The Effect of Temporary Housing Types on Permanent Housing Relocations

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ABSTRACT

The purpose of this study is to verify the effect of temporary housing types on how early the Great East Japan Earthquake survivors were relocated to their permanent housing. In addition to conventional Prefabricated temporary housing (PTH), Designated temporary housing (DTH) was systematically introduced to meet massive demands of housing after the earthquake in 2011. Since then, there have been two types of temporary dwellers, those who live in PTH and those in DTH. It has not been extensively studied how DTH policy would affect individual life recoveries, compared to PTH. Therefore, it is necessary to further verify how the temporary housing types affects the individual life recoveries. In this study, we especially focused on two sets of the population survey data. The first data is 2015 Natori City Population Mail Survey Data, whose subjects were citizens and residents of 3,154 people from 1,695 households that were affected by the GEJE. The response rate of households' questionnaire was 72.7% (N=1,695), the number of individual respondents was 3,145. The other data, which was also from Natori City, consisted of the information regarding when the DTH or PTH dwellers were transferred to permanent housing units or still remaining there. These two data sets were collated by the identification numbers. The integrated data was analyzed by survival analysis which clarified the relation between temporary housing types and the duration of temporary housing residency. As a result, the effects of temporary housing types on the duration of temporary housing residency was non-significant when the family size was controlled.

Keywords: prefabricated temporary housing (PTH), designated temporary housing (DTH), permanent housing relocations, survival analysis

INTRODUCTION

A. Background

Great East Japan Earthquake (GEJE) disaster caused by the 2011 the Pacific coast of Tohoku Earthquake took the lives of 19,575 and destroyed 121,776 houses completely. Such damages made many people lose their houses and forced them to reside in temporary housing units. This caused sudden demands for huge temporary housing units. In order to respond to these massive demands, the designated temporary housing (DTH) policy in addition to conventional prefabricated temporary housing (PTH) was systematically introduced in order to meet the demands. As of June 2012, more than 68,000 DTH units were supplied, while about 48,000 PTH units were built, out of approximately 136,000 temporary housing in total (other temporary housing units were public housing units). In other words, more than a half of those households that needed temporary housing arrangements opted for DTH. Although six years have passed since the GEJE, continuous supports are still needed for those living in temporary housing units are still. However, it has not been extensively studied how the DTH policy affects the individual life recoveries, compared to that of PTH because such a numerous amount of DTH units had not been used before the GEJE. Therefore, it is necessary to initiate and continue the study on if and how the difference in temporary housing types affects the individual life recoveries.

B. Previous studies on life recoveries

Studies on victims' life recoveries from large-scale disasters in Japan have been conducted since the Great Hanshin-Awaji Earthquake. The review about a series of studies on life recoveries from the Great Hanshin-Awaji Earthquake disaster in [1] mentioned that the following seven factors affected the individual life recoveries: Housing, Social Ties, Community Rebuilding, Physical and Mental Stress, Preparedness, Economic/

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Financial Situation and Relation to Government. Based on this framework, many studies have been conducted on individual life recovery processes from the GEJE disaster.

Early study after the GEJE based on the survey in September to October 2011, conducted at Futaba areas, Fukushima prefecture in [2] pointed out factors affecting psychological wellness. This study used "WHO-Five well-being Index" indicating psychological wellness as the dependent variable. As for the independent variables, damages, disaster characteristics, outlook of life and network were used. While variables of outlook of life based on seven factors model in the study of the Great Hanshin-Awaji Earthquake [1], the effects of disaster character istics relating with radioactivity was newly and originally investigated.

Studies from 2012 to 2014 in Ofunato city, Kesen-numa city and Shinchi town [3] showed the life recoveries was consistently affected by municipality reconstruction, daily dietary habit and housing. In this study, indicators of life recoveries were based on subjective feelings answered from 0% to 100%.

