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Mediation of the Relationship Between Home Loss and Worsened Cardiometabolic Profiles of Older Disaster Survivors by Post-disaster Relocation: a Natural Experiment From the Great East Japan Earthquake and Tsunami

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Abstract

The underlying mechanism for deterioration in cardiometabolic health after major natural disasters is unknown. We leveraged natural experiment data stemming from the 2011 Great East Japan Earthquake and Tsunami ($n = 1,165$) to examine whether specific types of post-disaster accommodations explain the association between disaster-related property damage and objectively measured cardiometabolic profiles of older disaster survivors. Causal mediation analysis showed that relocation to trailer-style temporary shelters largely mediated the associations between home loss and unhealthy changes in anthropometric measures (72.6% of 0.65 kg/m² for body mass index

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and 62.3% of 3.89 cm for waist circumference), but it did not mediate the associations with serum lipid measures. This study demonstrates that there are outcome-specific pathways linking disaster damage and health of survivors.

Keywords

disaster; cardiometabolic; neighborhood; mediation; natural experiment; fixed effects

Introduction

Besides the well-documented mental health effects (e.g., depression, post-traumatic stress disorder) of disaster exposure, growing evidence suggests that disaster survivors may be at increased risk of other long-term health consequences, including cardiovascular disease (1–11). Of various disaster-related traumatic experiences (e.g. property damage, job loss, loss of loved ones), complete home loss has been uniquely linked to a deterioration in cardiometabolic profiles of survivors. Previously it was reported that approximately 2.5 years after the 2011 Great East Japan Earthquake & Tsunami, survivors who experienced home loss exhibited markedly increased body mass index and waist circumference, as well as decreased high-density lipoprotein cholesterol, compared to individuals who suffered less severe housing damage (12). Outside Japan, a 23-year follow-up study after the 1988 Spitak earthquake in Armenia found that total home destruction, but not moderate damage, was linked to increased risk of diabetes (13).

The link between home loss and worsened cardiometabolic profiles could be explained by several factors. First, psychological distress could induce a range of health behaviors that lead to worsened cardiometabolic profiles, e.g., worse sleep quality, or higher alcohol & tobacco consumption (14–19). Interestingly, in the 2011 Japan earthquake and the 1988 Armenian earthquake, experiencing the loss of loved ones was not correlated with worsened cardiometabolic health; the association was specifically confined to those who experienced home loss (12, 13). This suggests that there is something unique about total home loss that is associated with the increased risk of cardiometabolic adversity.

Most obviously, home loss & relocation is accompanied by drastic changes in living conditions. For example, residential relocation involves changes in the neighborhood food and built environment, which may affect dietary behaviors and physical activity levels (20–23). Post-disaster relocation can also disrupt health-promoting local social networks and community-level social capital, yet the extent of the impact may vary dramatically depending on whether survivors are moved randomly (as in a lottery) or relocated together as a community, thereby helping with preserving the social ties that existed before the disaster (24–26).

At the same time, it is possible that the specific type of post-disaster accommodation may play a role in driving cardiometabolic profiles, and different types of accommodation may affect different pathways. For instance, both relocation to temporary trailer-style homes and relocation to existing rental accommodation can cause disruptive changes in the neighborhood environment. Yet in the case of those who are relocated to temporary trailer-

style accommodations, there may be inadequate kitchen facilities to prepare meals at home, so that disaster survivors end up eating out more often, or relying on pre-packaged (often calorie-dense) meals (27, 28).

Our purpose in this study was therefore to assess the extent to which the adverse impacts of home loss on cardiometabolic profiles of survivors are mediated through relocation to different types of housing, using causal mediation analysis allowing an exposure-mediator interaction that the conventional approaches for mediation cannot handle. We took advantage of a unique natural experiment stemming from the 2011 Great East Japan Earthquake in which baseline data (including cardiometabolic profiles) was obtained before the disaster, enabling us to take account of pre-disaster differences between groups of survivors.

Methods

Data

We used data from the Japan Gerontological Evaluation Study (JAGES), a nationwide cohort study of Japanese older adults aged 65 years or older, established in 2010 with the aim of studying the social determinants of healthy aging (29, 30). Notably, the baseline survey wave of JAGES was completed in 2010, 7 months prior to the 2011 Great East Japan Earthquake & Tsunami.

