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Title:

Housing type after the Great East Japan Earthquake and loss of motor function in elderly victims: A prospective study

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ABSTRACT

Objective: Previous studies have reported that elderly victims might decline in motor function after a disaster. Victims of the Great East Japan Earthquake have relocated to a wide range of different types of housing. Because the evacuee lifestyle varies depending on the housing type, victim's degree of loss of motor function might vary depending on housing type. However, the association between housing type after the disaster and loss of motor function has not been investigated. The aim was to investigate the association between housing type after the Great East Japan Earthquake and loss of motor function in elderly victims.

Methods: We conducted a prospective study in 478 Japanese individuals aged ≥ 65 y in Miyagi Prefecture of the Great East Japan Earthquake affected area. Information on housing type after the Great East Japan Earthquake, motor function as assessed by the Kihon checklist, and other lifestyle factors was corrected by getting interviews and using questionnaires in 2012. Information on motor function corrected one year later too.

Results: We used multiple logistic regression to investigate the association between housing type after the Great East Japan Earthquake and loss of motor function. We classified 53 (11.1%) of the respondents as having loss of motor function. The multivariate adjusted odds ratio (with 95%CI) of loss of motor function among subjects who living in privately-rented temporary housing/rental housing was 2.62 (1.10, 6.24) compared to those in the same housing as that before the Great East

Japan Earthquake, which was a statistically significant increase.

Conclusion: Our study shows that significant loss of motor function among elderly people who relocated to privately-rented temporary housing/rental housing after the Great East Japan Earthquake, compared with those who remained living in the same housing they had before the disaster.

Strengths and limitations of this study

- This study is the first to report an association between housing type after the Great East Japan Earthquake and loss of motor function.
- We applied the longitudinal design.
- Larger sample size was desired to examine the influence of each housing type.
- The mechanisms remain unclear.

INTRODUCTION

With the aging of societies around the world, loss of motor function among elderly people as the result of a disaster is increasingly becoming a public health issue.[1-3] In areas that were seriously affected by the tsunami caused by the Great East Japan Earthquake (GEJE), the prevalence of disability among elderly people increased steeply during the following year.[4] This suggests that the GEJE-induced increase in the number of disabled elderly people might have been the result not only of injury and other acute causes, but also of other chronic factors.

What could be causing this chronic increase of disabled elderly people in disaster-affected areas? One possible cause might be the evacuee lifestyle, which is a problem specific to victims of the disaster. After the GEJE, approximately 130,000 buildings were completely destroyed by the tsunami, and many homes were lost.[5] Three years after the GEJE, 260,000 people remained displaced from their homes.[6] Studies have indicated that relocated individuals are more likely to be experiencing psychological morbidity post-disaster.[7] The effect of the evacuee lifestyle on health, however, varied depending on the housing type to which people have relocated. Studies have indicated that elderly people who have relocated to temporary housing have a worse perception of their quality of life than the others,[8] and that those who have relocated to temporary trailer or newly purchased/rented housing are more likely to be experiencing post-traumatic stress disorder symptoms and psychological distress.[9-11] Possible reasons for this

housing-related effect on health include differences both in living environment and in social support depending on the housing type.[7, 8] Victims of the GEJE have relocated to a wide range of different types of housing, including temporary housing, living with relatives, and so on.[12] Prefabricated temporary housing and privately-rented temporary housing were provided by the government as emergency temporary housing.[13] However, these two types of housing were located in different areas, and their ease of access to public facilities varied. Because prefabricated temporary housing was erected on unused, undeveloped land, there were no public facilities in the surrounding areas; in many cases, too, they were not served by public transport, making access to public facilities difficult.[14] In contrast, most privately-rented temporary housing was likely to be located in urban areas with easy access to public facilities. This difference in access might have made going out too troublesome, thereby decreasing its frequency. The different procedures required for relocation to these two types of housing might have also had different effects on social support. In some places, people were relocated to prefabricated temporary housing by administrative district,[15] meaning that many people had relatives and friends living nearby. People who relocated to privately-rented temporary housing, however, did so as individual households[15] and did not have relatives or friends living nearby, meaning that, for many of them, their environment was lacking in social support. In environments with little social support, people have few opportunities to go out because no one is living nearby

with whom to engage in hobbies or local activities; therefore, they go out less frequently. In addition, there have also been concerns that the absence of psychological support from friends and acquaintances reduces people's motivation, leading to the same result. These differences in living environment and social support mean that displaced elderly people go out less frequently and decrease in physical activity. This promotes a decline in musculoskeletal and cardiopulmonary function, and might result in loss of motor function. If motor function declines, it becomes troublesome to go out, which causes people to go out even less frequently, which in turn leads to further decline in motor function, resulting in a vicious circle.[14]

Thus, as our hypothesis, elderly people who have relocated to temporary housing might easily decline in motor function. To our knowledge, however, no study has yet to report an association between relocation to a specific housing type and loss of motor function.

The aim of the present study was to investigate the association between the housing type after the GEJE and loss of motor function.

METHODS

Subjects

To assess the state of health and lifestyle habits of victims of the GEJE, health surveys were carried out through interviews and self-administered questionnaires in two coastal towns, Ogatu and Oshika, located in the area of Ishinomaki City, Miyagi Prefecture, every six months from June 2011 after the GEJE by Tohoku University Graduate School of Medicine. The study population comprised 2504 men and women aged ≥65 years (as of March 31, 2012) who were based on data taken from the Basic Resident Registration system of the Oshika and Ogatsu towns of Ishinomaki City, Miyagi Prefecture, or who had previously undergone the health surveys and whose subsequent address was known in June and July 2012 (figure 1). We excluded 1605 elderly questionnaire non-respondents, 85 persons who did not give their consent to participate in the study, 17 persons who either did not indicate their current housing type or answered “Other”, and 16 persons who did not respond to at least one of the items in the Kihon checklist, a total of 781 subjects were followed. After that, we excluded 303 persons who did not provide valid answers to the Kihon checklist in the subsequent year’s health survey carried out in May and July 2013. Thus, 478 responses were analyzed for the purpose of this study.

Parameters

Housing type after the GEJE (exposure measure)

With respect to housing after the GEJE, subjects were asked to circle the type that best described their current main place of residence from among the following options: same housing as that before the GEJE (no relocation); prefabricated temporary housing; rental housing; living with relatives; reconstructed housing; or privately-rented temporary housing. Of the baseline housing categories, rental housing and privately-rented temporary housing were placed in the same category because they comprised the same form of housing, and the following five categories were used as exposure: same housing as that before the GEJE; prefabricated temporary housing; privately-rented temporary housing/rental housing; living with relatives; or reconstructed housing. The same housing as that before the GEJE referred to continuing to live in the same housing after the GEJE as they had been before. Emergency temporary housing, which included prefabricated temporary housing and privately-rented temporary housing, referred to housing provided by the government to secure temporary accommodation for people who were unable to continue living in their own houses after the GEJE.[13] The local government defined the temporary housing entry criteria as "any person who has lost a place of residence due to the disaster and is having difficulty securing a new dwelling house for a long term through his/her own efforts (e.g. household economy)" without any distinction regarding the type of temporary housing. The characteristics of prefabricated temporary housing included the following: high humidity; poor insulation and air tightness; thin internal walls that were far from

soundproof; and poor access.[14] For some prefabricated temporary housing, residents were moved in by administrative district rather than by single households in order to maintain existing networks of social support.[15] Privately-rented temporary housing comprised existing privately-rented housing that was rented by the government and used as emergency temporary housing.[16] In this study, privately-rented temporary housing also included the leasing of public housing. The reasons for the use of privately-rented temporary housing included the fact that it was already in use as housing, meaning that a shorter time was required before residents could move in, and that it was cheaper than prefabricated temporary housing as it did not necessitate any construction costs.[15]

Motor function (outcome measure)

The study outcome, motor function, was assessed in terms of the following five yes-or-no questions from the motor function score of the Kihon checklist: “Can you climb stairs without holding onto a handrail or wall?”; “Can you get up from a chair without grabbing something?”; “Are you able to walking for about 15 minutes?”; “Have you fallen in the past year?”; and “Are you very worried about falling?”.[17-19] The responses were scored as 1 point for each negative response, and the total score for all five questions (0–5 points) was calculated.

Other survey questions

This survey included questions about present illness (stroke, myocardial infarction, kidney disease, and cancer), weight, height, smoking, drinking, subjective health, insomnia, social capital, psychological distress, social network, subjective household economic status, physical activity, and outdoor physical activity before the GEJE. The weight and the height were measured.

Subjective health was assessed by asking the question "How is your state of health?" and having the participants choose one of the following responses: "Very good"; "Somewhat good"; "Not good"; and "bad".

Insomnia was assessed by the Athens Insomnia Scale.[20, 21]

Social capital was assessed by asking the following four questions: "Do the people around you help each other?"; "Can you trust the people around you?"; "Do the people around you greet one another?"; and "If some sort of problem occurs, do the people around you work together to try and solve it?". The subjects were asked to choose one of the following responses: "Not at all"; "Not really"; "Neither"; "True to some extent"; and "Very true". The answers were scored from 0–4 points on a scale of increasing positivity, and the total score for all four questions (0–16 points) was calculated.

Psychological distress was assessed by the Kessler 6-Item Psychological Distress Scale (K6).[22, 23]

Social network (family and friendship ties) was assessed by the Lubben Social Network Scale-6.[24, 25]

Subjective household economic status was assessed by asking the question "How do you feel about your current household economy?" and having the participants choose one of the following responses: "Poorest"; "Poorer"; "Poor"; and "Fair".

Physical activity was assessed in terms of the following three parameters associated with physical activity: daily physical activity; frequency of going out; and walking time.[26] These questions were scored from 1–5 points on a scale of increasing physical activity, and the total score for all three questions (3–15 points) was calculated.

Outdoor physical activity before the GEJE was assessed by asking the question "How physically active were you during the day?" and having the participants choose one of the following responses: "I was very active both inside and outside the house"; "I was very active indoors"; "I spent a lot of time sitting"; "I sometimes lie down"; and "I spent most of the time lying down". These data were taken from two pre-baseline surveys (June–August 2011 and October 2011–February 2012).

Statistical analysis

Baseline characteristics were evaluated by using the chi-square test for categorical variables and ANOVA for continuous variables. "Loss of motor function" was defined as a change equal to or greater than 1 standard deviation (2 points) from the

mean change one year after baseline in the motor function score of the Kihon checklist. We used multivariate logistic regression analysis to calculate the odds ratio (OR) and 95% confidence interval (95% CI) for having loss of motor function according to categories of housing type after the GEJE. We established respondents living in the same housing as that before the GEJE as the reference category and investigated the association between the housing type after the GEJE and loss of motor function by using the following models.

Model 1 was adjusted for sex and age (continuous variable). Model 2 was adjusted for sex, age, town (Oshika or Ogatsu), smoking (smoker, non-smoker, or missing), drinking (drinker, non-drinker, or missing), body mass index (in kg/m^2; <18.5, 18.5–24.9, ≥25.0, or missing), the motor function score of the Kihon checklist at baseline (continuous variable), and outdoor physical activity before the GEJE (very active both inside and outside the house, not active outside the house, or missing). The motor function score of the Kihon checklist at baseline was used to take account of the fact that the degree of change over time would vary depending on motor function at baseline.[27] The reason for taking outdoor physical activity before the GEJE into account was that people who had been very physically active before the GEJE would have had high levels of physical activity whatever their housing type, and this might have affected the outcome of motor function.

We stratified the responses by sex (men or women) and age (<75y or ≥75y), and calculated the interactions of housing type after the GEJE with sex and age.

When we calculated the interactions, we used cross-product terms of housing type after the GEJE and sex or age. In addition, we performed two exclusion analyses. One is that excluded subjects with low motor function (≥4 points for the motor function score of the Kihon checklist) at baseline, and the other is that excluded subjects with a present illness (stroke, myocardial infarction, kidney disease, or cancer) at baseline. The multivariate adjustment model (Model 2) was used for the analyses of interaction and exclusion analyses.

All data were analyzed by using IBM SPSS statistics software version 22 (IBM Japan, Tokyo, Japan). All statistical tests described here were 2-sided, and differences at $P<0.05$ were accepted as significant.

RESULTS

Basic characteristics

The mean age ± standard deviation of the participants was 73.4 ± 5.4 y; 63.0% were aged <75 y, and 47.1% were men. The most common response concerning housing type at baseline was the same housing as that before the GEJE (195 subjects [40.8%]). This was followed by prefabricated temporary housing in 184 subjects (38.5%), privately-rented temporary housing/rental housing in 64 subjects (13.4%), living with relatives in 26 subjects (5.4%), and reconstructed housing in 9 subjects (1.9%). We consider a total of 53 subjects (11.1%) as loss of motor function.

