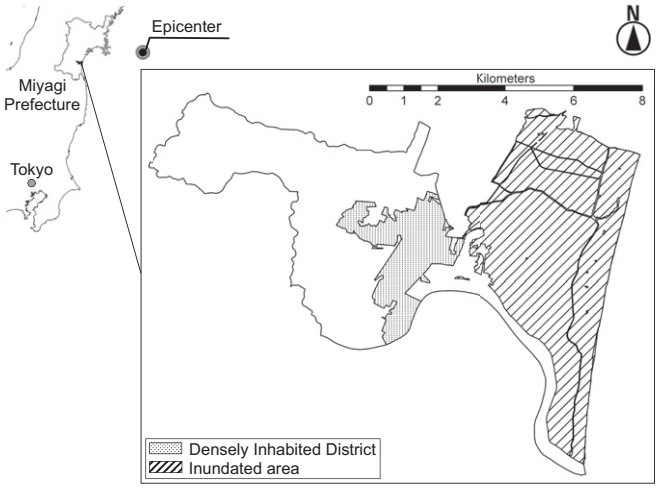

Fig. 1. Map of the tsunami-inundated area in Iwanuma, Japan.

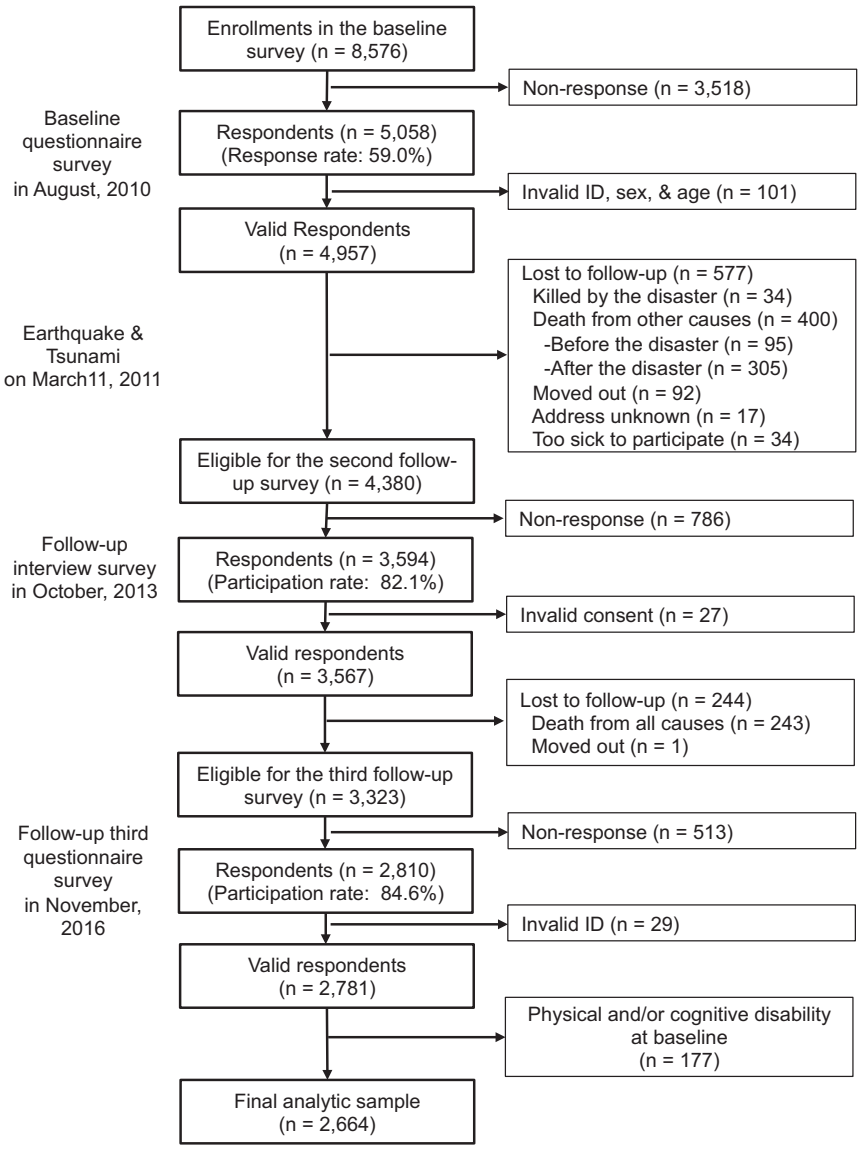

Fig. 2. Participants flow for analytic sample (n = 2,664).

farming but also encourages physical activity, which may assist in offsetting the risk of weight gain that we found in our study (16).

Methods

Study Participants. The Japan Gerontological Evaluation Study (JAGES) was established in 2010 as a nationwide sample of community-dwelling residents aged 65 y or older. One of the field sites of the JAGES cohort is based in the city of Iwanuma (total population 44,187 in 2010). We mailed questionnaires to every resident aged 65 y or older in August 2010 (n = 8,576), using the official residential register of Iwanuma. The survey inquired about personal characteristics, lifestyle, and health status. The response rate was 59.0% (n = 5,058), which is comparable to other surveys of community-dwelling residents (14).

The earthquake and tsunami occurred on 11 March 2011, 7 mo after the baseline survey was completed. Iwanuma is a coastal municipality located ~80 km west of the earthquake epicenter, so it was in the direct line of the tsunami. That disaster killed 180 of the town's residents, damaged 5,542 housing units, and inundated 48% of the land area (Fig. 1) (17).