In Natori city in Miyagi prefecture, continuous population surveys have been conducted from 2014 to now. The studies from these surveys [4] [5] focused on the effects of temporary housing types on individual life recoveries. Both studies employed then 14 item life recovery scale [1] scores. The 2014 Natori city survey study [4] showed that those DTH residents on average showed higher life recovery scores compared with those at PTH. However, there were significant interaction effects between "temporary housing types" and "presence of people who need special supports" on life recoveries. That is to say, those with disabilities or concerns about health issues and those who are single older household in PTH showed higher life recover scores than those vulnerable households in DTH.

As it was reviewed in the above, subjective life recovery scores have been used as the indicator of individual life recoveries in many studies. Although the subjective indicators are one of the most important aspects of the victims' life recoveries, other aspects of life recoveries, i.e., the more objective indicators of individual recovery also need to be considered. The 2014-2015 Natori city panel survey study [6] examined the characteristics of those who resolved the housing issues and were relocated to permanent housing unit from 2014 to 2015. However, this study has a limitation. The study focused only on the 2014 and 2015 panel survey data. In other words, those households that were relocated to permanent housing unit before 2014 or after 2015 were not examined. It is critical to use entire days of temporary housing residency as the dependent variable in the life recovery study.

Based on the critical reviews of the preceding studies, the current study sets the following research question: How do the temporary housing types affect the duration of temporary housing residency? In order to answer this research question, we used the data from Natori city in Miyagi, which was one of the most severely damaged area by the GEJE. By answering this research question, this study could help better execute temporary housing provision policies in the future.

METHODS

A. Data

In this study, we especially focused on two sets of the population survey data. The first data is the 2015 Natori City Population Mail Survey Data, whose subjects were 3,154 citizens and residents out of 1,695 households that were affected by the GEJE. The response rate of households' questionnaire was 72.7% (N=1695), and the number of individual respondents was 3,145 (The response rate was not calculated because questionnaires were sent in households). At the time of the survey, 408 households were in DTH, 604 households in PTH and 1,144 households had already been relocated to permanent housing. In this study, only responses from the head of each household were used since the interests of this study was not on individual but on household decisions.

The other data which was also obtained from Natori city administration was the duration between when the survivors started and ended the temporary housing residency up until August 1st, 2017. In order to compare the effect of temporary housing types (DTH or PTH) on when they moved to permanent houses, households who had never lived in temporary housing or who moved to other types of temporary housing were excluded from this study. As a result of data handling above, 3,178 households are extracted. By using this data, we calculated how many days they stayed in temporary housing, which used as the dependent variable in the following analysis. Then, this data is called "relocation data." These two data sets were combined by using the household identification numbers. Finally, 936 households remained for analyses. The cover rate of relocation data is 29.4%.

B. Analysis

In order to examine the effect of temporary housing types on the duration of temporary housing residency, survival analysis [6] was used. Survival analysis, also called "Event-history analysis", is a statistical analysis which is widely used in the medical field and the reliability engineering field. Survival analysis focuses on the duration of time until certain events happen. The duration of time is called "survival time", "failure time" or "life time". In general, the survival time is set as the dependent variable, and then how the other covariates affects the survival time is analyzed. In the current study, the event was defined as the relocation to permanent housing units, and the

survival time was the duration of temporary housing residency (from the time started the temporary housing residency to ended).

The exact survival time was only known for households which had been relocated to permanent housing units until observation ended. However, we cannot know the exact survival time of the households that were still residing in temporary housing. Such incomplete survival time is called "censoring", and these observations are called "censored observations". Although censored observations do not show the exact survival time, it is known that the event will happen after censoring. Therefore, we can know that the survival time is longer than the certain period at least. The advantage of survival analysis is that we can analyze the data that can include such censored observations. In the current study, the censoring is defined as the households had been residing in temporary housing units as of August 1, 2017. The relation between the survival time and the censoring in this study is illustrated in figure 1. In following analysis, the such Stata 14 commands as "sts test", "streg" and "sts graph" were used.