The baseline characteristics of participants according to housing type after the GEJE are shown in table 1. Subjects living in the same housing as that before the GEJE were less likely to be associated with low physical activity. Subjects living in prefabricated temporary housing were more likely to have a present illness of stroke, and to be associated with low physical activity, followed by those living in privately-rented temporary housing/rental housing. Subjects living in privately-rented temporary housing/rental housing were more likely to be men, to be current smokers, to have a present illness of kidney disease or cancer, to be associated with poor subjective health and subjective poor household economic status, to suffer from psychological distress and insomnia, to have little social capital and low motor function, and to be associated with low physical activity and high outside physical activity before the GEJE. Subjects living with relatives were

Table 1 Baseline characteristics (n=478 subjects)

	Housing type after the GEJE					
	Same as that before the GEJE	**Temporary***	**Privately-Rented Temporary†/Rental**	**With relatives**	**Reconstructed**	**P value‡**
n	195	184	64	26	9	
Male sex (%)	41.0	50.0	59.4	42.3	44.4	0.105
age (y)	74.1±5.5§	72.8±5.4	72.8±4.7	73.5±5.9	72.1±5.2	0.179
BMI (kg/m^2)	24.1±3.3	23.9±3.1	24.4±2.7	24.8±3.1	23.0±2.3	0.622
Present illness (%)						
Stroke	2.1	2.2	1.6	0.0	0.0	0.936
Myocardial infarction	5.1	12.0	9.4	23.1	22.2	0.013
Kidney disease	1.0	0.5	3.1	0.0	0.0	0.479
Cancer	3.6	1.6	4.7	0.0	0.0	0.509
Current smoker (%)	4.1	11.5	14.5	12.0	0.0	0.031
Current alcohol drinker (%)	21.1	35.3	41.9	38.5	57.1	0.002
Poor subjective health (%)	16.9	23.9	43.8	3.8	0.0	<0.001
Subjective poor household economic status (%)	36.4	48.4	69.4	26.9	44.4	<0.001
Psychological distress (%)**	2.6	6.6	12.9	7.7	0.0	0.033
High risk of insomnia (%)††	24.5	32.4	45.0	26.9	12.5	0.027
Little social capital (%)‡‡	5.7	5.4	16.1	11.5	0.0	0.035
High outside physical activity before the GEJE (%)	83.2	83.4	89.1	71.4	88.9	0.481
High risk of social isolation (%)§§	13.4	15.4	9.5	19.2	11.1	0.725
Marginal family ties (%)***	9.2	9.3	4.7	7.7	0.0	0.671
Marginal friendship ties (%)†††	20.1	21.4	17.5	38.5	22.2	0.259
Low physical activity at baseline (%)‡‡‡	17.5	31.7	35.5	26.9	22.2	0.010
Low motor function (%)§§§	23.6	16.3	25.0	23.1	0.0	0.174

* Prefabricated temporary housing.

† Existing privately-rented housing was rented by the government and used as emergency temporary housing.

‡ Obtained by using chi-square test for variables of proportion and 1-factor ANOVA for continuous variables.

§ Mean ± SD (all such values).

** Kessler 6-item psychological distress scale score ≥ 13.

†† Athens insomnia scale score ≥ 6.

‡‡ Social capital scale score ≤ 8.

§§ Lubben social network scale-6 score < 12.

*** The three-item Lubben social network scale-6 family subscale score < 6.

††† The three-item Lubben social network scale-6 friend subscale score < 6.

‡‡‡ The sum of 3 questions (the frequency of performing domestic and occupational physical activities, the frequency of leaving their residence, and walking duration per day) ≤ 9.

§§§ Motor function score of the Kihon checklist ≥ 3.

more likely to be associated with social isolation, and to have a present illness of myocardial infarction. Subjects living in reconstructed housing were more likely to be current alcohol drinkers.

Association between housing type after the GEJE and loss of motor function

The association between housing type after the GEJE and loss of motor function is shown in table 2. The proportion of subjects who showed a loss of motor function was as follows: 10.3% of those living in the same housing as that before the GEJE; 10.3% of those in prefabricated temporary housing; 20.3% of those in privately-rented temporary housing/rental housing; 3.8% of those with relatives; and 0% of those in reconstructed housing. In comparison with subjects who were living in the same housing as that before the GEJE, the multivariate adjusted OR (95% CI) of loss of motor function for those in privately-rented temporary housing/rental housing was 2.62 (1.10–6.24), which was a significant increase. There was no significant association for those living in prefabricated temporary housing (OR: 1.05, 95% CI: 0.52–2.12) or with relatives (OR: 0.37, 95% CI: 0.04–3.14). The Hosmer-Lemeshow goodness of model fit test did not indicate significance (p=0.589).

Table 2 Association between housing type after the GEJE and loss of motor function

		Housing type after the GEJE				
		Same as that before the GEJE	**Temporary**	**Privately-Rented Temporary/Rental**	**With relatives**	**Reconstructed**
n		195	184	64	26	9
Loss of motor function[†]						
	No. of the loss	20	19	13	1	0
	Percentage of the loss (%)	10.3	10.3	20.3	3.8	0.0
	Model 1[‡]	1.00 (Reference)	1.01 (0.52-1.96)[*]	2.22 (1.02-4.84)	0.35 (0.05-2.72)	-
	Model 2[§]	1.00 (Reference)	1.05 (0.52-2.12)	2.62 (1.10-6.24)	0.37 (0.04-3.14)	-

[*] Odds ratio; 95% confidential interval in parentheses (all such values).

[†] A change equal to or greater than 1SD (2 points) from the mean change one year after baseline in the motor function score of the Kihon checklist.

[‡] Model 1 was adjusted for age and for sex (continuous variable).

[§] Model 2 was adjusted as for model 1 plus town (Oshika or Ogatsu), smoking (smoker, non-smoker, or missing), drinking (drinker, non-drinker, or missing), body mass index (in kg/m^2; <18.5, 18.5–24.9, ≥25.0, or missing), the motor function score of the Kihon checklist at baseline (continuous variable), and outdoor physical activity before the GEJE (very active both inside and outside the house, not active outside the house, or missing).

Stratified analyses of the association between housing type after the GEJE and loss of motor function

In this study, two analyses of interaction as stratified analyses by sex and age were performed (table 3). There were no interactions between housing type after the GEJE and sex or age. Two exclusion analyses were performed (table 3). The analysis excluding subjects with low motor function at baseline revealed significant loss of motor function among subjects living in privately-rented temporary housing/rental housing, with a multivariate adjusted OR of 2.53 (95% CI: 1.06–6.03). The analysis excluding subjects with a present illness at baseline also found significant loss of motor function among subjects living in privately-rented temporary housing/rental housing, with a multivariate adjusted OR of 2.87 (95% CI: 1.15–7.17).

Table 3 Stratified analyses of the association between housing type after the GEJE and loss of motor function

	Housing type after the GEJE					
	Same as that before the GEJE	Temporary	Privately-Rented Temporary/Rental	With relatives	Reconstructed	P-interaction
Sex						
Men (n=225)						0.500
No. of participants	80	92	38	11	4	
No. of the loss (%)	9 (11.3)	10 (10.9)	7 (18.4)	0 (0.0)	0 (0.0)	
OR (95%CI)*	1.00 (Reference)	0.99 (0.36-2.73)†	2.13 (0.65-6.94)	-	-	
Women (n=253)						
No. of participants	115	92	26	15	5	
No. of the loss (%)	11 (9.6)	9 (9.8)	6 (23.1)	1 (6.7)	0 (0.0)	
OR (95%CI)	1.00 (Reference)	1.12 (0.42-3.00)	3.58 (0.92-13.97)	0.59 (0.06-5.95)	-	
Age						
< 75y (n=301)						0.627
No. of participants	110	126	43	16	6	
No. of the loss (%)	10 (9.1)	12 (9.5)	10 (23.3)	0 (0.0)	0 (0.0)	
OR (95%CI)	1.00 (Reference)	1.07 (0.42-2.69)	2.44 (0.82-7.26)	-	-	
≥ 75y (n=177)						
No. of participants	85	58	21	10	3	
No. of the loss (%)	10 (11.8)	7 (12.1)	3 (14.3)	1 (10.0)	0 (0.0)	
OR (95%CI)	1.00 (Reference)	1.41(0.41-4.83)	3.86 (0.62-23.99)	1.64 (0.13-20.33)	-	
Except for participants with low motor function at baseline (n=448)						
No. of participants	179	175	62	23	9	
No. of the loss (%)	20 (11.2)	19 (10.9)	13 (21.0)	1 (4.3)	0 (0.0)	
OR (95%CI)	1.00 (Reference)	1.04 (0.52-2.09)	2.53 (1.06-6.03)	0.37 (0.04-3.17)	-	
Except for participants with a present illness (stroke, myocardial infarction, kidney disease, and cancer) at baseline (n=411)						
No. of participants	173	158	53	20	7	
No. of the loss (%)	19 (11.0)	19 (12.0)	11 (20.8)	1 (5.0)	0 (0.0)	
OR (95%CI)	1.00 (Reference)	1.16 (0.57-2.36)	2.87 (1.15-7.17)	0.47 (0.06-4.05)	-	

* Adjusted as for model 2 in Table 2.

† Multiple adjusted odds ratio; 95% confidential interval in parentheses (all such values).

DISCUSSION

We investigated the association between housing type after the GEJE and loss of motor function among elderly people who were living in affected areas in a prospective study. We found a significant loss of motor function for elderly people who had relocated to privately-rented temporary housing/rental housing. However, there was no significant association for elderly people who had relocated to prefabricated temporary housing, relative's housing, or reconstructed housing.

The effect of living in privately-rented temporary housing or rental housing on health has been reported in previous studies. The prevalence of post-traumatic stress disorder is reportedly higher among individuals who have relocated to newly purchased/rented housing;[9] furthermore, those living in privately-rented temporary housing have been shown to suffer from psychological distress almost twice as much as community-dwelling elderly population in Japan.[10, 11] Although the present study had a different outcome, our results were consistent with those of previous studies in that people who have relocated to privately-rented temporary housing/rental housing were in poorer health.

In this study, both the ceiling effect and the effect of reverse causality were also considered. Should the ceiling effect result in the appearance of a false association, for example, if a large number of subjects with high motor function scores (those scoring near the maximum) at baseline would be living in the same housing as that before the GEJE, loss of motor function would be observed among

those living in privately-rented temporary housing/rental housing. To account for the ceiling effect, subjects with a high motor function score at baseline were excluded; however, the same results regarding a significant association with privately-rented temporary housing/rental housing was still observed. The above finding suggests that the present results are unlikely to be explained by the ceiling effect.

More subjects with a present illness might have relocated to privately-rented temporary housing/rental housing located in urban areas in order to obtain easier access to medical institutions. It is therefore possible that an effect of reverse causality may have been responsible for the significant association observed with privately-rented temporary housing/rental housing. To account for the effect of reverse causality, subjects with a present illness at baseline were excluded; however, the same result regarding a significant association with privately-rented temporary housing/rental housing was still observed. The above finding suggests that the present results are also unlikely to be explained by reverse causality.

Lack of social capital might be one possible reason for the significantly higher rate of loss of motor function among those living in privately-rented temporary housing/rental housing found in this study. Privately-rented temporary housing/rental housing had the highest proportion of subjects with little social capital, at 16.1% at baseline, although it did not have a high proportion of subjects with social isolation including friendship ties (table 1). One possible reason for this

low level of social capital in privately-rented temporary housing/rental housing might be that people were relocated to prefabricated temporary housing by administrative district, whereas for privately-rented temporary housing/rental housing, single households were relocated independently.[15] In this study, privately-rented temporary housing/rental housing also contained the highest proportion of subjects with low physical activity at baseline (table 1). People with little social capital are known to be physically inactive.[28, 29] People with lack of social capital might reduce their physical activity, and this in turn might have resulted in loss of motor function.

