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Relocation after the Great East Japan Earthquake and Cognitive Decline Among Affected Residents

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Abstract

The survey aimed to clarify the factors affecting the health status of the elderly living in Miyagi and Fukushima prefectures, based on residents' living conditions and recovery after the Great East Japan Earthquake in March 2011. I analyzed the impact of relocation on the cognitive abilities of residents in the affected areas of the Great East Japan Earthquake using the results of an original questionnaire survey. Tohoku University's Research Center for Aged Economy and Society surveyed the health status of elderly adults eight years after the disaster from March 26–28, 2019. In this paper, I compared the group means concerning those who did and did not relocate using three variables: the dementia risk index, professionally diagnosed dementia, and symptoms of dementia. Eight years after the Great East Japan Earthquake, several residents of the affected areas relocated. The results of our analysis indicated a close relationship between relocation and cognitive ability. Specifically, the group that relocated had worse health than those who did not. According to the regression analysis results, the relocation dummy was significant, and positively affected the cognitive ability (dementia risk index and professionally diagnosed dementia) of the elderly. In addition, the interaction between the relocation dummy and dummies who visited friends more than once a week was significantly negative. For older adults who relocated, visiting friends at least once a week was associated with improved cognitive performance. Therefore, it is crucial to create an environment that is conducive to interaction between residents.

Keywords: Relocation, the Great East Japan Earthquake, cognitive ability, survey data

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1. Introduction

In 2011, the Great East Japan Earthquake (GEJE) struck the Tohoku region in Japan, claiming the lives of more than 20 thousand, and destroying numerous houses and buildings (The Extreme Disaster Management Headquarters, 2020). Among the evacuees, most fixed or rebuilt their damaged homes and returned to their hometowns. However, some had to relocate to other places because they could not afford to fix or rebuild their houses. Relocation based on individuals' willingness is an excellent way to select a satisfying environment to reside in. Although the GEJE occurred more than nine years ago, people's health status is still affected owing to the damage to buildings, types of support activities, and relocation caused by the disaster (Chen, 2019; Hikichi et al., 2016, 2017).

The GEJE and sequent tsunami destroyed thousands of houses. Extensive housing damage means that the owners must invest more time and money to fix or rebuild. Therefore, the extent of housing damage caused by the GEJE was a key factor during recovery. Empirical studies also showed that housing damage significantly decreased the health status of the evacuees, including hindering cognitive ability (Hikichi et al., 2019), increasing psychological distress (Tsuchiya et al., 2017), and worsening their cardiometabolic profiles (Shiba et al., 2020). For example, Hikichi et al.(2019) applied a random-effects model with panel data from Iwanuma City and found that the experience of housing loss was related to declined cognitive ability. Therefore, how to deal with the issue of housing damage not only correlates to resilience in daily activities but also relates to the resilience of health status.

Among the evacuees that could not afford to fix or reconstruct their homes, most had to move to temporary emergency housings or live with relatives. In most cases, relocation was decided by a lottery. Therefore, they had to give up the social capital they had accumulated, such as living in a good neighborhood. Maintaining community social capital is a challenge for local governments. Group relocation is one possible way to deal with this issue. According to Hikichi et al. (2017), group relocation was related to improved informal socializing and social participation, while individual relocation declined as to these two indicators. However, group relocation would take more time and energy expenditures from the local government than would individual relocation.; in which case, the relocation schedule would be drastically postponed, resulting in the deterioration evacuees' health status. Therefore, individual relocation was much more popular than group relocation among the affected areas.

In February 2019, Nippon Hoso Kyokai (NHK; Japan Broadcasting Corporation)

surveyed eight towns and villages in Futaba County and Minamisoma City in the vicinity of the Fukushima Daiichi nuclear power plant regarding the status of disaster-related deaths. A majority of the respondents (58%) reported that they had relocated between five and nine times (mean = 6.7 times; NHK, 2019). The health of the elderly is particularly likely to deteriorate as they are repeatedly relocated. According to the NHK results, of the 195 people who died, the main causes were pneumonia (28%) and heart disease (20%). Malignant neoplasms accounted for just 2%. In contrast, the ranking and percentage of deaths (overall) in Japan in 2017 shows that malignant neoplasm is the main cause of death (27.8%), while cardiac disease and senility are the second and fourth leading causes of death at 15.2% and 7.6%, respectively (Ministry of Health, Labour and Welfare, 2019).