One of the field sites of the JAGES cohort was in Iwanuma City, Miyagi Prefecture, located approximately 80 km (50 miles) west of the earthquake epicenter. The total population of Iwanuma was 44,187 in 2010 (31). JAGES conducted a census of all residents aged 65 years or older ($n = 8,576$) in August 2010 and obtained valid responses from a total of 4,957 residents (Response rate = 57.8%).

The Great East Japan Earthquake (Richter scale: 9.0), occurred on March 11th, 2011. The subsequent tsunami resulting from the earthquake caused devastating damage to Iwanuma and other coastal areas of northeastern Japan. The tsunami killed 180 residents, damaged 5,542 houses, and inundated 48% of the land area in Iwanuma (Figure 1) (32). In the months following the disaster, survivors who had experienced home loss or severe housing damage were gradually moved out of emergency shelters into more stable accommodation – either temporary trailer-style homes built by the city (called *kasetsu jutaku*, resembling FEMA trailers in the US), or subsidized apartments listed on the private rental market (*minashi kasetsu*). Although the survivors could choose other types of relocation (e.g. building a new home at their own expense, or moving in with relatives), the majority chose these two types of temporary accommodation for their low financial burden. Specifically, among the participants who lost their homes ($n = 159$), 67% ($n=107$) took advantage of the opportunity to move to these units. Both types of temporary post-disaster accommodation were clustered in the densely populated areas of the city (see Figure S1 for pre- and post-disaster geographic distributions of home address of those who experienced home loss due to tsunami).

In November 2013, approximately 2.5 years after the disaster, we located the addresses of 99.7% of surviving members ($n = 4,857$) of the baseline cohort. Of the 4,380 eligible survivors who were healthy enough to participate and still lived in Iwanuma at the time of follow-up, 3,567 responded to the questionnaire (follow-up rate = 81.4%), which inquired about personal experiences of the earthquake and tsunami.

In addition to survey data, we also linked participants' data to medical record data from annual health checkups offered by Iwanuma city in June 2010 and 2013, including information about participants' objectively measured cardiometabolic profiles. Under the Japanese National Health Insurance system, municipalities provide health checkups annually (33). After excluding those who did not participate in the health checkup before and/or after the disaster onset ($n = 2,372$) and those whose information on housing damage and post-disaster relocation status was missing ($n = 30$), we ended up with an analytical sample of 1,165 individuals. Details on selection of the analytical sample are presented in Figure 2.

Measurements

Outcome—Our outcome of interest was a series of objectively measured cardiometabolic markers including systolic and diastolic blood pressure (mm Hg), body mass index (BMI; kg/m^2), waist circumference (cm), high-density lipoprotein cholesterol (HDL; mg/dL), low-density lipoprotein cholesterol (LDL; mg/dL), and triglycerides (mg/dL) measured in June 2010, and 2013. Waist circumference was measured only among persons under age 75 years. Systolic and diastolic blood pressure, BMI, and waist circumference were measured by public health nurses at the health check-ups. Serum levels of biomarkers (i.e. HDL, LDL, and triglyceride) were measured using blood samples collected during the same check-ups.

Exposure—Our exposure of interest was the severity of housing damage caused by the earthquake and tsunami. In the follow-up survey, survivors reported their housing damage, which was externally assessed by two technical officers inspecting each residential property based on established criteria for the purposes of compensation of victims (34). The degree of housing damage was classified into one of 5 levels: “no damage,” “partial damage,” “minor damage,” “major damage,” and “home loss”. The detailed definitions for each category are summarized in Table S1. Since prior studies using the same data have reported that only home loss was linked to unfavorable physical health outcomes of survivors, we created a binary variable representing home loss (1 = home loss and 0 = no damage/less severe damage) (12, 35).

Mediator—Our mediator of interest was the specific type of post-disaster accommodation. In the follow-up survey, the participants were asked to report whether they experienced relocation after the disaster and, if yes, what type of residential accommodation they lived in at the time of the 2013 survey. The types of post-disaster residence included: 1) temporary trailer-style homes, 2) subsidized apartments on the private rental market, and 3) other accommodations (e.g., building a new home at their own expense or moving in with relatives). We considered the temporary trailer-style homes and subsidized apartments as temporary accommodations.