However, the OR was lower for those living in prefabricated temporary housing, another form of emergency temporary housing along with privately-rented temporary housing, than for those living in privately-rented temporary housing/rental housing, and there was no significant association. Subjects with little social capital only comprised 5.4% of those living in prefabricated temporary housing, which is less than half the proportion of those in privately-rented temporary housing/rental housing. One reason for the low proportion of subjects with little social capital in prefabricated temporary housing might be that, unlike with privately-rented temporary housing, people were relocated to prefabricated temporary housing by administrative district,[15] making it highly likely that they would have relatives and friends living nearby. Assembly halls were also provided near the prefabricated temporary housing,[13] which permitted victims of the GEJE

to socialize with each other and enabled the creation of new social networks. Elderly victims of the GEJE also had the chance to be supported the creation of new social networks and take part in exercise classes offered by the government, hospitals, private organizations, and universities.[30] This type of support also offered opportunities for victims of the GEJE to socialize among themselves, thereby alleviating their lack of social capital. Exercise classes might also have been directly helpful in preventing loss of motor function.[31] Such support was mainly offered to people living in prefabricated temporary housing, and there have been almost no reports of this sort of assistance being offered to people living in privately-rented temporary housing/rental housing or other types of housing. In practice, for the protection of personal information, the government would not under any circumstances reveal information regarding the identity of residents of privately-rented temporary housing. This meant that if they did not appeal on their own, they would be unable to receive support from private organizations.[15] This suggests that there might have been no significant association because of the availability of social support in the environment of prefabricated temporary housing.

We were unable to thoroughly investigate the effect of living with relatives or in reconstructed housing in this study due to the small sample sizes.

In Japan, increasing the number of people who relocate to privately-rented temporary housing when they can no longer remain in their own homes is being

considered as housing policy in the event of future large-scale disasters. However, our analysis shows that relocating to privately-rented temporary housing/rental housing affected the health of elderly people in an adverse way. This suggests the need for housing policies that help avoid lack of social capital for elderly people who are unable to continue living in their own homes after a disaster.

This study is one of only a few to investigate the association between housing type after a disaster and loss of motor function, and the first to report an association between housing type after the GEJE and loss of motor function.

This study has some limitations. First, the sample size was small. The small numbers of subjects living in prefabricated temporary housing, living with relatives, and living in reconstructed housing might have prevented an adequate investigation of the association between housing type and loss of motor function.

Second, the Kihon checklist used in this study as the outcome index has a narrow range of possible scores, which might have made change difficult to detect, thereby making it an insensitive index.

Third, because 24 subjects (37.5%) who were living in privately-rented temporary housing/rental housing at baseline did not answer the question about housing type or relocated from privately-rented temporary housing/rental housing one year after baseline, the results might not have purely reflected the effect of privately-rented temporary housing/rental housing on loss of motor function. An analysis of only those subjects who responded that they were living in the same

housing type at baseline and one year later (n = 411) showed that the multivariate adjusted OR was 2.09 (95% CI: 0.76–5.78) for privately-rented temporary housing/rental housing, which showed a tendency to increase, although this association was not significant. It is unlikely that the present results would have changed if all the subjects who had relocated to privately-rented temporary housing/rental housing could have been followed up.

Fourth, in this study, the mechanisms involved were not investigated, and this is a subject for further study.

Fifth, in this study, the rate of valid responses at baseline was not high (35.9%). Our study population might not have included people who had a higher risk of motor function decline, and therefore the present study might have underestimated the risk for loss of motor function.

CONCLUSIONS

In this study, significant loss of motor function was found among elderly people who relocated to privately-rented temporary housing/rental housing after the GEJE, compared with those who remained living in the same housing they had before the GEJE. This suggested that, if relocation is necessary after a disaster, housing policies will be required that do not result in elderly people with lack of social capital.

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Figure 1. Flow chart of study subjects.

The study population comprised 2504 men and women aged ≥65 years (as of March 31, 2012) who were living in Oshika and Ogatsu towns of Ishinomaki City, Miyagi Prefecture, Japan, or who had previously undergone the health surveys and whose subsequent address was known. The surveys of this study were carried out through interviews and self-administered questionnaires in June-July 2012 and May-July 2013. This figure details the flow of study subjects. A total of 478 responses were analyzed for the purpose of this study.

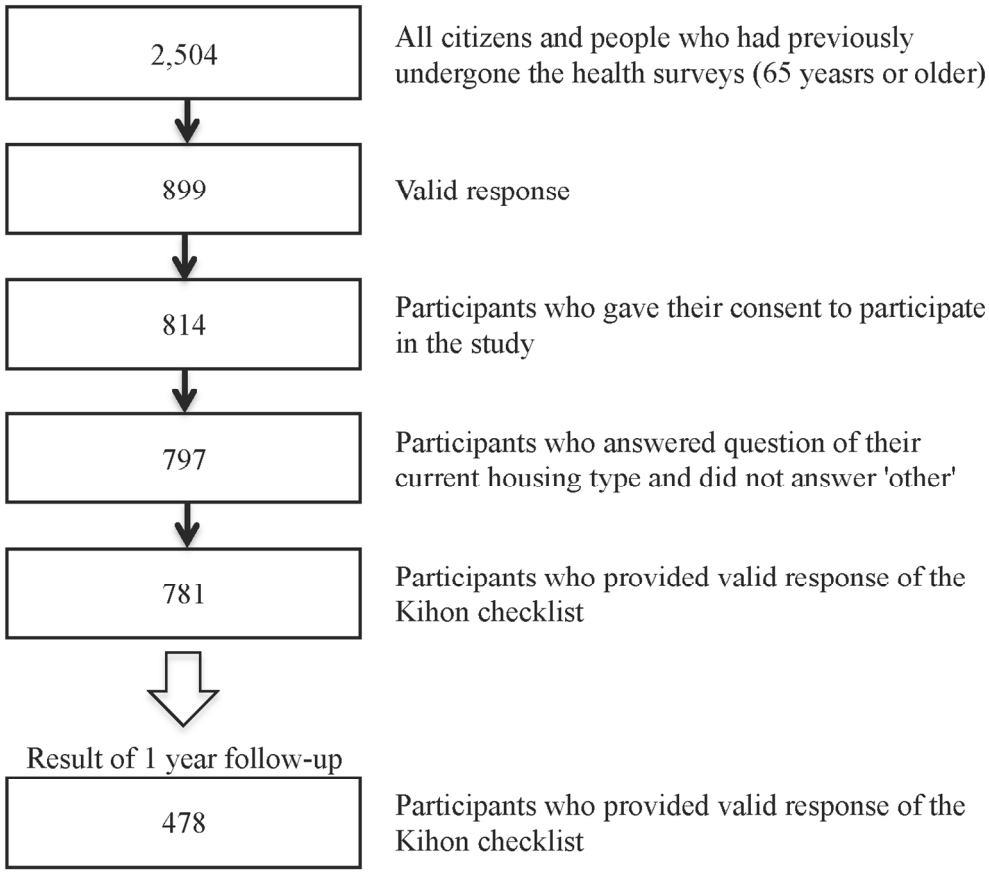

Figure 1. Flow chart of the study participants.
The study population comprised 2504 men and women aged ≥65 years (as of March 31, 2012) who were living in Oshika and Ogatsu towns of Ishinomaki City, Miyagi Prefecture, Japan, or who had previously undergone health surveys that included known addresses. The surveys for this study were carried out using interviews and self-administered questionnaires in June-July 2012 and May-July 2013. This figure details the flow of the study participants. A total of 478 responses were analyzed for the purposes of this study.

130x114mm (300 x 300 DPI)

STROBE 2007 (v4) checklist of items to be included in reports of observational studies in epidemiology*

Checklist for cohort, case-control, and cross-sectional studies (combined)

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1,3
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	3-4
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	5-7
Objectives	3	State specific objectives, including any pre-specified hypotheses	7
Methods			
Study design	4	Present key elements of study design early in the paper	8
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	8
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	8
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	8-12
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	8-12
Bias	9	Describe any efforts to address potential sources of bias	
Study size	10	Explain how the study size was arrived at	8
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	12
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	12-14
		(*b*) Describe any methods used to examine subgroups and interactions	13-14
		(*c*) Explain how missing data were addressed	8
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed	8

		Cross-sectional study—If applicable, describe analytical methods taking account of sampling strategy	
		(*e*) Describe any sensitivity analyses	13
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	8
		(b) Give reasons for non-participation at each stage	8
		(c) Consider use of a flow diagram	8, Fig.1
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	15-17, Table.1
		(b) Indicate number of participants with missing data for each variable of interest	8
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	8
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	17, Table.2
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	
		Cross-sectional study—Report numbers of outcome events or summary measures	
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	17, Table.2
		(*b*) Report category boundaries when continuous variables were categorized	12-13
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	19, Table3
Discussion			
Key results	18	Summarise key results with reference to study objectives	21
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	25-26
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	21-26
Generalisability	21	Discuss the generalisability (external validity) of the study results	25-26
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	28

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Housing type after the Great East Japan Earthquake and loss of motor function in elderly victims: A prospective study

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Title:

Housing type after the Great East Japan Earthquake and loss of motor function in elderly victims: A prospective study

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ABSTRACT

Objective: Previous studies have reported that elderly victims might decline in motor function after a disaster. Victims of the Great East Japan Earthquake have relocated to a wide range of different types of housing. Because the evacuee lifestyle varies depending on the housing type, victim's degree of loss of motor function might vary depending on housing type. However, the association between housing type after the disaster and loss of motor function has not been investigated. The aim was to investigate the association between housing type after the Great East Japan Earthquake and loss of motor function in elderly victims.

Methods: We conducted a prospective study in 478 Japanese individuals aged ≥65 y in Miyagi Prefecture of the Great East Japan Earthquake affected area. Information on housing type after the Great East Japan Earthquake, motor function as assessed by the Kihon checklist, and other lifestyle factors was corrected by getting interviews and using questionnaires in 2012. Information on motor function corrected one year later too.

Results: We used multiple logistic regression to investigate the association between housing type after the Great East Japan Earthquake and loss of motor function. We classified 53 (11.1%) of the respondents as having loss of motor function. The multivariate adjusted odds ratio (with 95%CI) of loss of motor function among subjects who living in privately-rented temporary housing/rental housing was 2.62 (1.10, 6.24) compared to those in the same housing as that before the Great East

Japan Earthquake, which was a statistically significant increase.

Conclusion: The proportion of motor function loss was higher among persons who relocated to privately-rented temporary housing/rental housing after the Great East Japan Earthquake. This result might suggest the influence of a change in living environment like a move to a location where few acquaintances were living (lack of social capital).

Strengths and limitations of this study

- This study is the first to report an association between housing type after the Great East Japan Earthquake and loss of motor function.
- We applied the longitudinal design.
- Larger sample size was desired to examine the influence of each housing type.
- The mechanisms remain unclear.

INTRODUCTION

With the aging of societies around the world, loss of motor function among elderly people as the result of a disaster is increasingly becoming a public health issue.[1-3] In areas that were seriously affected by the tsunami caused by the Great East Japan Earthquake (GEJE) on 11 March 2011, the prevalence of functional disability among elderly people increased steeply during the following year.[4] This suggests that the GEJE-induced increase in the number of disabled elderly people might have been the result not only of injury and other acute causes, but also of other chronic factors.

What could be causing this chronic increase of disabled elderly people in disaster-affected areas? One possible cause might be the evacuee lifestyle, which is a problem specific to victims of the disaster. After the GEJE, approximately 130,000 buildings were completely destroyed by the tsunami, and many homes were lost.[5] Three years after the GEJE, 260,000 people remained displaced from their homes.[6] Studies have indicated that relocated individuals are more likely to be experiencing psychological morbidity post-disaster.[7] The effect of the evacuee lifestyle on health, however, varied depending on the housing type to which people have relocated. Studies have indicated that elderly people who have relocated to temporary housing have a worse perception of their quality of life than the others,[8] and that those who have relocated to temporary trailer or newly purchased/rented housing are more likely to be experiencing post-traumatic stress

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disorder symptoms and psychological distress.[9-11] Possible reasons for this housing-related effect on health include differences both in living environment and in social support from relatives and friends on the housing type.[7, 8] Victims of the GEJE have relocated to a wide range of different types of housing, including temporary housing, living with relatives, and so on.[12] Prefabricated temporary housing and privately-rented temporary housing were provided by the government as emergency temporary housing.[13] However, these two types of housing were located in different areas, and their ease of access to facilities such as hospitals and supermarkets varied. Because prefabricated temporary housing was erected on unused, undeveloped land, there were no facilities in the surrounding areas; in many cases, too, they were not served by public transport, making access to facilities difficult.[14] In contrast, most privately-rented temporary housing was likely to be located in urban areas with easy access to facilities. This difference in access might have made going out too troublesome, thereby decreasing its frequency. The different procedures required for relocation to these two types of housing might have also had different effects on social support from relatives and friends. In some places, people were relocated to prefabricated temporary housing by administrative district,[15] meaning that many people had relatives and friends living nearby. People who relocated to privately-rented temporary housing, however, did so as individual households[15] and did not have relatives or friends living nearby, meaning that, for many of them, their environment was lacking in social support

from relatives and friends. In environments with little social support from relatives and friends, people have few opportunities to go out because no one is living nearby with whom to engage in hobbies or local activities; therefore, they go out less frequently. In addition, there have also been concerns that the absence of psychological support from friends and acquaintances reduces people's motivation, leading to the same result. These differences in living environment and social support from relatives and friends mean that displaced elderly people go out less frequently and decrease in physical activity. This promotes a decline in musculoskeletal and cardiopulmonary function, and might result in loss of motor function.[16] If motor function declines, it becomes troublesome to go out, which causes people to go out even less frequently, which in turn leads to further decline in motor function, resulting in a vicious circle.[14]

Thus, as our hypothesis, elderly people who have relocated to temporary housing might easily decline in motor function. To our knowledge, however, no study has yet to report an association between relocation to a specific housing type and loss of motor function.