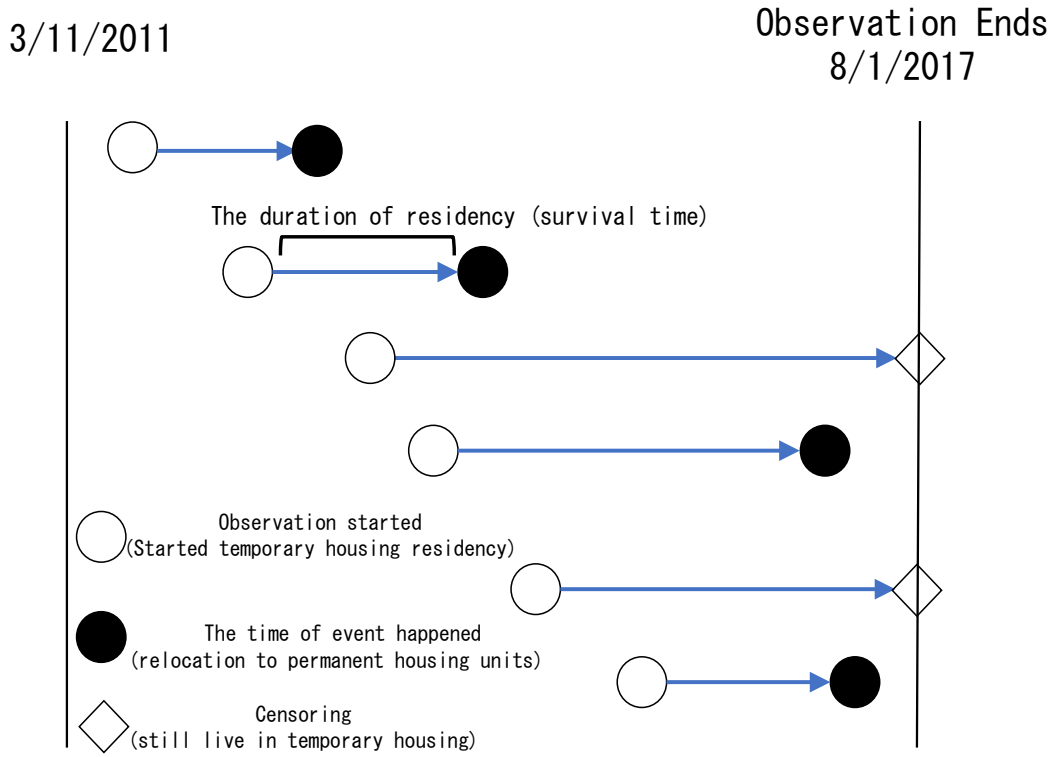

Figure 1: Survival time and Censoring

C. Variables

As it was mentioned in the above, the dependent variable was the survival time, that is to say, the duration of temporary housing residency. The independent variables were drawn from the 2015 Natori City Population Mail Survey Data and those included "temporary housing types (PTH or DTH)", "house damage", "household size", "ownership of the house prior to the GEJE", "age" and "job type of the head of the household before the GEJE." These independent variables were converted into dummy variables.

RESULT

A. Fitting survival functions

Before examining covariate effects on the duration of residency, the survival curves needed to be fitted to certain distribution functions. Figure 2 shows the estimate of survival function (i.e., proportion of those still residing in temporary housing units on a given day) by Kaplan-Meier method and Weibull function. As it shows, Weibull function showed a good fit to the survival curve estimated by Kaplan-Meier method. Therefore, in the following multivariable analysis, Weibull distributions were employed as the hazard function.