There are two kinds of temporary emergency housings provided for evacuees: prefabricated temporary emergency housing and privately rented temporary housing. Empirical studies showed that housing type significantly contributed to contracting bad habits such as excessive alcohol consumption (Murakami et al., 2017). Housing type is also related to decreased health, including hindered cognitive ability (Ishiki et al., 2016), increased depressive symptoms (Sasaki et al., 2018; and decreased motor function (Ito et al., 2016), subjective health (Kusama et al., 2020), and subjective well-being (Moriyama et al., 2019). However, these studies did not provide enough evidence concerning why housing damage and housing types are associated with declined health among evacuees.

A few previous studies showed that social capital is significantly associated with cognitive ability. It is challenging for evacuees to keep existing social capital and accumulate new social capital in a new environment. Both the deaths of residents and changes in environments caused by the GEJE contributed to the decline in community-level social capital. However, few previous studies examined the impacts of the decline of social capital caused by the GEJE on cognitive ability (Hikichi et al., 2020). Therefore, the purpose of this paper was to investigate the effects of relocation on the cognitive abilities of the elderly using questionnaire survey data. It focused on older adult evacuees' cognitive ability (dementia) and discussed the possible social capital mechanisms.

2. Method

2.1 Data

The CAES conducted a questionnaire survey of elderly people living in Miyagi and Fukushima prefectures, following a review by the Research Ethics Review Committee of the Graduate School of Economics and Management, Tohoku University. This academic survey was designed to clarify the factors affecting the health status of the elderly, based on the living conditions and recovery of the residents since the GEJE.

The methods of this study were as follows: 1) screening selected monitors living with elderly people aged 65 years or older; 2) asking the monitors to answer about the situation of the oldest elderly person living with them after obtaining the oldest elderly person's consent. I targeted Miyagi and Fukushima prefectures, and 734 respondents (435 in Miyagi and 299 in Fukushima) were requested to cooperate in the survey through Internet member survey agencies (Chen and Yoshida, 2019).

Table 1 shows the distribution of relocations among the respondents. The highest frequency of relocations was only once, accounting for 9.7% of the total number of relocations. This differs from the results of the NHK survey, which showed that the number of relocations ranged from 5 to 9 times. This is owing to the fact that the participants of the two surveys were very different.

Table 1. Number of relocations after the Great East Japan Earthquake

Number of relocations	n	%
One	71	9.7
Two	36	4.9
Three	17	2.3
Four	3	0.4
Five	0	0.0
Six	0	0.0
Seven and more	1	0.1
Never	606	82.6
Total	734	100.0

Note: Based on the individual data of "A Questionnaire on the Health Status of the Elderly Eight Years after the Great East Japan Earthquake."

Table 2 summarizes the reasons for the first relocation among those who had relocated. Most (58.6%) moved for reasons related to the earthquake. In contrast, 23.4% of respondents moved for reasons unrelated to the earthquake, such as buying a home or family reasons. Since the decision concerning where to live was primarily a matter of personal choice, there was no room for the involvement of others. However, owing to the disaster, many residents were forced to leave their familiar towns. For elderly residents, it is quite difficult for them to solve their housing problems on their own; thus, government assistance was essential.

Table 2. Reasons for the first relocation

Reason	n	%
1. Houses were damaged or destroyed in the GEJE	36	28.1
2. Houses were damaged or destroyed by the tsunami in the GEJE	23	18.0
3. Houses are safe; but the dangers of radiation are still there	13	10.2
4. Other reasons for relocating owing to the GEJE	3	2.3

5. Other reasons regardless of the GEJE (e.g., purchase of a home, family reasons)	30	23.4
6. An elderly person had become ill and needed care	7	5.5
7. An elderly person started cohabitating with his/her children	8	6.3
8. Other	8	6.3
Total	128	100.0

Note: Based on the individual data of "A Questionnaire on the Health Status of the Elderly Eight Years after the Great East Japan Earthquake." GEJE = Great East Japan Earthquake.