The aim of the present study was to investigate the association between the housing type after the GEJE and loss of motor function in elderly victims.

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METHODS

Subjects

To assess the state of health and lifestyle habits of victims of the GEJE, health surveys were carried out by Tohoku University Graduate School of Medicine every six months from June 2011 after the GEJE. These surveys, employing interviews and self-administered questionnaires, were carried out in two coastal towns, Oshika and Ogatsu, located in the area of Ishinomaki City, Miyagi Prefecture. The study population comprised 2504 men and women aged ≥65 years (as of March 31, 2012) who were based on data taken from the Basic Resident Registration system of the Oshika and Ogatsu towns of Ishinomaki City, Miyagi Prefecture, or who had previously undergone the health surveys and whose subsequent address was known in June and July 2012 (figure 1). We excluded 1605 elderly questionnaire non-respondents, 85 persons who did not give their consent to participate in the study, 17 persons who either did not indicate their current housing type or answered "Other", and 16 persons who did not respond to at least one of the items in the Kihon checklist, a total of 781 subjects were followed. After that, we excluded 303 persons who did not provide valid answers to the Kihon checklist in the subsequent year's health survey carried out in May and July 2013. Thus, 478 responses were analyzed for the purpose of this study.

Housing type after the GEJE (exposure measure)

With respect to housing after the GEJE, subjects were asked to circle the type that best described their current main place of residence from among the following options: same housing as that before the GEJE (no relocation); prefabricated temporary housing; rental housing; living with relatives; reconstructed housing; or privately-rented temporary housing. Of the baseline housing categories, rental housing and privately-rented temporary housing were placed in the same category because they comprised the same form of housing, and the following five categories were used as exposure: same housing as that before the GEJE; prefabricated temporary housing; privately-rented temporary housing/rental housing; living with relatives; or reconstructed housing.

Emergency temporary housing, which included prefabricated temporary housing and privately-rented temporary housing, referred to housing provided by the government to secure temporary accommodation for people who were unable to continue living in their own houses after the GEJE.[13] The local government defined the temporary housing entry criteria as "any person who has lost a place of residence due to the disaster and is having difficulty securing a new dwelling house for a long term through his/her own efforts (e.g. household economy)" without any distinction regarding the type of temporary housing.

The same housing as that before the GEJE

The same housing as that before the GEJE referred to continuing to live in the same

housing after the GEJE as they had been before.

Prefabricated temporary housing

The characteristics of prefabricated temporary housing included the following: high humidity; poor insulation and air tightness; thin internal walls that were far from soundproof; and poor access.[14] For some prefabricated temporary housing, residents were moved in by administrative district rather than by single households in order to maintain existing networks of social support from relatives and friends.[15]

Privately-rented temporary housing

Privately-rented temporary housing comprised existing privately-rented housing that was rented by the government and used as emergency temporary housing.[17] In this study, privately-rented temporary housing also included the leasing of public housing. The reasons for the use of privately-rented temporary housing included the fact that it was already in use as housing, meaning that a shorter time was required before residents could move in, and that it was cheaper than prefabricated temporary housing as it did not necessitate any construction costs.[15]

Motor function (outcome measure)

The study outcome, motor function, was assessed in terms of the following five

yes-or-no questions from the motor function score of the Kihon checklist: “Can you climb stairs without holding onto a handrail or wall?”; “Can you get up from a chair without grabbing something?”; “Are you able to walk for about 15 minutes?”; “Have you fallen in the past year?”; and “Are you very worried about falling?”.[18-20] The responses were scored as 1 point for each negative response, and the total score for all five questions (0–5 points) was calculated.

Covariate

This survey included questions about present illness (stroke, myocardial infarction, kidney disease, and cancer), weight, height, smoking, drinking, subjective health, insomnia, social capital, psychological distress, social network, subjective household economic status, physical activity, and outdoor physical activity before the GEJE. The weight and the height were measured.

Subjective health was assessed by asking the question “How is your state of health?” and having the participants choose one of the following responses: “Very good”; “Somewhat good”; “Not good”; and “bad”.

Insomnia was assessed by the Athens Insomnia Scale.[21, 22]

Social capital was assessed by asking the following four questions: “Do the people around you help each other?”; “Can you trust the people around you?”; “Do the people around you greet one another?”; and “If some sort of problem occurs, do the people around you work together to try and solve it?”. The subjects were asked

to choose one of the following responses: “Not at all”; “Not really”; “Neither”; “True to some extent”; and “Very true”. The answers were scored from 0–4 points on a scale of increasing positivity, and the total score for all four questions (0–16 points) was calculated.

Psychological distress was assessed by the Kessler 6-Item Psychological Distress Scale (K6).[23, 24]

Social network (family and friendship ties) was assessed by the Lubben Social Network Scale-6.[25, 26]

Subjective household economic status was assessed by asking the question “How do you feel about your current household economy?” and having the participants choose one of the following responses: “Poorest”; “Poorer”; “Poor”; and “Fair”.

Physical activity was assessed in terms of the following three parameters associated with physical activity: daily physical activity; frequency of going out; and walking time.[27] These questions were scored from 1–5 points on a scale of increasing physical activity, and the total score for all three questions (3–15 points) was calculated.

Outdoor physical activity before the GEJE was assessed by asking the question “How physically active were you during the day?” and having the participants choose one of the following responses: “I was very active both inside and outside the house”; “I was very active indoors”; “I spent a lot of time sitting”;

"I sometimes lie down"; and "I spent most of the time lying down". These data were taken from two pre-baseline surveys (June–August 2011 and October 2011–February 2012).

Statistical analysis

Baseline characteristics were evaluated by using the chi-square test for categorical variables and ANOVA for continuous variables. "Loss of motor function" was defined as a change equal to or greater than 1 standard deviation (2 points) from the mean change one year after baseline in the motor function score of the Kihon checklist. We used multivariate logistic regression analysis to calculate the odds ratio (OR) and 95% confidence interval (95% CI) for having loss of motor function according to categories of housing type after the GEJE. We established respondents living in the same housing as that before the GEJE as the reference category and investigated the association between the housing type after the GEJE and loss of motor function by using the following models.

Model 1 was adjusted for sex and age (continuous variable). Model 2 was adjusted for sex, age, town (Oshika or Ogatsu), smoking (smoker, non-smoker, or missing), drinking (drinker, non-drinker, or missing), body mass index (in kg/m^2; <18.5, 18.5–24.9, ≥25.0, or missing), the motor function score of the Kihon checklist at baseline (continuous variable), and outdoor physical activity before the GEJE (very active both inside and outside the house, not active outside the house, or

missing). The motor function score of the Kihon checklist at baseline was used to take account of the fact that the degree of change over time would vary depending on motor function at baseline.[28] The reason for taking outdoor physical activity before the GEJE into account was that people who had been very physically active before the GEJE would have had high levels of physical activity whatever their housing type, and this might have affected the outcome of motor function.

We stratified the responses by sex (men or women) and age (<75y or ≥75y), and calculated the interactions of housing type after the GEJE with sex and age. When we calculated the interactions, we used cross-product terms of housing type after the GEJE and sex or age. In addition, we performed two exclusion analyses. One is that excluded subjects with low motor function (≥4 points for the motor function score of the Kihon checklist) at baseline, and the other is that excluded subjects with a present illness (stroke, myocardial infarction, kidney disease, or cancer) at baseline. The multivariate adjustment model (Model 2) was used for the analyses of interaction and exclusion analyses.

All data were analyzed by using IBM SPSS statistics software version 22 (IBM Japan, Tokyo, Japan). All statistical tests described here were 2-sided, and differences at $P<0.05$ were accepted as significant.

RESULTS

Basic characteristics

The mean age ± standard deviation of the participants was 73.4 ± 5.4 y; 63.0% were aged <75 y, and 47.1% were men. The most common response concerning housing type at baseline was the same housing as that before the GEJE (195 subjects [40.8%]). This was followed by prefabricated temporary housing in 184 subjects (38.5%), privately-rented temporary housing/rental housing in 64 subjects (13.4%), living with relatives in 26 subjects (5.4%), and reconstructed housing in 9 subjects (1.9%). We considered a total of 53 subjects (11.1%) as loss of motor function.

The baseline characteristics of participants according to housing type after the GEJE are shown in table 1. Subjects living in the same housing as that before the GEJE were less likely to be associated with low physical activity. Subjects living in prefabricated temporary housing were more likely to have a present illness of stroke, and to be associated with low physical activity, followed by those living in privately-rented temporary housing/rental housing. Subjects living in privately-rented temporary housing/rental housing were more likely to be men, to be current smokers, to have a present illness of kidney disease or cancer, to be associated with poor subjective health and subjective poor household economic status, to suffer from psychological distress and insomnia, to have little social capital and low motor function, and to be associated with low physical activity and high outside physical activity before the GEJE. Subjects living with relatives were

Table 1 Baseline characteristics (n=478 subjects)

	Housing type after the GEJE					
	Same as that before the GEJE	Temporary*	Privately-Rented Temporary†/Rental	With relatives	Reconstructed	P value‡
n	195	184	64	26	9	
Male sex (%)	41.0	50.0	59.4	42.3	44.4	0.105
age (y)	74.1±5.5§	72.8±5.4	72.8±4.7	73.5±5.9	72.1±5.2	0.179
BMI (kg/m^2)	24.1±3.3	23.9±3.1	24.4±2.7	24.8±3.1	23.0±2.3	0.622
Present illness (%)						
Stroke	2.1	2.2	1.6	0.0	0.0	0.936
Myocardial infarction	5.1	12.0	9.4	23.1	22.2	0.013
Kidney disease	1.0	0.5	3.1	0.0	0.0	0.479
Cancer	3.6	1.6	4.7	0.0	0.0	0.509
Current smoker (%)	4.1	11.5	14.5	12.0	0.0	0.031
Current alcohol drinker (%)	21.1	35.3	41.9	38.5	57.1	0.002
Poor subjective health (%)	16.9	23.9	43.8	3.8	0.0	<0.001
Subjective poor household economic status (%)	36.4	48.4	69.4	26.9	44.4	<0.001
Psychological distress (%)**	2.6	6.6	12.9	7.7	0.0	0.033
High risk of insomnia (%)††	24.5	32.4	45.0	26.9	12.5	0.027
Little social capital (%)‡‡	5.7	5.4	16.1	11.5	0.0	0.035
High outside physical activity before the GEJE (%)	83.2	83.4	89.1	71.4	88.9	0.481
High risk of social isolation (%)§§	13.4	15.4	9.5	19.2	11.1	0.725
Marginal family ties (%)***	9.2	9.3	4.7	7.7	0.0	0.671
Marginal friendship ties (%)†††	20.1	21.4	17.5	38.5	22.2	0.259
Low physical activity at baseline (%)‡‡‡	17.5	31.7	35.5	26.9	22.2	0.010
Low motor function (%)§§§	23.6	16.3	25.0	23.1	0.0	0.174

* Prefabricated temporary housing.

† Existing privately-rented housing was rented by the government and used as emergency temporary housing.

‡ Obtained by using chi-square test for variables of proportion and 1-factor ANOVA for continuous variables.

§ Mean ± SD (all such values).

** Kessler 6-item psychological distress scale score ≥ 13.

†† Athens insomnia scale score ≥ 6.

‡‡ Social capital scale score ≤ 8.

§§ Lubben social network scale-6 score < 12.

*** The three-item Lubben social network scale-6 family subscale score < 6.

††† The three-item Lubben social network scale-6 friend subscale score < 6.

‡‡‡ The sum of 3 questions (the frequency of performing domestic and occupational physical activities, the frequency of leaving their residence, and walking duration per day) ≤ 9.

§§§ Motor function score of the Kihon checklist ≥ 3.

more likely to be associated with marginal friendship ties, and to have a present illness of myocardial infarction. Subjects living in reconstructed housing were more likely to be current alcohol drinkers.