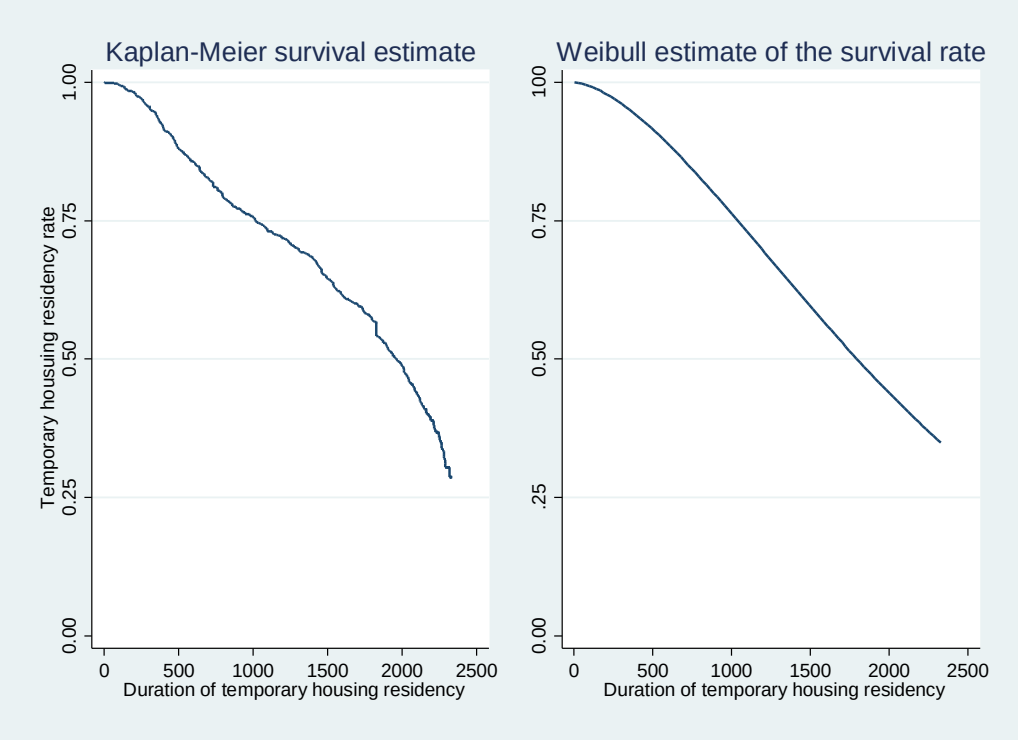

Figure 2: Estimated survival functions by Kaplan-Meier method and Weibull function.

B. The simple comparison of DTH and PTH survival curves

Figure 3 illustrates the comparison of survival curves estimated by the Kaplan-Meier analysis between people who resided in PTH and those in DTH. The horizontal axis shows duration of temporary housing residency, and the vertical axis shows the proportion those residing in temporary housing units on a given day (survival rate) on a given day.

As a result of the Log rank test which is a significance test for the difference of survival curves, people in DTH were relocated significantly earlier than those in PTH ($\chi^2 = 7.28$, $p < .01$). Although this differences were evident from a simple eye-ball comparison, other covariates were not controlled. Hence, the multivariate analyses was conducted in order to control the effects of other covariates.