2.2 Dependent Variables

I used three indicators to measure the cognitive abilities of the elderly. The first indicator was the dementia risk index based on the "Dementia Awareness Checklist," which was initially created by the Tokyo Metropolitan Health and Longevity Medical Center Research Institute. The higher the scores, the more likely respondents had problems with their cognitive abilities and social lives. The center's validation showed that, among the 131 respondents identified as high-risk on the checklist, 76% were suspected to have dementia, which was determined in a post-professional interview. Table 3 provides a breakdown of the ten questions used to calculate the dementia risk index in this paper.

Table 3. Questions for calculating individuals' dementia risk

1. Do you always lose track of where you put things, such as your wallet and keys?
2. Do you fail to remember a story from five minutes ago?
3. Are you told that you always ask the same things?
4. Do you fail to answer questions regarding information about the current day?
5. Do the words you are trying to say not come out immediately?
6. Can you manage daily financial matters alone?
7. Can you go shopping alone?
8. Can you go out using a bus, train, or private car alone?
9. Can you clean your bedroom using a vacuum cleaner or broom?
10. Can you look up a phone number and make a call?

Note: These questions were based on the checklist for dementia diagnosis, developed by the Tokyo Metropolitan Health and Longevity Medical Center Research Institute. Response options for the first five questions include "not at all" (1 point), "a little" (2 points), "often" (3 points), and "always" (4 points). Response options for the remaining questions include "I can do it" (1 point), "I can do it with a little help" (2 points), "I can do it with much help" (3 points), and "I cannot do it" (4 points). Summed scores indicated individuals' dementia risk.

The second indicator was whether the respondent was diagnosed with dementia by

a specialist. Regarding the question, “Does the elderly person currently have doctor-diagnosed dementia such as Alzheimer’s disease,” the dummy variable “diagnosed dementia” was assigned a value of 1 when the response was “yes.” “No” was assigned a value of 0.

The third indicator was the number of symptoms of dementia. The symptoms of dementia can be broadly divided into two types: core symptoms, which are the main symptoms of dementia, depending on the part of the cortex where the neuronal degeneration occurs; and behavioral and psychological symptoms, which are also known as peripheral symptoms. Here, I measured older adults’ cognitive abilities by adding the number of core and peripheral symptoms of dementia (Table 4).

Table 4. Symptoms of dementia

1. The respondent often does not know his/her age
2. Cohabitating children or spouse could be mistaken as strangers
3. It is possible that the respondent forgets the meal that he/she ate just before
4. Sometimes, the respondent does not answer the number of children correctly
5. The respondent walks around the house aimlessly
6. The respondent is rambling continuously all day
7. The respondent eats whatever he/she can eat
8. The respondent does not want to bathe or change clothes for no particular reason
9. Waking up at night and making a lot of noise for no reason
10. The respondent puts something in his/her mouth that is not food

Note: Based on the individual data of “A Questionnaire on the Health Status of the Elderly Eight Years after the Great East Japan Earthquake.”

2.3 Explanatory Variables

The explanatory variables used in this paper included not only individual attributes but also the recovery status of the community. The definition of each variable is presented in Table 5.

Table 5. Definitions of variables

Variables	Definitions
Dementia Risk Index	Based on the “Dementia Awareness Checklist,” adding ten items as a total score
Diagnosed dementia dummy	Regarding the question, “Does the elderly person currently have doctor-diagnosed dementia such as Alzheimer’s disease,” the dummy variable “diagnosed dementia” was assigned a value of 1 when the respondence was “yes.” “No” was assigned a value of 0.
Number of symptoms of dementia	The number of symptoms of dementia that the elderly person has

Relocation dummy	If the number of relocations after the GEJE exceeded one, the relocation dummy was assigned a value of 1. Otherwise, this dummy was assigned a value of 0
Male dummy	Male = 1, Female = 0
Cohabitating with spouse dummy	Cohabitating with spouse＝1, other＝0
Aged ≥ 85 years dummy	Aged ≥ 85 years＝1, other＝0
Higher education dummy	More than an undergraduate degree = 1, Other = 0
Total activities of daily living score	Total activities of daily living score was calculated based on ten items: independent (1 point), partially assisted (2 points), and fully assisted (3 points)
Support needed dummy	Support needed level 1–2 = 1, Other = 0
Care needed dummy	Care needed level 1–5 = 1, Other = 0
Income and economic living conditions	Self-reported as 1. very poor, 2. poor, 3. normal, 4. good, or 5. very good
Access to medical and welfare facilities	Self-reported as 1. very poor, 2. poor, 3. normal, 4. good, or 5. very good
Relationship with family members	Self-reported as 1. very poor, 2. poor, 3. normal, 4. good, or 5. very good
Visiting friends more than once a week dummy	Visiting friend more than once a week = 1, Other = 0
Recovery of municipalities after the GEJE	Self-reported as 1. very poor, 2. poor, 3. normal, 4. good, or 5. very good

Note: Based on the individual data of "A Questionnaire on the Health Status of the Elderly Eight Years after the Great East Japan Earthquake." GEJE = Great East Japan Earthquake.