Association between housing type after the GEJE and loss of motor function

The association between housing type after the GEJE and loss of motor function is shown in table 2. The proportion of subjects who showed a loss of motor function was as follows: 10.3% of those living in the same housing as that before the GEJE; 10.3% of those in prefabricated temporary housing; 20.3% of those in privately-rented temporary housing/rental housing; 3.8% of those with relatives; and 0% of those in reconstructed housing. In comparison with subjects who were living in the same housing as that before the GEJE, the multivariate adjusted OR (95% CI) of loss of motor function for those in privately-rented temporary housing/rental housing was 2.62 (1.10–6.24), which was a significant increase. There was no significant association for those living in prefabricated temporary housing (OR: 1.05, 95% CI: 0.52–2.12) or with relatives (OR: 0.37, 95% CI: 0.04–3.14). The Hosmer-Lemeshow goodness of model fit test did not indicate significance (p=0.589).

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Table 2 Association between housing type after the GEJE and loss of motor function

		Housing type after the GEJE				
		Same as that before the GEJE	Temporary	Privately-Rented Temporary/Rental	With relatives	Reconstructed
n		195	184	64	26	9
Loss of motor function†						
	No. of the loss	20	19	13	1	0
	Percentage of the loss (%)	10.3	10.3	20.3	3.8	0.0
	Model 1‡	1.00 (Reference)	1.01 (0.52-1.96)*	2.22 (1.02-4.84)	0.35 (0.05-2.72)	-
	Model 2§	1.00 (Reference)	1.05 (0.52-2.12)	2.62 (1.10-6.24)	0.37 (0.04-3.14)	-

* Odds ratio; 95% confidential interval in parentheses (all such values).

† A change equal to or greater than 1SD (2 points) from the mean change one year after baseline in the motor function score of the Kihon checklist.

‡ Model 1 was adjusted for age and for sex (continuous variable).

§ Model 2 was adjusted as for model 1 plus town (Oshika or Ogatsu), smoking (smoker, non-smoker, or missing), drinking (drinker, non-drinker, or missing), body mass index (in kg/m^2; <18.5, 18.5–24.9, ≥25.0, or missing), the motor function score of the Kihon checklist at baseline (continuous variable), and outdoor physical activity before the GEJE (very active both inside and outside the house, not active outside the house, or missing).

Stratified analyses of the association between housing type after the GEJE and loss of motor function

In this study, two analyses of interaction as stratified analyses by sex and age were performed (table 3). There were no interactions between housing type after the GEJE and sex or age. Two exclusion analyses were performed (table 3). The analysis excluding subjects with low motor function at baseline revealed significant loss of motor function among subjects living in privately-rented temporary housing/rental housing, with a multivariate adjusted OR of 2.53 (95% CI: 1.06–6.03). The analysis excluding subjects with a present illness at baseline also found significant loss of motor function among subjects living in privately-rented temporary housing/rental housing, with a multivariate adjusted OR of 2.87 (95% CI: 1.15–7.17).

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Table 3 Stratified analyses of the association between housing type after the GEJE and loss of motor function

	Housing type after the GEJE					
	Same as that before the GEJE	Temporary	Privately-Rented Temporary/Rental	With relatives	Reconstructed	P-interaction
Sex						
Men (n=225)						0.500
No. of participants	80	92	38	11	4	
No. of the loss (%)	9 (11.3)	10 (10.9)	7 (18.4)	0 (0.0)	0 (0.0)	
OR (95%CI)*	1.00 (Reference)	0.99 (0.36-2.73)†	2.13 (0.65-6.94)	-	-	
Women (n=253)						
No. of participants	115	92	26	15	5	
No. of the loss (%)	11 (9.6)	9 (9.8)	6 (23.1)	1 (6.7)	0 (0.0)	
OR (95%CI)	1.00 (Reference)	1.12 (0.42-3.00)	3.58 (0.92-13.97)	0.59 (0.06-5.95)	-	
Age						
< 75y (n=301)						0.627
No. of participants	110	126	43	16	6	
No. of the loss (%)	10 (9.1)	12 (9.5)	10 (23.3)	0 (0.0)	0 (0.0)	
OR (95%CI)	1.00 (Reference)	1.07 (0.42-2.69)	2.44 (0.82-7.26)	-	-	
≥ 75y (n=177)						
No. of participants	85	58	21	10	3	
No. of the loss (%)	10 (11.8)	7 (12.1)	3 (14.3)	1 (10.0)	0 (0.0)	
OR (95%CI)	1.00 (Reference)	1.41(0.41-4.83)	3.86 (0.62-23.99)	1.64 (0.13-20.33)	-	
Except for participants with low motor function at baseline (n=448)						
No. of participants	179	175	62	23	9	
No. of the loss (%)	20 (11.2)	19 (10.9)	13 (21.0)	1 (4.3)	0 (0.0)	
OR (95%CI)	1.00 (Reference)	1.04 (0.52-2.09)	2.53 (1.06-6.03)	0.37 (0.04-3.17)	-	
Except for participants with a present illness (stroke, myocardial infarction, kidney disease, and cancer) at baseline (n=411)						
No. of participants	173	158	53	20	7	
No. of the loss (%)	19 (11.0)	19 (12.0)	11 (20.8)	1 (5.0)	0 (0.0)	
OR (95%CI)	1.00 (Reference)	1.16 (0.57-2.36)	2.87 (1.15-7.17)	0.47 (0.06-4.05)	-	

* Adjusted as for model 2 in Table 2.

† Multiple adjusted odds ratio; 95% confidential interval in parentheses (all such values).

DISCUSSION

We investigated the association between housing type after the GEJE and loss of motor function among elderly people who were living in affected areas in a prospective study. We observed that study participants were living in various types of housing one year after the GEJE: the same housing as that before the GEJE, prefabricated temporary housing, privately-rented temporary housing, rental housing, relative's housing, and reconstructed housing. We found a significant loss of motor function for elderly people who had relocated to privately-rented temporary housing/rental housing. However, there was no significant association for elderly people who had relocated to prefabricated temporary housing, relative's housing, or reconstructed housing.

The effect of living in privately-rented temporary housing or rental housing on health has been reported in previous studies. The prevalence of post-traumatic stress disorder is reportedly higher among individuals who have relocated to newly purchased/rented housing;[9] furthermore, those living in privately-rented temporary housing have been shown to suffer from psychological distress almost twice as much as community-dwelling elderly population in Japan.[10, 11] Although the present study had a different outcome, our results were consistent with those of previous studies in that people who have relocated to privately-rented temporary housing/rental housing were in poorer health.

In this study, both the ceiling effect and the effect of reverse causality were

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also considered. Should the ceiling effect result in the appearance of a false association, for example, if a large number of subjects with high motor function scores (those scoring near the maximum) at baseline would be living in the same housing as that before the GEJE, loss of motor function would be observed among those living in privately-rented temporary housing/rental housing.[29] To account for the ceiling effect, subjects with high motor function scores at baseline were excluded; however, the same result regarding a significant association with privately-rented temporary housing/rental housing was still observed. The above finding suggests that the present results are unlikely to be explained by the ceiling effect.

More subjects with a present illness might have relocated to privately-rented temporary housing/rental housing located in urban areas in order to obtain easier access to medical institutions. It is therefore possible that an effect of reverse causality may have been responsible for the significant association observed with privately-rented temporary housing/rental housing. To account for the effect of reverse causality, subjects with a present illness at baseline were excluded; however, the same result regarding a significant association with privately-rented temporary housing/rental housing was still observed. The above finding suggests that the present results are also unlikely to be explained by reverse causality.

Lack of social capital might be one possible reason for the significantly higher rate of loss of motor function among those living in privately-rented

temporary housing/rental housing found in this study. Privately-rented temporary housing/rental housing had the highest proportion of subjects with little social capital, at 16.1% at baseline, although it did not have a high proportion of subjects with social isolation including friendship ties (table 1). One possible reason for this low level of social capital in privately-rented temporary housing/rental housing might be that people were relocated to prefabricated temporary housing by administrative district, whereas for privately-rented temporary housing/rental housing, single households were relocated independently.[15] In this study, privately-rented temporary housing/rental housing also contained the highest proportion of subjects with low physical activity at baseline (table 1). People with little social capital are known to be physically inactive.[30, 31] People with lack of social capital might reduce their physical activity, and this in turn might have resulted in loss of motor function.

However, the OR was lower for those living in prefabricated temporary housing, another form of emergency temporary housing along with privately-rented temporary housing, than for those living in privately-rented temporary housing/rental housing, and there was no significant association. Subjects with little social capital only comprised 5.4% of those living in prefabricated temporary housing, which was less than half the proportion of those in privately-rented temporary housing/rental housing. One reason for the low proportion of subjects with little social capital in prefabricated temporary housing might be that, unlike

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with privately-rented temporary housing, people were relocated to prefabricated temporary housing by administrative district,[15] making it highly likely that they would have relatives and friends living nearby. Assembly halls were also provided near the prefabricated temporary housing,[13] which permitted victims of the GEJE to socialize with each other and enabled the creation of new social networks. Elderly victims of the GEJE also had the chance to be supported by the creation of new social networks and take part in exercise classes offered by the government, hospitals, private organizations, and universities.[32] This type of support also offered opportunities for victims of the GEJE to socialize among themselves, thereby alleviating their lack of social capital. Exercise classes might also have been directly helpful in preventing loss of motor function.[33] Such support was mainly offered to people living in prefabricated temporary housing, and there have been almost no reports of this sort of assistance being offered to people living in privately-rented temporary housing/rental housing or other types of housing. In practice, for the protection of personal information, the government would not under any circumstances reveal information regarding the identity of residents of privately-rented temporary housing. This meant that if they did not appeal on their own, they would be unable to receive support from private organizations.[15] This suggests that there might have been no significant association because of the availability of social support from relatives and friends in the environment of prefabricated temporary housing.

We were unable to thoroughly investigate the effect of living with relatives or in reconstructed housing in this study due to the small sample sizes.

In Japan, increasing the number of people who relocate to privately-rented temporary housing when they can no longer remain in their own homes is being considered as housing policy in the event of future large-scale disasters. However, our analysis shows that relocating to privately-rented temporary housing/rental housing affected the health of elderly people in an adverse way. This suggests the need for housing policies that help avoid lack of social capital for elderly people who are unable to continue living in their own homes after a disaster.

This study is one of only a few to investigate the association between housing type after a disaster and loss of motor function, and the first to report an association between housing type after the GEJE and loss of motor function.

This study has some limitations. First, the sample size was small. The small numbers of subjects living in prefabricated temporary housing, living with relatives, and living in reconstructed housing might have prevented an adequate investigation of the association between housing type and loss of motor function.

Second, the Kihon checklist used in this study as the outcome index has a narrow range of possible scores, which might have made change difficult to detect, thereby making it an insensitive index.

Third, because 24 subjects (37.5%) who were living in privately-rented temporary housing/rental housing at baseline did not answer the question about

housing type or relocated from privately-rented temporary housing/rental housing one year after baseline, the results might not have purely reflected the effect of privately-rented temporary housing/rental housing on loss of motor function. An analysis of only those subjects who responded that they were living in the same housing type at baseline and one year later (n = 411) showed that the multivariate adjusted OR was 2.09 (95% CI: 0.76–5.78) for privately-rented temporary housing/rental housing, which showed a tendency to increase, although this association was not significant. It is unlikely that the present results would have changed if all the subjects who had relocated to privately-rented temporary housing/rental housing could have been followed up.

Fourth, in this study, the mechanisms involved were not investigated, and this is a subject for further study.

Fifth, in this study, the rate of valid responses at baseline was not high (35.9%). Our study population might not have included people who had a higher risk of motor function decline, and therefore the present study might have underestimated the risk for loss of motor function.

CONCLUSIONS

In this study, significant loss of motor function was found among elderly people who relocated to privately-rented temporary housing/rental housing after the GEJE, compared with those who remained living in the same housing they had before the GEJE. This suggested that, if relocation is necessary after a disaster, housing policies will be required that do not result in elderly people with lack of social capital.