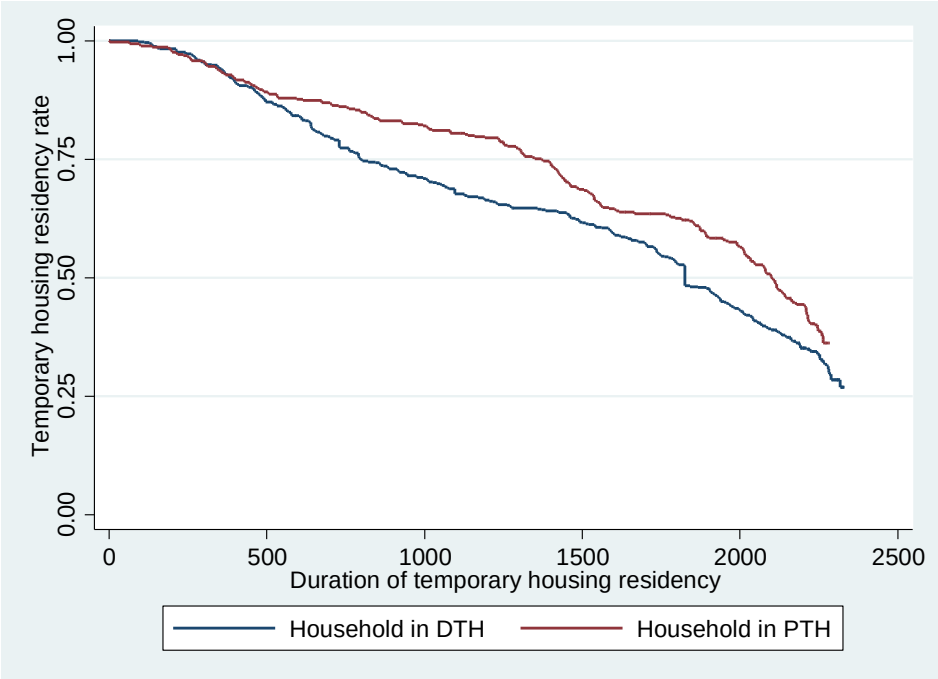

Figure 3: hazard function of failure time (duration of residency)

C. Comparison of regression models to predict the duration of temporary housing residency.

Table 1 shows the effects of covariates on the duration of temporary housing residency based on Weibull distribution where parameters lager than 1.0 contribute to faster exit to permanent housing and those smaller than 1.0 imply slower exit from temporary housing. First model (1) shows the effect of PTH residency (DTH was used as the baseline) and it showed a significant less than 1.0 effect ($p < .01$), suggesting PTH caused slower exit to permanent housing.

Table 1: The effects of covariates on the duration of residency

VARIABLES		Model (1)		Model (2)		Model (3)	
		Hazard ratio	(S.E)	Hazard ratio	(S.E)	Hazard ratio	(S.E)
Temporary housing types	DTH units(baseline)	-	-	-	-	-	-
	PTH units	0.785***	(0.0654)	0.836*	(0.0821)	1.026	(0.103)
Degree of the house damage	Completely destroyed(baseline)			-	-	-	-
	Large-scale partial destroyed			1.175	(0.242)	1.063	(0.220)
	Partial destroyed			2.599***	(0.388)	2.542***	(0.379)
	Unknow because of relocation from other city			1.014	(0.149)	0.955	(0.143)
Head of household's gender	Male(baseline)			-	-	-	-
	Female			0.689***	(0.0778)	0.867	(0.100)
Ownership of the house household lived in before the GEJE	Owned house and land(baseline)			-	-	-	-
	Owned house but rented land			0.613	(0.208)	0.618	(0.210)
	Rental house			0.476***	(0.0550)	0.479***	(0.0554)
	Others			0.502***	(0.122)	0.458***	(0.112)
Head of household's Job before the GEJE	Laborer(baseline)			-	-	-	-
	Agriculture and fishing industry			1.516**	(0.259)	1.404**	(0.240)
	Self-owned business			0.960	(0.131)	0.965	(0.132)
	Office worker			1.139	(0.179)	1.159	(0.183)
	Employee of an association			1.132	(0.285)	1.044	(0.264)
	Public service worker			1.154	(0.241)	1.250	(0.262)
	Part-time worker			0.961	(0.165)	1.027	(0.178)
	Student			0.631	(0.371)	0.868	(0.511)
	Retired person			1.331**	(0.173)	1.346**	(0.174)
	Unemployed			0.846	(0.208)	0.972	(0.239)
	Home manager			0.931	(0.321)	1.070	(0.370)
	Others			1.419	(0.611)	1.918	(0.827)
When they started tenporary housng residency	Before April 2011 (baseline)			-	-	-	-
	March 2011 to August 2011			0.976	(0.122)	0.968	(0.121)
	After September 2011			1.256	(0.215)	1.351*	(0.233)
Household size	single(baseline)					-	-
	two persons					1.988***	(0.266)
	three persons					2.625***	(0.374)
	four persons					3.534***	(0.534)
	More than five persons					4.504***	(0.759)
	Constant	4.37e-06***	(1.97e-06)	2.65e-06***	(1.25e-06)	6.09e-07***	(3.07e-07)
	Observations			936			
	log likelihood	-1059.73		-993.26		-936.18	
	AIC	2117.46		1944.52		1822.36	
	m(shape parameter)	1.612		1.691		1.773	