Covariates—As potential time-varying confounders, we controlled for age, household income, marital status, working status, depressive symptoms, instrumental activities of daily living (IADL), and treatment for major diseases including hypertension, diabetes, stroke, and dyslipidemia. Age was categorized into “75 years or older” and “65–74 years” to control for the difference in medical cost-sharing expenses under the national healthcare insurance system (36). In Japan, older adults renew their health-care insurance when they turn 75 years of age. Under the Japanese insurance system, copayment associated with healthcare services for persons aged 75 years is less than it is for persons aged 74 years. Annual household income was equivalized (i.e.; household income was divided by the square root of the number of household members) in order to adjust for difference in household size (37). We created binary indicators for marital status (married vs divorced/widowed/single) and working status (current working vs not working). Depressive symptoms were assessed using the 15-item Geriatric Depression Scale, a commonly used screening tool for depression among older adults, where higher scores indicate more depressive symptoms. The Japanese version of the scale has been shown to have high reliability and validity (38). Instrumental activities of daily living was measured by the 13-item Tokyo Metropolitan Institute of Gerontology Index of Competence (39). Four binary variables were created based on self-reported current medical treatment for hypertension, diabetes, stroke, and dyslipidemia.

Statistical Analysis

To take advantage of the rich panel data structure of JAGES, all analyses were performed under a fixed-effects regression approach, which effectively eliminates confounding bias due to observed and unobserved time-invariant confounders in addition to observed time-varying confounders (40). Because we used 2-wave panel data, the fixed-effects regression using within-estimator was equivalent to the first-difference model regressing changes in the outcomes on changes in the exposure and covariates, which is represented by the following equation.

$$\Delta Y_i = \Delta X_i \beta + \delta + \epsilon_i$$

where ΔY_i is change in the cardiometabolic profiles from 2010 to 2013, ΔX_i is change in a vector of the exposure and covariates for i th individual, and δ captures secular change in the outcomes between waves. Our exposure variable, home loss assessed in the follow-up survey, can be interpreted as a “change” variable because nobody was exposed at baseline.

First, we examined the association between the combination of home loss status and post-disaster accommodation type and changes in the cardiometabolic profiles. We created the following categories for the exposure-mediator combination; 1) no home loss, 2) home loss + move to temporary trailer-style homes, 3) home loss + move to subsidized apartments, and 4) home loss + other accommodations. As the result of this analysis indicated home loss was linked to deteriorated cardiometabolic profiles only when it was accompanied by post-disaster relocation to trailer homes, we created a binary indicator for the relocation to trailer homes compared to other types of post-disaster accommodation altogether and used it as a new mediator variable in the following formal mediation analysis.

Second, we performed a formal causal mediation analysis based on a counterfactual framework to quantify the extent to which the associations between the home loss and the cardiometabolic profiles are mediated by post-disaster relocation to temporary trailer-style homes (41, 42).

Specifically, we conducted decomposition of the total effect of home loss on cardiometabolic profiles of survivors into natural direct effect (NDE) and natural indirect effect (NIE), represented by the following formulas.

$$NDE = E[Y_{1, M_0} - Y_{0, M_0}]$$

$$NIE = E[Y_{0, M_1} - Y_{0, M_0}]$$

where $Y_{a,m}$ is a counterfactual outcome that would have been observed had the exposure been $A = a$ and mediator been $M = m$, and M_a is a counterfactual value of mediator that would have been observed had the exposure been set to $A = a$. Thus, for instance, NDE can be interpreted as the effect of an intervention in the exposure on the outcome with the mediator set to the value it would have taken under $A = 0$. We then computed proportion of the total effect mediated by the mediator (proportion mediated; PM) using the following formula.

$$PM = \frac{NIE}{Total\ Effect}$$

In estimating NDE and NIE, we used the Monte Carlo simulation-based algorithm proposed by Imai *et al* as implemented in the R package “mediation” (43, 44). Briefly, we fitted two models; one for the outcome conditional on the exposure, mediator, and covariates, and another model for the mediator conditional on the exposure and covariates. In the outcome model, we introduced a product term between exposure and mediator. The conventional approaches for mediation analysis (e.g., Baron and Kenny’s product method) provide a biased estimate of an indirect effect in the presence of exposure-mediator interaction (42, 45). We then used the mediator models to simulate M_a and the outcome model to simulate Y_{a, M_a} based on the predicted M_a . Standard errors for NDE and NIE were computed via bootstrapping with 1,000 resampling.