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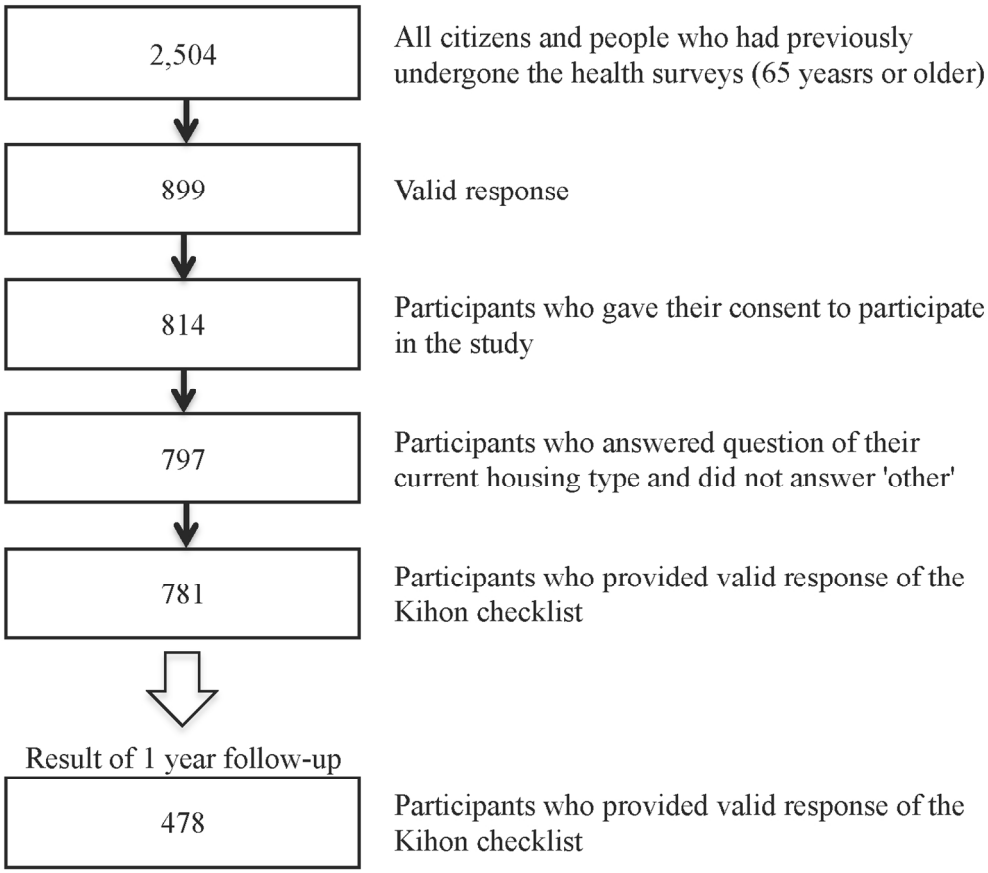
Figure 1. Flow chart of study subjects.

The study population comprised 2504 men and women aged ≥65 years (as of March 31, 2012) who were living in Oshika and Ogatsu towns of Ishinomaki City, Miyagi Prefecture, Japan, or who had previously undergone the health surveys and whose subsequent address was known. The surveys of this study were carried out through interviews and self-administered questionnaires in June-July 2012 and May-July 2013. This figure details the flow of study subjects. A total of 478 responses were analyzed for the purpose of this study.



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STROBE 2007 (v4) checklist of items to be included in reports of observational studies in epidemiology*

Checklist for cohort, case-control, and cross-sectional studies (combined)

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1,3
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	3-4
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	5-7
Objectives	3	State specific objectives, including any pre-specified hypotheses	7
Methods			
Study design	4	Present key elements of study design early in the paper	8
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	8
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	8
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	8-12
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	8-12
Bias	9	Describe any efforts to address potential sources of bias	
Study size	10	Explain how the study size was arrived at	8
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	12
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	12-14
		(*b*) Describe any methods used to examine subgroups and interactions	13-14
		(*c*) Explain how missing data were addressed	8
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed	8

		Cross-sectional study—If applicable, describe analytical methods taking account of sampling strategy	
		(*e*) Describe any sensitivity analyses	13
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	8
		(b) Give reasons for non-participation at each stage	8
		(c) Consider use of a flow diagram	8, Fig.1
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	15-17, Table.1
		(b) Indicate number of participants with missing data for each variable of interest	8
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	8
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	17, Table.2
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	
		Cross-sectional study—Report numbers of outcome events or summary measures	
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	17, Table.2
		(*b*) Report category boundaries when continuous variables were categorized	12-13
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	19, Table3
Discussion			
Key results	18	Summarise key results with reference to study objectives	21
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	25-26
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	21-26
Generalisability	21	Discuss the generalisability (external validity) of the study results	25-26
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	28

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.
Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Housing type after the Great East Japan Earthquake and loss of motor function in elderly victims: A prospective observational study

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Title:

Housing type after the Great East Japan Earthquake and loss of motor function in elderly victims: A prospective observational study

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ABSTRACT

Objective: Previous studies have reported that elderly victims of natural disasters might be prone to a subsequent decline in motor function. Victims of the Great East Japan Earthquake (GEJE) relocated to a wide range of different types of housing. Because the evacuee lifestyle varies according to the type of housing available to them, their degree of motor function loss might also vary accordingly. However, the association between post-disaster housing type and loss of motor function has never been investigated. The present study was conducted to investigate the association between housing type after the GEJE and loss of motor function in elderly victims.

Methods: We conducted a prospective observational study of 478 Japanese individuals aged ≥65 y living in Miyagi Prefecture, one of the areas most significantly affected by the GEJE. Information on housing type after the GEJE, motor function as assessed by the Kihon checklist, and other lifestyle factors was collected by interview and questionnaire in 2012. Information on motor function was then collected one year later. The multiple logistic regression model was used to estimate the multivariate adjusted odds ratios of motor function loss.

Results: We classified 53 (11.1%) of the respondents as having loss of motor function. The multivariate adjusted odds ratio (with 95% CI) for loss of motor function among participants who were living in privately-rented temporary housing/rental housing was 2.62 (1.10–6.24) compared to those who had remained in the same housing as that before the GEJE, and this increase was statistically

significant.

Conclusion: The proportion of individuals with loss of motor function was higher among persons who had relocated to privately-rented temporary housing/rental housing after the GEJE. This result may reflect the influence of a move to a living environment where few acquaintances are located (lack of social capital).

Strengths and limitations of this study

- This study is the first to have reported an association between housing type after the Great East Japan Earthquake and loss of motor function.
- This study examined the chronic effect on motor function one year after the disaster.
- A larger sample size would have been desirable to examine the influence of the various types of housing.
- As this study was based on data from only one city (Ishinomaki), its external validity was not clear.

INTRODUCTION

With the aging of societies around the world, loss of motor function among elderly people affected by natural disasters is becoming a significant public health issue.[1-3] In areas that were seriously affected by the tsunami caused by the Great East Japan Earthquake (GEJE) on 11 March 2011, the prevalence of functional disability among the elderly population increased steeply during the following year,[4] suggesting the influence of not only injury and acute causes, but also chronic factors.

One possible reason for this chronic increase of functional disability among the elderly might be the evacuee lifestyle, which is a problem specific to disaster victims. Approximately 130,000 buildings were completely destroyed by the tsunami that accompanied the GEJE, and many homes were lost.[5] Three years after the disaster, 260,000 people remained displaced from their homes.[6] Studies have indicated that relocated individuals are more likely to experience psychological morbidity after natural disasters.[7] However, the effect of an evacuee lifestyle on health varies according to the type of housing to which people have relocated. Studies have indicated that elderly people who have relocated to temporary housing have a worse perception of their quality of life than others,[8] and that those who have relocated to temporary trailer or newly purchased/rented residence are more likely to experience post-traumatic stress disorder symptoms and psychological distress.[9-11] Possible reasons for this housing-related effect on health include

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differences in both living environment and social support from relatives and friends.[7, 8] Victims of the GEJE have relocated to a wide range of different housing types, including temporary housing, the homes of relatives, and so on.[12] Prefabricated temporary housing and privately-rented temporary housing were provided by the government as emergency temporary housing.[13] However, these two types of housing were located in different areas, which meant that ease of access to facilities such as hospitals and supermarkets varied. Because prefabricated temporary housing was erected on unused, undeveloped land, there were no facilities or public transport services in the surrounding areas. Therefore, those who were living in prefabricated temporary housing found it difficult to access to facilities.[14] In contrast, most privately-rented temporary housing was likely to be located in urban areas with easy access to such facilities. Therefore, people living in prefabricated temporary housing might have been discouraged from going out, thus decreasing its frequency. The various procedures required for relocation to these two types of housing might also have affected social support from relatives and friends in different ways. In some places, people were relocated to prefabricated temporary housing on the basis of administrative district,[15] meaning that many people would have had relatives and friends living nearby. People who relocated to privately-rented temporary housing, however, did so as individual households,[15] meaning that they did not have relatives or friends living nearby; therefore, their environment would have lacked social support from relatives and friends. In

environments with little social support from relatives and friends, people have few opportunities to go out because they lack local company for sharing hobbies or other activities; therefore, they tend to remain at home. There has also been concern that absence of psychological support from relatives and friends reduces individual motivation, again discouraging people from going out. These differences in living environment and social support from relatives and friends mean that displaced elderly people go out less frequently and decrease in physical activity. This leads to a decline in musculoskeletal and cardiopulmonary function, and possibly motor function.[16] If motor function declines, it becomes even more troublesome to go out, creating a vicious cycle that leads to further decline in motor function.[14]

Our hypothesis, therefore, is that elderly people who have relocated to temporary housing after a natural disaster might be prone to a decline in motor function. To our knowledge, however, no study has yet reported an association between relocation to a specific housing type and loss of motor function. The aim of the present study was to investigate the association between the type of housing to which elderly people relocated after the GEJE and loss of motor function.

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METHODS

Participants

To assess the state of health and lifestyle habits of victims of the GEJE, health surveys were carried out by Tohoku University Graduate School of Medicine every six months from June 2011 after the disaster. These surveys, employing interviews and self-administered questionnaires, were carried out in two coastal towns, Oshika and Ogatsu, located in the area of Ishinomaki City, Miyagi Prefecture. The study population comprised 2504 men and women aged ≥65 years (as of March 31, 2012) on the basis of data taken from the Basic Resident Registration system of the Oshika and Ogatsu towns of Ishinomaki City, or data from previous health surveys that included known addresses in June and July 2012 (figure 1). We excluded 1605 elderly questionnaire non-respondents, 85 persons who did not consent to participate, 17 persons who either did not indicate their current housing type or answered “Other”, and 16 persons who did not respond to at least one of the items in the Kihon checklist, leaving a total of 781 persons. Thereafter, we excluded 303 persons who did not provide valid answers for the Kihon checklist in the subsequent health survey carried out in May and July 2013. Thus, 478 responses were analyzed for the purposes of this study.

Housing type after the GEJE (exposure measure)

With respect to housing after the GEJE, participants were asked to circle the option

that best described their current main place of residence from among the following: same housing as that before the GEJE (no relocation), prefabricated temporary housing, rental housing, the homes of relatives, reconstructed housing, or privately-rented temporary housing. Of the baseline housing categories, rental housing and privately-rented temporary housing were placed in the same category because they were considered to represent the same form of housing, and the following five categories were used as exposure variables: same housing as that before the GEJE, prefabricated temporary housing, privately-rented temporary housing/rental housing, the homes of relatives, or reconstructed housing.

Emergency temporary housing, which included prefabricated temporary housing and privately-rented temporary housing, was considered to be housing provided by the government to secure temporary accommodation for people who were unable to continue living in their own homes after the GEJE.[13] The local government defined the temporary housing entry criteria as "any person who has lost a place of residence due to the disaster and is having difficulty securing a new dwelling house for long-term occupation through his/her own efforts (e.g. household economy)" without any distinction regarding the type of temporary housing.

Same housing as that before the GEJE

The same housing as that before the GEJE referred to continuing to live in the same

housing after the GEJE as that before the disaster.

Prefabricated temporary housing

Prefabricated temporary housing was characterized by high humidity, poor insulation and air tightness, thin internal walls that were far from soundproof, and poor access.[14] In some cases, residents were moved into prefabricated temporary housing on the basis of administrative district rather than by single households in order to maintain existing networks of social support from relatives and friends.[15]

Privately-rented temporary housing

Privately-rented temporary housing comprised existing privately-rented housing that had been rented by the government and used as emergency temporary housing.[17] In this study, privately-rented temporary housing also included leased public housing. There were two reasons for the use of privately-rented temporary housing. One was that a shorter time was required before residents could move in because it was already in use as housing. The other was that privately-rented temporary housing was cheaper than prefabricated temporary housing because no construction costs were necessary.[15]

Motor function (outcome measure)

The study outcome, motor function, was assessed in terms of the following five

yes-or-no questions from the motor function score of the Kihon checklist: “Can you climb stairs without holding onto a handrail or wall?”, “Can you get up from a chair without grabbing something?”, “Are you able to walk for about 15 minutes?”, “Have you fallen in the past year?”, and “Are you very worried about falling?”. Previous validation studies have reported that the motor function score of the Kihon checklist is correlated with objective measurements of motor function, and predicts incident functional disability.[18-20] The responses were scored as 1 point for each negative response, and the total score for all five questions (0–5 points) was calculated.