*** p<0.01, ** p<0.05, * p<0.1

Model (2) included a part of control variables (household size not entered). The effect of temporary housing types over the duration of temporary housing residency decreased to a level of $p < .10$. On the other hand, such dummy variables as "partial damage", "female", "rental housing dweller prior to the GEJE", "agriculture and fishery" turned out to be stronger predictors ($p < .01$). Households whose houses were partially damaged exited at about 2.6 times faster than the completely damaged households, female-headed households were about 70 % slower than their male counterpart, the households that used to reside in rental units were about 50 % slower than house owners, those in agriculture and fishery and the retired were 1.5 and 1.3 times respectively faster than laborers.

Model (3) included household size in addition to previous covariates in model (2). As a result, the households with more than two persons exited to permanent housing at the speed about two to four and a half times faster than single households. Among all significant predictors, the households with four or more turned out to be the best predictors. In addition, the sudden improvement of goodness-of-fit indicators (log-likelihood and AIC) also suggested that the last entered covariate, i.e., household sizes, contributed to the best fitted model among the examined three models. In the mean time, after entering the household sizes as control variables in Model (3), the effects of PTH residency and of gender disappeared.

DISCUSSION

In the current study, if and how the temporary housing types affects the duration of temporary housing residency was analyzed. As a result, Figure 2 and model (1) in table 1 showed the significant effects of temporary housing types on duration of residency. However, the effect disappeared by controlling household size in model (3). What was the meaning of this finding?

In order to interpret this result, cross-table analysis between the household size and temporary housing types was presented as in figure 4. It demonstrates that household size of those in PTH units were significantly smaller than those in DTH *($\chi^2 = 52.72$, $p < .001$)*. The smaller household sizes in PTH was attributed for the slower exit to permanent housing and the effect of temporary housing types as shown in model (1) was caused by spurious correlation.

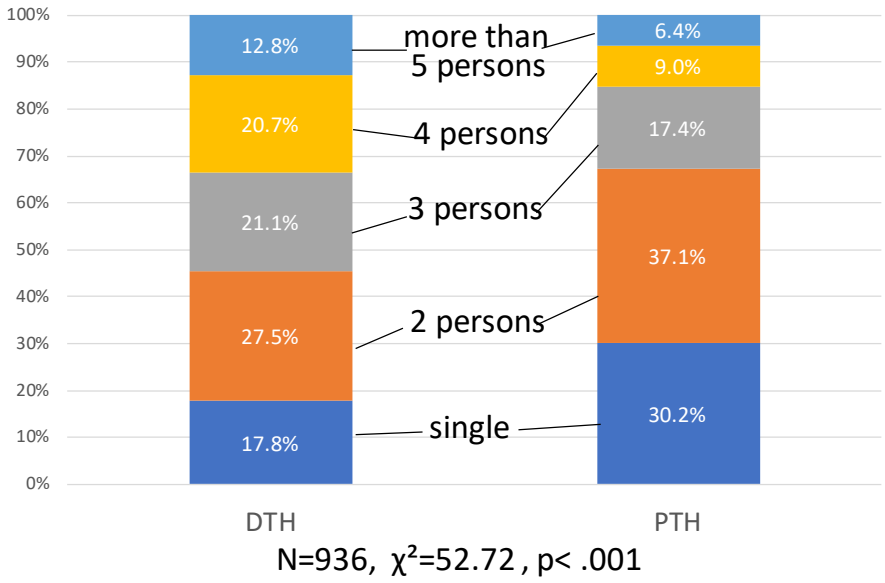

Figure 4: the relation between temporary housing types, and family size

Such a relation was also observed in the effect of the head of household's gender as well. Figure 5 illustrates the result of cross-table analysis between temporary housing types and head of household's gender. As it was observed in analysis between the household size and temporary housing types in the figure 4, the household headed by female have significantly smaller household size *($\chi^2 = 77.28$, $p < .001$)*. It is considered from figure5 and model (3) in table1 that the effect of gender on the duration of temporary housing residency was caused by difference of the household size, and the effect was spurious correlation too.