Multiple imputation for missing data in covariates via chained equations was performed using the R package “MICE” (46). After generating 20 imputed datasets, we performed the analyses described above using each imputed dataset and combined the results across imputations. All analyses were conducted in R, version 3.6.0.

Results

Baseline demographic characteristics of the participants, including sex, age, marital status, and working status, were comparable to those from the census of older residents in Iwanuma (Table S2). The analytic sample of the follow-up survey participants linked to the medical records ($n = 1,165$) tended to be younger and married and to report less current medical treatment for major diseases and depressive symptoms compared to the whole sample of disaster survivors (Table S3). Table 1 describes the baseline demographic characteristics of the analytic sample according to home loss status. Of the 1,165 survivors, 42 individuals experienced complete home loss due to the tsunami. Approximately 60% of the individuals who experienced home loss moved into temporary trailer homes ($n = 25$). Compared to those who did not experience home loss, individuals who lost their homes were more likely to be female and report lower household income. However, the baseline cardiometabolic profiles were comparable between the two groups.

Figure 3 (see Table S4 for the full results) shows point estimates and confidence intervals for the associations between the combination of home loss status and post-disaster accommodation type and cardiometabolic profiles from the fixed-effect regression models. We found that experiencing home loss + post-disaster relocation to temporary trailer-style homes (vs no home loss) was associated with increased BMI (1.05 kg/m^2 , 95% CI: 0.61 to 1.49), waist circumference (5.18 cm, 95% CI: 3.12 to 7.24), LDL cholesterol (11.0 mg/dL, 95% CI: 1.24 to 20.7), and triglycerides (31.9 mg/dL, 95% CI: 6.72 to 57.1), and decreased HDL cholesterol (-5.88 mg/dL , 95% CI: -8.99 to -2.77). We did not find strong evidence that home loss in combination with other types of post-disaster accommodation (i.e., subsidized apartments and other accommodations) was associated with cardiometabolic profiles. The point estimates for the associations between home loss + other accommodations and changes in LDL and HDL cholesterol were similar to the corresponding estimates for home loss + move to trailer-style homes, although the confidence intervals were wide and included the null value.

Results of the formal causal mediation analysis are shown in Table 2. After adjusting for all time-invariant and observed time-varying confounders via fixed-effects regression, home loss was significantly associated with increased BMI (0.65 kg/m^2 , 95% CI: 0.14 to 1.08), waist circumference (3.89 cm, 95% CI: 1.41 to 6.17), LDL cholesterol (9.73 mg/dL, 95% CI: 4.79 to 16.8), and triglycerides (20.4 mg/dL, 95% CI: 3.80 to 43.5), as well as decreased HDL cholesterol (-5.08 mg/dL , 95% CI: -7.51 to -3.40). We did not find evidence of the total effect of home loss on systolic/diastolic blood pressure. We found that 72.6% of the estimated total effect of home loss was mediated through post-disaster relocation to trailer homes in the case of BMI (NIE: 0.47, 95% CI: 0.01 to 0.96), and 62.3% for waist circumference (NIE: 2.42, 95% CI: -0.35 to 5.43). We did not find strong evidence of mediation by post-disaster relocation to trailer homes for other outcomes with non-null total effect estimates (i.e., LDL cholesterol, HDL cholesterol, and triglyceride).

Discussion

Our study sought to provide a quantitative estimate of the extent to which the association between total home loss and worsened cardiometabolic profile can be explained by the specific type of post-disaster accommodation, viz., relocation to temporary trailer-style homes.