Covariates

This survey included questions about present illness (stroke, myocardial infarction, kidney disease, and cancer), body weight, height, smoking, drinking, subjective health, insomnia, social capital, psychological distress, social networks, subjective household economic status, physical activity, and outdoor physical activity before the GEJE. Body weight and height were measured. Subjective health was assessed by asking the question “What is your state of health?” for which available responses were “Very good”, “Somewhat good”, “Not good”, and “Bad”. Insomnia was assessed using the Athens Insomnia Scale.[21, 22] Social capital was assessed by asking the following four questions: “Do the people around you help each other?”, “Can you trust the people around you?”, “Do the people around you greet one another?”, and “If some sort of problem occurs, do the people around you work

together to try and solve it?". The participants were asked to choose one of the following responses: "Not at all", "Not really", "Neither", "True to some extent", and "Very true". The answers were scored from 0–4 points on a scale of increasing positivity, and the total score for all four questions (0–16 points) was calculated. Psychological distress was assessed using the Kessler 6-Item Psychological Distress Scale (K6).[23, 24] Social networks (family and friendship ties) were assessed using the Lubben Social Network Scale-6.[25, 26] Subjective household economic status was assessed by asking the question "How do you feel about your current household economy?" for which available responses were "Poorest", "Poorer", "Poor", and "Fair". Physical activity was assessed in terms of the following three parameters: daily physical activity, frequency of going out, and walking time.[27] These items were scored from 1–5 points on a scale of increasing physical activity, and the total score for all three questions (3–15 points) was calculated. Outdoor physical activity before the GEJE was assessed by asking the question "How physically active were you during the day?" for which available responses were "I was very active both inside and outside the house", "I was very active indoors", "I spent a lot of time sitting", "I sometimes used to lie down", and "I spent most of the time lying down". These data were taken from two pre-baseline surveys (June–August 2011 and October 2011–February 2012).

Statistical analysis

Baseline characteristics were evaluated by using the chi-squared test for categorical variables and ANOVA for continuous variables. “Loss of motor function” was defined as a change equal to or greater than 1 standard deviation (2 points) from the mean change one year after the baseline in the motor function score of the Kihon checklist. We used multivariate logistic regression analysis to calculate the odds ratio (OR) and 95% confidence interval (95% CI) for having loss of motor function according to the categories of housing type after the GEJE. We established respondents living in the same housing as that before the GEJE as the reference category and investigated the association between the housing type after the GEJE and loss of motor function by using the following models.

Model 1 was adjusted for sex and age (continuous variable). Model 2 was adjusted for sex, age, town (Oshika or Ogatsu), smoking (smoker, non-smoker, or missing), drinking (drinker, non-drinker, or missing), body mass index (in kg/m^2; <18.5, 18.5–24.9, ≥25.0, or missing), the motor function score of the Kihon checklist at the baseline (continuous variable), and outdoor physical activity before the GEJE (very active both inside and outside the house, not active outside the house, or missing). Motor function score of the Kihon checklist at the baseline was taken into account because it was assumed that it would impact on the degree of change in motor function over time.[28] Outdoor physical activity before the GEJE was taken into account because it was assumed that people who had been very physically active before the disaster would have retained high levels of physical

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activity whatever their housing type, thus affecting motor function outcome.

We stratified the responses by sex (men or women) and age (<75 y or ≥75 y), and calculated their interactions with housing type after the GEJE. When calculating these interactions, we used cross-product terms of housing type after the GEJE with sex or age. In addition, we performed two exclusion analyses. One excluded participants with low motor function (≥4 points for the motor function score of the Kihon checklist) at the baseline, and the other excluded participants who had some form of illness (stroke, myocardial infarction, kidney disease, or cancer) at the baseline. The multivariate adjustment model (Model 2) was used for analyses of interactions and exclusion analyses.

All data were analyzed using IBM SPSS statistics software version 22 (IBM Japan, Tokyo, Japan). All statistical tests described here were 2-sided, and differences at $P<0.05$ were accepted as significant.

RESULTS

Basic characteristics

The mean age ± standard deviation of the participants was 73.4 ± 5.4 y; 63.0% were aged <75 y, and 47.1% were men. With regard to housing type at the baseline, most of the participants (195; 40.8%) stated that they were living in the same housing as that before the GEJE, 184 (38.5%) were living in prefabricated temporary housing, 64 (13.4%) in privately-rented temporary housing/rental housing, 26 (5.4%) in the homes of relatives, and 9 (1.9%) in reconstructed housing. We considered that a total of 53 participants (11.1%) had loss of motor function.

The baseline characteristics of participants according to the type of housing they were living in after the GEJE are shown in table 1. Participants living in the same housing as that before the GEJE were less likely to have low physical activity. Participants living in prefabricated temporary housing were more likely to have stroke as a present illness, and to have low physical activity, followed by those living in privately-rented temporary housing/rental housing. Participants living in privately-rented temporary housing/rental housing were more likely to be men, to be current smokers, to have kidney disease or cancer as a present illness, to have subjectively poor health and subjectively poor household economic status, to suffer from psychological distress and insomnia, to have little social capital and low motor function, and to have low physical activity and high outside physical activity before the GEJE. Participants living in the homes of relatives were more likely to have

Table 1 Baseline characteristics (n=478 participants)

	Housing type after the GEJE					
	Same as that before the GEJE	Temporary*	Privately-rented temporary†/rental	Relatives	Reconstructed	P value‡
n	195	184	64	26	9	
Male sex (%)	41.0	50.0	59.4	42.3	44.4	0.105
Age (y)	74.1±5.5§	72.8±5.4	72.8±4.7	73.5±5.9	72.1±5.2	0.179
BMI (kg/m^2)	24.1±3.3	23.9±3.1	24.4±2.7	24.8±3.1	23.0±2.3	0.622
Present illness (%)						
Stroke	2.1	2.2	1.6	0.0	0.0	0.936
Myocardial infarction	5.1	12.0	9.4	23.1	22.2	0.013
Kidney disease	1.0	0.5	3.1	0.0	0.0	0.479
Cancer	3.6	1.6	4.7	0.0	0.0	0.509
Current smoker (%)	4.1	11.5	14.5	12.0	0.0	0.031
Current alcohol drinker (%)	21.1	35.3	41.9	38.5	57.1	0.002
Poor subjective health (%)	16.9	23.9	43.8	3.8	0.0	<0.001
Subjectively poor household economic status (%)	36.4	48.4	69.4	26.9	44.4	<0.001
Psychological distress (%)**	2.6	6.6	12.9	7.7	0.0	0.033
High risk of insomnia (%)††	24.5	32.4	45.0	26.9	12.5	0.027
Little social capital (%)‡‡	5.7	5.4	16.1	11.5	0.0	0.035
High outside physical activity before the GEJE (%)	83.2	83.4	89.1	71.4	88.9	0.481
High risk of social isolation (%)§§	13.4	15.4	9.5	19.2	11.1	0.725
Marginal family ties (%)***	9.2	9.3	4.7	7.7	0.0	0.671
Marginal friendship ties (%)†††	20.1	21.4	17.5	38.5	22.2	0.259
Low physical activity at the baseline (%)‡‡‡	17.5	31.7	35.5	26.9	22.2	0.010
Low motor function (%)§§§	23.6	16.3	25.0	23.1	0.0	0.174

* Prefabricated temporary housing.

† Existing privately-rented housing was rented by the government and used as emergency temporary housing.

‡ Obtained using the chi-squared test for variables of proportion and 1-factor ANOVA for continuous variables.

§ Mean ± SD (all such values).

** Kessler 6-item psychological distress scale score ≥13.

†† Athens insomnia scale score ≥6.

‡‡ Social capital scale score ≤8.

§§ Lubben social network scale-6 score <12.

*** Three-item Lubben social network scale-6 family subscale score <6.

††† Three-item Lubben social network scale-6 friend subscale score <6.

‡‡‡ Summed score of 3 questions (the frequency of performing domestic and occupational physical activities, the frequency of leaving their residence, and walking duration per day) ≤9.

§§§ Motor function score of the Kihon checklist ≥3.

marginal friendship ties, and to have myocardial infarction as a present illness. Participants living in reconstructed housing were more likely to be current alcohol drinkers.

Association between housing type after the GEJE and loss of motor function

The association between housing type after the GEJE and loss of motor function is shown in table 2. Participants who showed loss of motor function accounted for 10.3% of those living in the same housing as that before the GEJE, 10.3% of those in prefabricated temporary housing, 20.3% of those in privately-rented temporary housing/rental housing, 3.8% of those in the homes of relatives, and 0% of those in reconstructed housing. In comparison with participants who were living in the same housing as that before the GEJE, the multivariate adjusted OR (95% CI) for loss of motor function among those in privately-rented temporary housing/rental housing was 2.62 (1.10–6.24), which represented a significant increase. There was no significant association among those in prefabricated temporary housing (OR: 1.05, 95% CI: 0.52–2.12) or the homes of relatives (OR: 0.37, 95% CI: 0.04–3.14). The Hosmer-Lemeshow goodness of model fit test did not indicate significance (p=0.589).

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Table 2 Association between housing type after the GEJE and loss of motor function

		Housing type after the GEJE				
		Same as that before the GEJE	Temporary	Privately-rented temporary/rental	Relatives	Reconstructed
n		195	184	64	26	9
Loss of motor function[†]						
	No. with loss	20	19	13	1	0
	Proportion of those with loss (%)	10.3	10.3	20.3	3.8	0.0
	Model 1[‡]	1.00 (Reference)	1.01 (0.52-1.96)[*]	2.22 (1.02-4.84)	0.35 (0.05-2.72)	-
	Model 2[§]	1.00 (Reference)	1.05 (0.52-2.12)	2.62 (1.10-6.24)	0.37 (0.04-3.14)	-

[*] Odds ratio; 95% confidence interval in parentheses (all such values).

[†] A change equal to or greater than 1SD (2 points) from the mean change in the motor function score of the Kihon checklist one year after the baseline.

[‡] Model 1 was adjusted for age and for sex (continuous variable).

[§] Model 2 was adjusted as for model 1 plus town (Oshika or Ogatsu), smoking (smoker, non-smoker, or missing), drinking (drinker, non-drinker, or missing), body mass index (in kg/m^2; <18.5, 18.5–24.9, ≥25.0, or missing), the motor function score of the Kihon checklist at the baseline (continuous variable), and outdoor physical activity before the GEJE (very active both inside and outside the house, not active outside the house, or missing).

Stratified analyses of the association between housing type after the GEJE and loss of motor function

In this study, two stratified analyses of interaction by sex and age were performed (table 3). Housing type after the GEJE showed no interactions with sex or age. Two exclusion analyses were also performed (table 3). Analysis excluding participants with low motor function at the baseline revealed significant loss of motor function among those living in privately-rented temporary housing/rental housing (multivariate adjusted OR 2.53 (95% CI: 1.06–6.03)). Analysis excluding participants in whom illness had been present at the baseline also revealed significant loss of motor function among those living in privately-rented temporary housing/rental housing (multivariate adjusted OR 2.87 (95% CI: 1.15–7.17)).

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Table 3 Stratified analyses of the association between housing type after the GEJE and loss of motor function

	Housing type after the GEJE					
	Same as that before the GEJE	Temporary	Privately-rented temporary/rental	Relatives	Reconstructed	P-interaction
Sex						
Men (n=225)						0.500
No. of participants	80	92	38	11	4	
No. with loss (%)	9 (11.3)	10 (10.9)	7 (18.4)	0 (0.0)	0 (0.0)	
OR (95% CI)*	1.00 (Reference)	0.99 (0.36-2.73)†	2.13 (0.65-6.94)	-	-	
Women (n=253)						
No. of participants	115	92	26	15	5	
No. with loss (%)	11 (9.6)	9 (9.8)	6 (23.1)	1 (6.7)	0 (0.0)	
OR (95% CI)	1.00 (Reference)	1.12 (0.42-3.00)	3.58 (0.92-13.97)	0.59 (0.06-5.95)	-	
Age						
<75 y (n=301)						0.627
No. of participants	110	126	43	16	6	
No. with loss (%)	10 (9.1)	12 (9.5)	10 (23.3)	0 (0.0)	0 (0.0)	
OR (95% CI)	1.00 (Reference)	1.07 (0.42-2.69)	2.44 (0.82-7.26)	-	-	
≥75 y (n=177)						
No. of participants	85	58	21	10	3	
No. with loss (%)	10 (11.8)	7 (12.1)	3 (14.3)	1 (10.0)	0 (0.0)	
OR (95% CI)	1.00 (Reference)	1.41(0.41-4.83)	3.86 (0.62-23.99)	1.64 (0.13-20.33)	-	
Except for participants with low motor function at the baseline (n=448)						
No. of participants	179	175	62	23	9	
No. with loss (%)	20 (11.2)	19 (10.9)	13 (21.0)	1 (4.3)	0 (0.0)	
OR (95% CI)	1.00 (Reference)	1.04 (0.52-2.09)	2.53 (1.06-6.03)	0.37 (0.04-3.17)	-	
Except for participants with illness (stroke, myocardial infarction, kidney disease, and cancer) at the baseline (n=411)						
No. of participants	173	158	53	20	7	
No. with loss (%)	19 (11.0)	19 (12.0)	11 (20.8)	1 (5.0)	0 (0.0)	
OR (95% CI)	1.00 (Reference)	1.16 (0.57-2.36)	2.87 (1.15-7.17)	0.47 (0.06-4.05)	-	

* Adjusted as for model 2 in Table 2.