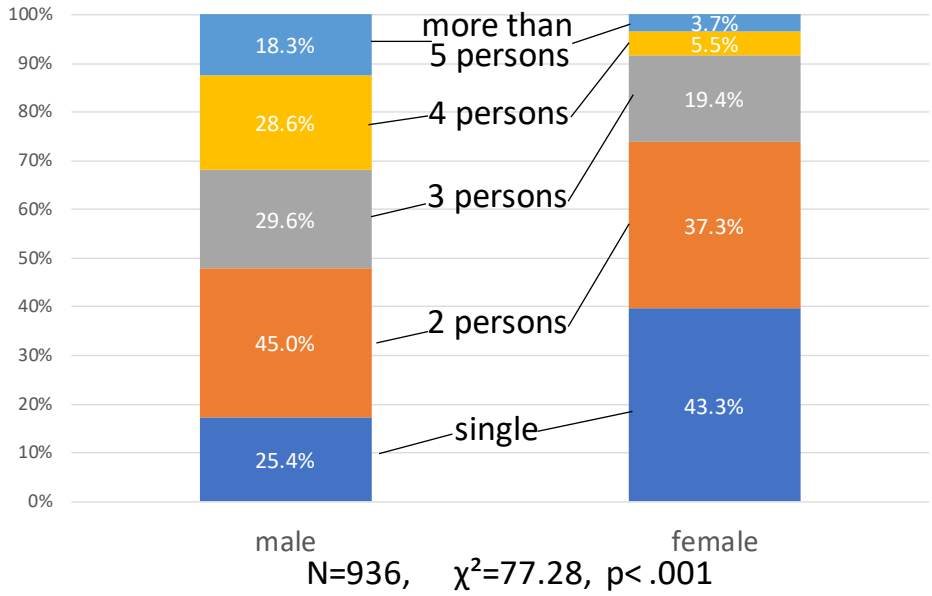

Figure 5: the relation between temporary housing types and head of household's gender

The previous study which employed 14 item subjective life recovery scale scores in [4] pointed out that people who lived in DTH had higher life recovery scores in general. However, the current study employed the duration of temporary housing residency as the objective indicator of individual recoveries, and it proved that temporary housing types did not affect individual life recoveries.

With regard to policy implication of the current study, this is not to say that there are no differences between the DTH policy and PTH policy for individual life recoveries. DTH policy has an advantage. As was the case in the GEJE and the Kumamoto earthquake, DTH units were provided earlier than PTH units, because the DTH units does not need to be newly constructed. Moreover, DTH units are much more economical than PTH units for the same reason. Therefore, even if the temporary housing types do not affect the duration of temporary housing residency, DTH units have an advantage which can be provided to the victims far sooner than PTH units. The early starting the temporary housing residency also means that they can be relocated to permanent housing units earlier.

Finally, there are two limitations of this study. The first is problem of the external validity, and the other is the lack of variables. The first is that, findings of the current study are based on the data from only Natori city, therefore it is possible that the same result will not be observed in other regions. Hence, attention need to be paid when applying these findings to other regions, and this point is one of challenges for the future research. Secondly, dependent variables used in the current study were mainly demographic variables which were observed before the GEJE or the entrance to temporary housing. Therefore, variables observed after the GEJE or collected after the temporary housing residency, were not included in the analyses. For example, the seven critical factors for life recovery as mentioned in [1] -- Social Ties, Community Rebuilding, Physical and Mental Stress, Preparedness, Economic/Financial Situation and Relation to Government -- were not included. It is possible that the effects confirmed in the current study may disappear by controlling these variables. This point is one of the challenges for the future as well.

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