2.4 Descriptive Statistics

Table 6 shows the descriptive statistics of the variables. Overall, 16.1% of the study population had moved to a new location and 8.2% had professionally diagnosed dementia. The average number of symptoms of dementia was 0.768. The elderly aged ≥ 85 years accounted for 23.8% of the study population, and 5.7% and 14.2%, respectively, were identified as needing support or care. About one-third visited their friends at least once a week.

Table 6. Descriptive statistics

	Mean	**SD**	**Min**	**Max**
Dementia Risk Indicator	16.740	7.272	10.000	40.000
Diagnosed dementia dummy	0.082	0.274	0.000	1.000
Number of symptoms of dementia	0.768	1.838	0.000	10.000
Relocation dummy	0.161	0.368	0.000	1.000
Male dummy	0.496	0.500	0.000	1.000
Cohabitating with spouse dummy	0.521	0.499	0.000	1.000
Aged ≥ 85 years dummy	0.238	0.426	0.000	1.000
Higher education dummy	0.153	0.360	0.000	1.000
Total activities of daily living score	11.178	3.137	10.000	30.000
Support needed dummy	0.057	0.232	0.000	1.000
Care needed dummy	0.142	0.349	0.000	1.000
Income and economic living conditions	2.857	0.876	1.000	5.000
Access to medical and welfare facilities	3.213	0.902	1.000	5.000
Relationship with family members	3.294	0.877	1.000	5.000
Visiting friend more than once a week dummy	0.338	0.473	0.000	1.000
Recovery of municipalities after the GEJE	3.228	0.712	1.000	5.000

Note: Based on the individual data of "A Questionnaire on the Health Status of the Elderly Eight Years after the Great East Japan Earthquake." GEJE = Great East Japan Earthquake, SD = standard deviation.

3. Empirical Results

3.1 Mean Difference Test Results

Two subsamples were created here, A and B, depending on the presence or absence of relocation. Table 7 shows the results of the test of the difference between the means of each indicator of older adults' cognitive ability. The group mean values of three indicators were significantly higher for the group that relocated (vs. did not), indicating relatively low cognitive ability. This was consistent with our hypothesis. In other words, relocation history was associated with negative effects on older adults' cognitive abilities.

Table 7. Mean difference test results

	A (have a history of relation)	B (without a history of relocation)	A–B
	116	604	-
Dementia Risk Indicator	17.879	16.522	1.358**
Diagnosed dementia dummy	0.138	0.071	0.067***
Number of symptoms of dementia	0.991	0.725	0.266*

Note: Based on the individual data of "A Questionnaire on the Health Status of the Elderly Eight Years after the Great East Japan Earthquake." *p < .10, **p < .05, ***p < .01 (t-tests).

3.2 Regression results

I analyzed the relationship between relocation and cognitive ability without controlling for the effects of other variables in 3.1. Here, I further look into the relationship between relocation and cognitive ability through regression analysis. The dependent variables in estimating equations A1, B1, and C1 were dementia risk, diagnosed dementia dummy, and the number of symptoms of dementia, respectively. Table 8 shows the details of the estimation results. First, based on the results of A1, the coefficient for the relocation dummy was significantly positive. Compared to older adults without a history of relocation, older adults with a history of relocation had a higher risk of developing dementia, leading to lower cognitive performance. This result was consistent with our expectations. The control variables showed that older adults aged 85 years and older had significantly lower cognitive abilities than those aged younger than 85 years. The coefficient on the total ADL score was significant, with an average increase of one point in the total ADL score raising the risk index for developing dementia by

0.971 points. Concerning income and economic living conditions, the result was significant at the 5% level. As the income and economic living conditions of older adults improved, their cognitive ability also improved. A similar result was obtained for the relationship with family members. Next, the estimation results for B1 showed that the result was significant at the 5% level for the relocation dummy. Compared to older adults with no history of relocation, older adults with a history of relocation were more likely to have professionally diagnosed dementia. In other words, a history of relocation was negatively associated with older adults' cognitive abilities. Finally, looking at the C1 estimates, the regression coefficient for the relocation dummy was positive, but non-significant.