† Multiple adjusted odds ratio; 95% confidence interval in parentheses (all such values).

DISCUSSION

In this prospective observational study, we investigated the association between housing type after the GEJE and loss of motor function among elderly people who were living in affected areas. One year after the disaster, the study participants were living in various types of housing: same housing as that before the GEJE, prefabricated temporary housing, privately-rented temporary housing, rental housing, the homes of relatives, and reconstructed housing. We found that elderly people who had relocated to privately-rented temporary housing/rental housing showed significant loss of motor function. However, no such significant association was found for elderly people who had relocated to prefabricated temporary housing, the homes of relatives, or reconstructed housing.

Previous studies have reported the health-related effect of living in privately-rented temporary housing or rental housing. The prevalence of post-traumatic stress disorder is reportedly higher among individuals who have relocated to newly purchased/rented housing;[9] furthermore, in Japan, it has been shown that the incidence of psychological distress among elderly people living in privately-rented temporary housing is almost twice as high as that among those living in the community.[10, 11] Although the present study had a different outcome, our results were consistent with those of previous studies in that people who had relocated to privately-rented temporary housing/rental housing were in poorer health.

The present study considered both the ceiling effect and the effect of reverse causality. First, we were concerned that the main findings might be explained by the ceiling effect.[29] If a large number of participants with high motor function scores (close to the maximum) at the baseline were still living in the same housing as that before the GEJE, their motor function score would not worsen. In such a case, loss of motor function would have been observed among those living in privately-rented temporary housing/rental housing. However, even when participants with high motor function scores (≥4 points) at the baseline were excluded, the significant association with privately-rented temporary housing/rental housing was still observed. Therefore, it seemed unlikely that the main findings of the present study were explained by the ceiling effect. Second, we were concerned that the main findings might be attributable to reverse causality. More participants with a present illness might have relocated to privately-rented temporary housing/rental housing located in urban areas in order to obtain easier access to medical institutions. It is therefore possible that reverse causality may have been responsible for the significant association observed for privately-rented temporary housing/rental housing. To account for the effect of reverse causality, participants who already had an illness at the baseline were excluded, but the significant association with privately-rented temporary housing/rental housing still remained. Therefore it seemed unlikely that the main findings of the present study were also attributable to reverse causality.

Lack of social capital is another possible reason for the significantly higher rate of motor function loss that has been observed among participants living in privately-rented temporary housing/rental housing. Participants living in privately-rented temporary housing/rental housing included the highest proportion of individuals with little social capital (16.1% at the baseline), although the proportion of those with social isolation, including friendship ties, was not high (table 1). This low level of social capital associated with privately-rented temporary housing/rental housing might have been attributable to the fact that people relocated by single households independently, whereas relocation to prefabricated temporary housing was organized according to administrative district.[15] Participants relocated to privately-rented temporary housing/rental housing also included the highest proportion of individuals with low physical activity at the baseline (table 1). Little social capital is known to be a risk factor of physically inactive.[30, 31]

For those living in prefabricated temporary housing, however, the OR was lower than for those living in privately-rented temporary housing/rental housing, and there was no significant association. Only 5.4% of study participants living in prefabricated temporary housing reported having little social capital, being less than half the proportion of those living in privately-rented temporary housing/rental housing who reported this problem. One reason for this may have been that relocation to prefabricated temporary housing was organized according to administrative district,[15] and therefore relatives and friends would have been

living nearby. Assembly halls were also provided near areas of prefabricated temporary housing,[13] which enabled disaster victims to socialize with each other and create new social networks. Support for elderly disaster victims was also facilitated by the creation of new social networks and exercise programs offered by the government, hospitals, private organizations, and universities.[32] This type of support also offered opportunities for disaster victims to socialize among themselves, thereby alleviating their lack of social capital. Exercise classes might also have been directly helpful for prevention of motor function loss.[33] Such support was offered mainly to people living in prefabricated temporary housing, and in fact there have been few reports of this sort of assistance being offered to people living in privately-rented temporary housing/rental housing or other types of housing. In practice, because of the laws designed to safeguard personal information in Japan, the government is unable to reveal information about the identity of residents living in privately-rented temporary housing. This meant that if they did not appeal on their own, they would be unable to receive support from private organizations.[15] This suggests that there may have been no significant association for prefabricated temporary housing because of the availability of social support from their surroundings.

In Japan, the housing policy being considered in the event of future large-scale disasters is to increase the number of people who are relocated to privately-rented temporary housing if they can no longer remain in their own homes.

However, our present analysis shows that relocating elderly people to privately-rented temporary housing/rental housing has an adverse effect on their health. Therefore, future rehousing policies for elderly disaster victims will need to consider the issue of social capital.

This study had some limitations. First, the sample size was small, and this may have hindered adequate assessment of motor function loss in participants who were living in prefabricated temporary housing, in the homes of relatives, or in reconstructed housing. Second, the external validity of our findings was unclear because this study was based on data from only a single city, Ishinomaki. Third, the Kihon checklist used in this study as an outcome measure has a narrow range of possible scores, which might have made changes difficult to detect, thereby rendering it insensitive as an index. Fourth, because 24 participants (37.5%) who were living in privately-rented temporary housing/rental housing at the baseline did not answer the question about housing type or relocated from privately-rented temporary housing/rental housing one year later, the results might not have reflected the true effect of this form of housing on motor function. An analysis of only those participants who stated that they were living in the same type of housing at the baseline and one year later (n = 411) showed that the multivariate adjusted OR for privately-rented temporary housing/rental housing was 2.09 (95% CI: 0.76–5.78), which tended to be higher, although the association did not reach statistical significance. Therefore, if all the participants who had relocated to privately-rented

temporary housing/rental housing could have been followed up, it is unlikely that the present results would have changed. Fifth, in this study, the rate of valid responses at the baseline was not high (35.9%), and therefore our study population might not have included people who had a higher risk of motor function decline, thus leading to possible underestimation of the risk of motor function loss.

CONCLUSIONS

In this study, significant loss of motor function was found among elderly people who had relocated to privately-rented temporary housing/rental housing after the GEJE, in comparison with those who had continued to live in the same housing as that before the disaster. This suggests that if relocation is necessary after a disaster, rehousing policies should ensure that elderly people retain their social capital.

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Contributors: KI, YT and IT conceived and designed the study. KI, YT, MK, YS, TW and IT collected the data. KI and YT analyzed the data. KI and YT drafted the article. MK, YS, TW, TA and IT revised the article and reviewed the draft.

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Competing interests: None to declare.

Ethical approval: This survey study was performed with the approval of the Institutional Review Board of Tohoku University Graduate School of Medicine. The survey participants provided written, informed consent after being provided a written and oral explanation of the study contents.

Provenance and peer review: Not commissioned; externally peer reviewed.

Data sharing statement: No additional data are available.

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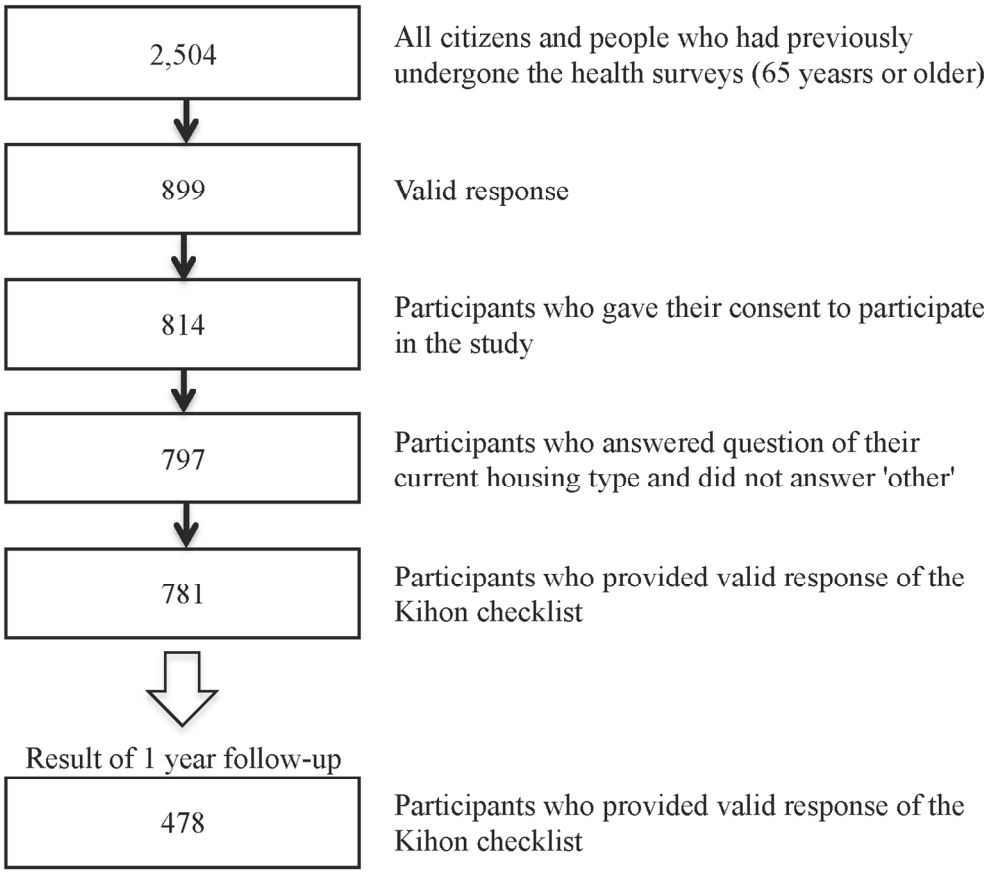
Figure 1. Flow chart of the study participants.

The study population comprised 2504 men and women aged ≥65 years (as of March 31, 2012) who were living in Oshika and Ogatsu towns of Ishinomaki City, Miyagi Prefecture, Japan, or who had previously undergone health surveys that included known addresses. The surveys for this study were carried out using interviews and self-administered questionnaires in June-July 2012 and May-July 2013. This figure details the flow of the study participants. A total of 478 responses were analyzed for the purposes of this study.



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130x114mm (300 x 300 DPI)

STROBE 2007 (v4) checklist of items to be included in reports of observational studies in epidemiology*

Checklist for cohort, case-control, and cross-sectional studies (combined)

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1,3
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	3-4
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	5-7
Objectives	3	State specific objectives, including any pre-specified hypotheses	7
Methods			
Study design	4	Present key elements of study design early in the paper	8
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	8
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	8
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	8-12
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	8-12
Bias	9	Describe any efforts to address potential sources of bias	
Study size	10	Explain how the study size was arrived at	8
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	12
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	12-14
		(*b*) Describe any methods used to examine subgroups and interactions	13-14
		(*c*) Explain how missing data were addressed	8
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed	8

		Cross-sectional study—If applicable, describe analytical methods taking account of sampling strategy	
		(*e*) Describe any sensitivity analyses	13
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	8
		(b) Give reasons for non-participation at each stage	8
		(c) Consider use of a flow diagram	8, Fig.1
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	15-17, Table.1
		(b) Indicate number of participants with missing data for each variable of interest	8
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	8
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	17, Table.2
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	
		Cross-sectional study—Report numbers of outcome events or summary measures	
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	17, Table.2
		(*b*) Report category boundaries when continuous variables were categorized	12-13
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	19, Table3
Discussion			
Key results	18	Summarise key results with reference to study objectives	21
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	25-26
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	21-26
Generalisability	21	Discuss the generalisability (external validity) of the study results	25-26
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	28

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.
Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.