Our main findings were two-fold. First, a substantial fraction of the adverse impacts of home loss on anthropometric measures (i.e., BMI and waist circumference) appeared to be explained by the indirect effect mediated through post-disaster relocation to trailer homes. Second, we did not find clear evidence of mediation by type of post-disaster residence for changes in serum lipids (i.e., increased LDL cholesterol and triglycerides, and decreased HDL cholesterol), suggesting that there is an effect of home loss on these outcomes that is mediated through other pathways besides post-disaster relocation to trailer homes).

A similar post-disaster increase in BMI and waist circumference among survivors living in temporary trailer homes has been reported in other studies (9, 10). In Iwanuma, all types of temporary accommodation (i.e., trailer homes and subsidized apartments) were geographically clustered in the same densely-populated area of the city (Figure S1). Thus, changes in neighborhood environment due to relocation cannot fully explain the indirect effect because the survivors were exposed to similar changes in neighborhood environment regardless of the type of accommodation.

Changes in social capital due to relocation cannot explain the indirect effect either. Previously, we have reported that survivors moving into temporary trailer-style housing did so via two alternative mechanisms – either by lottery (which hastened their exit from emergency shelters) or by group resettlement, in which neighbors were moved together (24). We found that group resettlement was more effective in preserving social connections after the disaster. Interestingly, all individuals in our analytic sample moved into temporary trailer-style homes via group resettlement. Thus, it is unlikely that changes in social capital could explain the adverse impact of trailer-style accommodation on changes in cardiometabolic profiles.

The indirect effect via post-disaster residence in trailer homes may be explained by other experiences unique to the situations of those living in the trailer homes. In the trailer home village, abundant disaster relief supplies, including pre-packaged foods, were delivered to ease the daily lives of the victims. We speculate that residents of the trailer-style villages may have increased their reliance on these food supplies, typically meals that require little preparation such as rice balls, bread, and instant noodles. Moreover, the cramped kitchen facilities in the trailer homes may have further nudged people away from preparing meals at home (27). The resulting increase in refined carbohydrate and calorie intake could explain the increased BMI and waist circumference (47, 48). Our finding suggests a public health policy targeting those living in temporary shelters to improve access to healthy diet may be effective in maintaining healthy anthropometric profiles.

By contrast, relocation to temporary trailer-style homes did not mediate the total effect of home loss on the serum lipid measures. In other words, the adverse effect of home loss on

serum lipid fractions appeared to be due to other experiences shared in common among all victims of home loss, regardless of their post-disaster type of accommodation. For instance, psychological distress of experiencing home loss may have triggered overconsumption of foods high in fat, dysregulation of metabolism, and sleep problems, all of which would ultimately could affect serum lipid levels (14–19).

Moreover, most of the survivors with home loss in Iwanuma lived in the coastal area before the earthquake and moved to the inland area, where more food outlets were located. Such “improved” access to food outlets may also have resulted in increased consumption of foods high in fat and deteriorated serum lipid levels regardless of post-disaster accommodation (20–22). These pathways may similarly explain the remaining direct effect of home loss on anthropometric outcomes that is not mediated through post-disaster relocation to trailer homes. Taken together, our findings suggest that the underlying pathways linking home loss resulting from a major disaster and cardiometabolic profiles may differ depending on the specific outcomes of interest (i.e., anthropometric measures vs serum lipids). More research on the intermediate pathways with detailed data on survivors’ behaviors (e.g., dietary intake) is needed to make more specific policy recommendations to maintain health of disaster survivors.

