Physical performance deterioration of temporary housing residents after the Great East Japan Earthquake

Takeaki Ishii a,b,⁎, Sae Ochi c, Masaharu Tsubokura d,e, Shigeaki Kato d, Takahiro Tetsuda f, Junpei Kato f, Yoshitaka Nishikawa c, Tomohiro Morita c, Masahiro Kami e, Yukihide Iwamoto b, Hidekiyo Tachiyag

a Department of Orthopaedic Surgery, Soma Central Hospital, Soma, Fukushima, Japan
b Department of Orthopaedic Surgery, Graduate School of Medical Sciences, Kyushu University, Fukuoka, Fukuoka, Japan
c Department of Internal Medicine, Soma Central Hospital, Soma, Fukushima, Japan
d Department of Radiation Protection, Soma Central Hospital, Soma, Fukushima, Japan
e Division of Internal Medicine, Fukuoka Hospital, Fukuoka, Fukuoka, Japan
f Division of Rehabilitation, Fukuoka Jouheikai Hospital, Fukuoka, Fukuoka, Japan
g City Office of Soma, Soma, Fukushima, Japan

A B S T R A C T

Disaster has a negative impact on health conditions, especially on those of temporary housing residents. Health status has a close relationship with physical activity and performance. However, few reports have assessed physical performance among residents living in temporary housing. In this study, we compared physical capabilities between the elderly who evacuated to temporary housing and those who stayed in their own homes after the Great East Japan Earthquake.

Subjects were recruited from those over 65 years of age who participated in the medical check-ups for temporary housing residents (TH group) or check-ups for residents of downtown areas (control group) in Soma City, Fukushima, in 2012. The subjects underwent grip strength, one-leg standing (OLS), and timed up and go tests (TUG).

In total, 1890 participants were recruited. The TH group showed significantly stronger grip strength than that of the control group. On the other hand, the TH group showed weaker standing stability, according to decreased OLS and increased TUG scores.

We revealed that standing stability was impaired among elderly temporary housing residents 1.5 years after the disaster. Disaster responders should take into account the health risks associated with living in temporary housing.

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Introduction

Disaster has a negative impact on health conditions. Many refugees relocate to evacuation camps and temporary housing developments after a catastrophic event and, consequently, are forced to change their lifestyle. Loss of jobs and homes disrupts daily routines and affects physical activity. Depleted food supplies make it difficult to maintain well-balanced diets. These changes are assumed to result in an increased risk of non-communicable disease. In fact, increased blood pressure and decreased glycemic control in temporary housing residents have been reported in several previous disaster settings (Fonseca et al., 2009; Jiao et al., 2012; Kario, 2012). Therefore, there is a growing need to identify those at higher health risk to provide proper intervention after a disaster.

As a measure used to identify individuals less likely to achieve a long and healthy life, tests assessing physical performance have gained attention (Cooper et al., 2014). Physical performance, such as walking speed, standing balance, and grip strength, is a reportedly potential predictor of all-cause mortality in aged communities (Cooper et al., 2010). Since disaster has been reported to induce physical inactivity (Ardalan et al., 2011; Engberg et al., 2012), which is a remarkably modifiable factor (Cooper et al., 2011), health concerns regarding the deteriorating physical capabilities of evacuees after a disaster are emerging. In this regard, paying close attention to the physical performance of evacuees is necessary.

Similar to past disasters, it was reported that the Great East Japan Earthquake impaired the health conditions of evacuees living in temporary housing (Tsubokura et al., 2013). Official temporary housing developments in Japan consist of flat buildings approximately 30 m² in area.
per household, the designs of which limit indoor movement. Thus, residing in a temporary housing appears to be a risk factor for physical inactivity, which may result in deteriorated physical performance. As Japan consists of one of the most aged societies, many elderly individuals reside in temporary housing and appear prone to frailty. Nevertheless, there are few reports on the physical performance of residents in temporary housings.

Soma City is located on the northeast coast of Japan, close to the center of the earthquake, and approximately 40 km from the Fukushima Daiichi nuclear power plant, near the mandatory evacuation zone. The seaside areas were destroyed by the tsunami, and those who lived there evacuated to temporary housing. A number of families were also moved to temporary housing to avoid radiation exposure in radio-contaminated areas due to the crippled nuclear plant. The local government has been providing physical performance evaluations together with medical check-ups for elderly residents living in the city since 2012. Using these data, this study compared physical capabilities between the elderly who evacuated to temporary housings and those who were able to remain in their own homes.