Table 8. The estimated results (1)

	A1 Dementia risk	B1 Diagnosed dementia dummy	C1 Number of symptoms of dementia
Relocation dummy	0.902*	0.052**	0.144
Male dummy	-0.725	-0.012	-0.356**
Cohabitating with spouse dummy	0.203	0.001	0.317**
Aged ≥ 85 years dummy	2.633***	0.025	0.096
Higher education dummy	-0.696	-0.013	0.038
Total activities of daily living score	0.971***	0.017***	0.198***
Support needed dummy	2.712***	0.083**	-0.109
Care needed dummy	5.550***	0.251***	0.723***
Income and economic living conditions	-0.519**	-0.005	0.035
Access to medical and welfare facilities	-0.166	0.025**	0.114
Relationship with family members	-1.104***	-0.020*	-0.176**
Visiting friend more than once a week dummy	-0.464	0.017	0.186
Recovery of municipalities after the GEJE	0.225	-0.010	-0.262**
Adjusted R^2	0.535	0.231	0.211
Observations	720	720	720

Note: Author's estimates; *p < .10, **p < .05, ***p < .01 (OLS analysis); GEJE = Great East Japan Earthquake.

The results of the above analyses indicated that relocation history has a negative impact on older adults' cognitive abilities. Here, I further added the intersection term for relocation dummy and visiting a friend more than once a week dummy to examine possible mechanisms. Table 9 presents detailed results. The estimated coefficient for the intersection term was significantly negative, according to the A2 estimation results. For older adults with a history of relocation, visiting a friend at least once a week significantly reduced their risk of developing dementia and improved their cognitive abilities. Similarly, the estimation results for B2 and C2 showed similar results for the intersection term (the

result in B2 was non-significant).

Table 9. The estimated results (2)

	A2 Dementia Risk	B2 Diagnosed dementia dummy	C2 Number of symptoms of dementia
Relocation dummy	1.640***	0.075**	0.346*
Visiting friend more than once a week dummy	-0.099	0.028	0.286
Relocation × visiting friend	-2.347**	-0.072	-0.642*
Male dummy	-0.732	-0.012	-0.358**
Cohabitating with spouse dummy	0.194	0.001	0.315**
Aged ≥ 85 years dummy	2.624***	0.025	0.093
Higher education dummy	-0.609	-0.011	0.062
Total activities of daily living score	0.975***	0.017***	0.199***
Support needed dummy	2.732***	0.083**	-0.103
Care needed dummy	5.484***	0.249***	0.705***
Income and economic living conditions	-0.512**	-0.005	0.037
Access to medical and welfare facilities	-0.154	0.025**	0.117
Relationship with family members	-1.155***	-0.021*	-0.190**
Visiting friend more than once a week dummy	0.241	-0.009	-0.258**
Recovery of municipalities after the GEJE	0.538	0.232	0.213
Adjusted R^2	720	720	720

Note: Author's estimates; *p < .10, **p < .05, ***p < .01 (OLS analysis); GEJE = Great East Japan Earthquake.

4. Conclusion and Discussion

This paper presents an empirical analysis of the relationship between relocation history and the cognitive abilities of the elderly, using individual data from an original questionnaire. The results of the regression analysis are summarized as follows. First, compared to older adults with a history of relocation, cognitive ability (dementia risk and diagnosed dementia dummy) was significantly lower for older adults without a history of relocation. Second, for older people with a history of relocation, visiting friends at least once a week significantly increased their cognitive ability.

Since relocation is a decision made by the individual, there is no room for involvement from the government. However, owing to earthquakes and secondary

disasters, many residents are forced to leave their familiar towns and move to distant locations. In this case, they lose the social capital they have built over the years, such as neighborhood relationships. The estimates in this paper suggest that social capital, such as visiting friends at least once a week, plays a vital role in maintaining older adults' cognitive abilities. Therefore, during recovery, sufficient emphasis should be placed not only on restoring visible infrastructure and lifelines but also on restoring invisible social capital.

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