There are several limitations to note. First, selective attrition due to non-participation in the follow-up survey and the health check-ups may have resulted in selection bias (49). First, selective attrition due to non-participation in the follow-up survey and the health check-ups may have resulted in selection bias (49). Compared to our target population (i.e., disaster survivors), the analytic sample appeared to be younger and healthier, suggesting that selection into the analyses may have prior common causes with the cardiometabolic profiles. Because home loss is likely to be associated with lower likelihood of participation in the follow-up survey and health check-ups, the association between home loss and the cardiometabolic profiles may not represent the true causal effect of home loss in the target population (2, 50–52). Second, causal mediation analysis requires a set of fairly strong assumptions of no unmeasured confounders for: 1) exposure-outcome relationship, 2) mediator-outcome relationship, and 3) exposure-mediator relationship, as well as the assumption of 4) no exposure-induced mediator-outcome confounding, which we are not able to guarantee (42). Third, we were unable to collect data to empirically identify what aspect of the trailer homes resulted in increased BMI and waist circumference; in Iwanuma, all the trailer homes were built in the same location and the properties were identical in size and structure. Moreover, we did not have enough data on dietary behaviors of the residents of trailer homes. Fourth, post-disaster accommodation (i.e., mediator) was assessed based on the type of respondents’ residence at the time of the 2013 survey. Unfortunately, we did not have exact information about when they relocated (month/year), and it is possible that the magnitude of mediation varied according to how long they lived in the accommodation. Lastly, some of the potential time-varying confounders we adjusted for may in fact be mediators. For instance, change in current treatment for dyslipidemia may occur as a result of the post-disaster relocation (e.g., increased access to healthcare services). These variables, when adjusted, would result in underestimation of the total effect of home loss as well as the indirect effect mediated through post-disaster relocation to trailer homes. Strengths of the study, however, include the rare natural experiment setting with rich pre-disaster data of the

victims to adjust for all time-invariant (e.g., genetic factors and long-term preferences) and observed time-varying confounders. Future studies investigating the mechanisms underlying the indirect effect of home loss through residence in trailer homes is warranted to better inform post-disaster interventions to maintain health of disaster victims.

In conclusion, our natural experiment study demonstrated that post-disaster relocation to temporary trailer homes may largely explain the adverse effect of home loss on BMI and waist circumference of survivors, while home loss could have unfavorable impacts on HDL and LDL cholesterol and triglyceride of all victims regardless of their post-disaster accommodation type. The specificity of our findings suggests that different post-disaster public health interventions are needed to maintain healthy anthropometric profiles and serum lipid levels of disaster victims experiencing home loss.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Highlights

- We investigated the mechanisms for worsening health among disaster survivors
- Post-disaster relocation explains increased body mass index and waist circumference
- Worsening triglycerides and HDL/LDL cholesterol are not explained by relocation
- Disaster damage appears to affect different health outcomes via specific pathways

Figure1.
Map of Iwanuma City, Miyagi Prefecture, Japan

Figure 2.
Flow Chart of the Analytical Sample Selection

Figure 3.

Associations Between Combination of Home Loss Experience and Type of Post-disaster Accommodation and Changes in Cardiometabolic Profiles Point estimates and 95% confidence intervals from the fixed-effect regression adjusted for all time-invariant confounders as well as observed time-varying confounders including age category, equivalized household income, marital status, job, depressive symptoms, instrumental activities of daily living, and treatment for hypertension, diabetes, dyslipidemia, and stroke.

Table 1.

Baseline Characteristics of the Analytic Sample, Iwanuma, Japan 2010 (n = 1165)

	Overall (n=1165)	Home Loss (n=42)	No Home Loss (n=1123)
	n (%)	n (%)	n (%)
Type of Post-disaster Accommodation			
Trailer-style Homes	28 (2.4%)	25 (59.5%)	3 (0.3%)
Subsidized Apartments	11 (0.9%)	9 (21.4%)	2 (0.2%)
Other Accommodations	1126 (96.7%)	8 (19.0%)	1118 (99.6%)
Gender			
Men	602 (51.7%)	18 (42.9%)	584 (52.0%)
Women	563 (48.3%)	24 (57.1%)	539 (48.0%)
Marital Status			
Not Married	201 (17.3%)	7 (16.7%)	194 (17.3%)
Married	946 (81.2%)	34 (81.0%)	912 (81.2%)
Missing	18 (1.5%)	1 (2.4%)	17 (1.5%)
Job			
Not Working	905 (77.7%)	29 (69.0%)	876 (78.0%)
Working	172 (14.8%)	7 (16.7%)	165 (14.7%)
Missing	88 (7.6%)	6 (14.3%)	82 (7.3%)
Hypertension Treatment			
No	746 (64.0%)	24 (57.1%)	722 (64.3%)
Yes	401 (34.4%)	17 (40.5%)	384 (34.2%)
Missing	18 (1.5%)	1 (2.4%)	17 (1.5%)
Stroke Treatment			
No	1130 (97.0%)	40 (95.2%)	1090 (97.1%)
Yes	17 (1.5%)	1 (2.4%)	16 (1.4%)
Missing	18 (1.5%)	1 (2.4%)	17 (1.5%)
Diabetes Treatment			
No	1047 (89.9%)	36 (85.7%)	1011 (90.0%)
Yes	100 (8.6%)	5 (11.9%)	95 (8.5%)
Missing	18 (1.5%)	1 (2.4%)	17 (1.5%)
Dyslipidemia Treatment			
No	1014 (87.0%)	37 (88.1%)	977 (87.0%)
Yes	133 (11.4%)	4 (9.5%)	129 (11.5%)
Missing	18 (1.5%)	1 (2.4%)	17 (1.5%)
	Mean (SD)	Mean (SD)	Mean (SD)
Age (years)	71.4 (4.99)	70.0 (4.20)	71.5 (5.01)
Equivalized Household Income (10K Yen)	233 (117)	173 (145)	235 (116)
IADL score	12.3 (1.22)	12.2 (1.11)	12.3 (1.23)