We conducted the follow-up survey of survivors ~2.5 y after the disaster (starting October 2013). The survey gathered information about personal experiences during the disaster as well as updated information about health status. The detailed flowchart of the analytic sample is presented in Fig. 2. Of the 4,380 eligible participants from the baseline survey, we managed to recontact 3,594 individuals (participation rate: 82.1%). From the participants, 27 individuals were excluded due to incompletely signed informed consent forms.

Approximately 3 y after the second survey, we administered the third survey wave to respondents who answered the prior two surveys. We updated their health status and housing status. As shown in Fig. 2, we collected data from 2,810 individuals (participation rate: 84.6%; follow-up rate through three surveys: 68.4%) and dropped 29 respondents due to invalid identification. Finally, the analytic sample was 2,664 respondents, after excluding 177 respondents who had physical and/or cognitive disability at baseline (Fig. 2).

The study procedures were approved by the human subjects committee of the Harvard T.H. Chan School of Public Health as well as the human subjects committees of Tohoku University, Nihon Fukushi University, and Chiba University. We obtained written informed consent from participants via mail at baseline and during the third survey, as well as in person during the second survey.

Outcome Variables. We chose depressive symptoms (4), BMI (5), higher-level IADL (2), and cognitive decline (3), as we previously demonstrated that personal disaster experiences associated with these outcomes.

Depressive symptoms were measured by GDS-15. BMI was calculated from self-reported height and weight. The accuracy of self-reported BMI has been

previously demonstrated in a Japanese older population, by comparing with physical measurements of BMI (18). Higher-level IADL was measured by TMIG-IC (Tokyo Metropolitan Institute of Gerontology Index of Competence), which consists of 13 items asking about physical and cognitive performances whose higher scores indicate higher ability to perform these instrumental activities. The level of cognitive disability was assessed by a standardized in-home assessment under the Japanese Long-Term Care Insurance (LTCI) scheme established in 2000 (19). Following the assessment, the applicants requesting long-term care are classified into one of seven levels (1: Suffering some cognitive deficits, but otherwise almost completely independent to 7: Needs constant treatment in a specialized medical facility) according to the severity of their cognitive disability. These data include the results of the initial assessment as well as subsequent reassessments for each individual (described in detail elsewhere) (20).

In a sensitivity analysis, we analyzed the association between relocation and risk of obesity, using a binary outcome indicating being obese according to the World Health Organization classification for Asian populations (≥25.0 BMI) (21).

Explanatory Variables. We inquired about involuntary resettlement due to housing damage in the second and third waves. In the second-wave survey, respondents were asked to select from 1) relocated to publicly provided prefabricated temporary housing (*kasetsu jutaku*, which resembled FEMA-style trailer parks in the United States) together with other community members (group relocation) or 2) individually relocated to public housing via lottery, moved to rental housing on the open market, or built new homes (individual relocation).

In the third-wave survey, we identified who 1) relocated to government-provided housing or new private homes in a permanent housing village (group relocation) or 2) moved to another apartment or new own housing individually (individual relocation) using their answer to a question about housing type and information of their residential address on geographic information system (ArcGIS Desktop version 10.4; Esri).

Covariates. According to previous studies (2, 4, 5, 20), we selected several demographic variables as potential confounding variables for the association of residential relocation and the health outcomes: age, sex, income, educational attainment, divorce or bereavement, working status, and living alone. We also adjusted for experiences of loss of relatives and/or friends in the disaster.

We additionally examined whether social capital mediated the relation between relocation and health outcomes. In our survey, the cognitive component of social capital was assessed on the basis of responses to questionnaire items about residents' perceptions of trust in the community, levels of mutual help, and community attachment. The structural dimension of social capital was measured by the frequency of meeting with friends, the number of friends whom the respondent met during the past month, and the frequency of participating in sports and hobby clubs per week (also see *SI Appendix*, Table S6). The results of a factor analysis supported our approach to create two subscales for social capital—one representing the cognitive dimension (social cohesion) and the other representing the structural dimension (informal socializing and social participation). The subscales had good internal consistency reliability, with Cronbach's $\alpha = 0.77$ and 0.70, respectively (also see *SI Appendix*, Table S6).

Statistical Analysis. To address clustering due to the repeated measures design, we employed a random effects model (multiple waves of data clustered within individuals) to calculate coefficients and 95% CI for the association of residential relocation and the health outcomes.

As shown in Table 1, more than 10% of the samples were missing information on depressive symptoms, household equivalized income, employment status, higher-level IADL, and living arrangement. To address potential bias due to missing data, we implemented multiple imputation by the Markov chain Monte Carlo method, creating 20 imputed datasets, and then combining the results of analyses using the Stata command "mi estimate." All analyses were performed using Stata version 14.0 (StataCorp LP).

Data and Materials Availability. All data needed to evaluate the conclusions in the paper are present in the paper and/or *SI Appendix*. The JAGES data used in this study will be made available upon request, as per NIH data access policies. The authors require the applicant to submit an analysis proposal to be reviewed by an internal JAGES committee to avoid duplication. Confidentiality concerns prevent us from depositing our data in a public repository. Authors requesting access to the Iwanuma data need to contact the principal investigator of the parent cohort (K.K.) and the Iwanuma substudy principal investigator (I.K.) in writing. Proposals submitted by outside investigators will be discussed during the monthly investigators' meeting to ensure that there is no overlap with ongoing analyses. If approval to access the data is granted, the JAGES researchers will request the outside investigator to help financially support our data manager's time to prepare the data for outside use. Further information is available at: https://www.jages.net/data_application/.

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