GDS score	2.88 (2.96)	3.11 (2.79)	2.87 (2.96)
Systolic Blood Pressure (mmHg)	129 (16.4)	128 (16.6)	130 (16.4)
Diastolic Blood Pressure (mmHg)	75.0 (10.3)	75.0 (9.55)	75.0 (10.3)
Body Mass Index (kg/m²)	23.5 (3.04)	24.7 (3.01)	23.4 (3.03)
Waist Circumference (cm)	84.4 (8.57)	85.0 (9.01)	84.3 (8.55)
Triglycerides (mg/dL)	119 (69.7)	113 (63.2)	119 (70.0)
HDL Cholesterol (mg/dL)	59.4 (15.2)	58.8 (14.5)	59.5 (15.3)
LDL Cholesterol (mg/dL)	120 (27.3)	110 (25.4)	120 (27.3)

Table 2.

Effect Decomposition of Total Effect of Home Loss Experience on Changes in Cardiometabolic Profiles Mediated Through Post-disaster Relocation to Trailer Homes^{a,b}

Outcomes	Total Effect	Natural Direct Effect	Natural Indirect Effect	Proportion Mediated
	Coefficient (95% CI)	Coefficient (95% CI)	Coefficient (95% CI)	%
Body Mass Index (kg/m ²)	0.65 (0.14 to 1.08)	0.18 (−0.32 to 0.66)	0.47 (0.01 to 0.96)	72.6
Waist Circumference (cm)	3.89 (1.41 to 6.17)	1.47 (−1.29 to 5.07)	2.42 (−0.35 to 5.43)	62.3
LDL Cholesterol (mg/dL)	9.73 (4.79 to 16.8)	8.26 (−1.92 to 19.7)	1.47 (−7.32 to 7.21)	15.1
HDL Cholesterol (mg/dL)	−5.08 (−7.51 to −3.40)	−3.58 (−7.25 to −0.27)	−1.50 (−4.45 to 1.93)	29.5
Triglyceride (mg/dL)	20.4 (3.80 to 43.5)	5.60 (−21.6 to 34.6)	14.8 (−9.28 to 40.3)	72.6
Systolic Blood Pressure (mmHg) ^c	−1.15 (−7.18 to 4.95)	0.07 (−6.21 to 6.91)	−1.23 (−6.93 to 4.18)	107
Diastolic Blood Pressure (mmHg) ^c	−0.001 (−3.19 to 3.04)	−0.50 (−4.49 to 3.61)	0.50 (−2.59 to 4.15)	−500

^aFixed-effect regression was used for both outcome and mediator model to adjust for all time-invariant confounders as well as observed time-varying confounders including age category, equivalized household income, marital status, job, depressive symptoms, instrumental activities of daily living, and treatment for hypertension, diabetes, dyslipidemia, and stroke.

^bExposure-mediator interaction was allowed in the outcome model by including the product term between home loss and post-disaster relocation to trailer homes.

^cEffect decomposition was not performed when the total effects were estimated to be null.