**Methods**

**Participants**

Subjects were recruited from those over 65 years of age who participated in the medical check-ups for temporary housing residents (TH group), conducted from July 10 to 17, 2012, and the check-ups for residents of downtown areas (control group), conducted from September 24 to October 19, 2012. Participants were excluded if they required walking aids (e.g., canes, wheels) or if the examiner decided it was dangerous to conduct the tests.

Most of the temporary housing residents lived in coastal areas before the earthquake, and their homes were destroyed by the tsunami. They were moved to evacuation shelters just after the earthquake and then to temporary housing by September 2011, 10 months prior to this study. The participants in the control group were not forced to evacuate their residences due to minimal damage by the earthquake.

**Physical performance tests**

**Examiners**

Physical therapists conducted the assessments in the TH group. They devised a procedure manual for the physical performance tests prior to the assessment. In contrast, non-healthcare workers conducted the assessments in the control group. They received lectures and training to conduct these assessments of the examinees in accordance with the procedure manual.

**Grip strength**

The grip strength of the dominant hand was measured once, with the subject in a standing position, using a Smedley hand dynamometer.

**One-leg standing test (OLS)**

The OLS is a method used to assess static balance. The subjects were directed to place both hands on the waist, raise their preferred leg without touching the opposite leg, and balance with eyes open as long as possible. They were timed for up to 40 s maximum starting from the time of raising the leg until placing it on the floor or touching the opposite leg or removing the hands from the waist. Those who stood for less than 15 s were categorized as “decreased OLS,” according to the musculoskeletal ambulation disability symptom complex criteria (Ito, 2008).

**Timed up and go test (TUG)**

TUG is a method used to assess functional mobility. The subjects were timed from the time that they rose from a chair, walked 3 m, turned around, walked back to the chair, and sat down. The test was performed twice, and the better score was recorded. Those who took 11 s or more to perform the test were categorized as “increased OLS,” according to the musculoskeletal ambulation disability symptom complex criteria (Ito, 2008).

**Statistical analysis**

The statistical analyses were conducted using STATA SE13® (STATA Corp LP, TX, USA). For grip strength, linear regression was conducted to compare the means between the TH and control groups. For the OLS and TUG, logistic regression was conducted to compare the proportions of deteriorated scores among each group. Each comparison was controlled for age. A significance level of 0.05 was used for the tests.

**Ethical concerns**

The Institutional Review Board of the Institute of Medical Science at the University of Tokyo approved the study (approval number 25-40-1011). Soma City instituted the physical performance test, and the anonymized results were provided to us. The ethics committee waived the requirement for written consent for all participants in this study.

**Results**

In total, 1890 participants (207 in the TH group and 1683 in the control group) were recruited. Table 1 shows the age distribution of the participants by group and gender, and there was no apparent difference between the two groups. Table 2 compares the test results between the two groups. For both males and females, the TH group showed significantly stronger grip strength than that of the control group, even after controlling for age. In contrast, the TH group showed weaker standing stability, as represented by decreased OLS and increased TUG scores. Specifically, the TH group showed a significantly higher proportion of decreased OLS scores, and the odds ratios (ORs) of decreased OLS scores for the TH group residents compared with the control residents were 5.2 for males and 5.4 for females ( \( P < 0.01 \)). Similarly, the ORs of increased TUG scores among males and females were 2.1 and 2.3, respectively, although no statistical significance was found.

**Discussion**

This study revealed that standing stability was impaired among elderly temporary housing residents 1.5 years after the Great East Japan Earthquake. The impaired physical performance of the TH group suggested that moving to and living in temporary housing have negative effects on physical activity, in addition to those of the natural disaster itself.

| Table 1: Age distribution of the participants in Soma City, Fukushima, in 2012. | TH group \( (N = 207) \) | Control group \( (N = 1683) \) | Total \( (N = 1890) \) |
|---|---|---|---|
| | Male \( (N = 82) \) | Female \( (N = 125) \) | Male \( (N = 669) \) | Female \( (N = 974) \) | |
| Mean age (median) | 73.7 (71.5) | 73.6 (72) | 73.7 (73) | 73.1 (72) | 73.4 (73) |
| \( \geq 65-69 \) yr | 31 (38) | 45 (36) | 193 (29) | 282 (29) | 583 (30) |
| \( \geq 70-74 \) yr | 19 (23) | 31 (25) | 192 (29) | 318 (33) | 578 (30) |
| \( \geq 75-80 \) yr | 11 (13) | 22 (18) | 145 (22) | 244 (25) | 442 (23) |
| \( >80 \) yr | 21 (26) | 27 (22) | 139 (21) | 130 (13) | 236 (17) |
| Total | 82 | 125 | 669 | 974 | 1890 |
There are several tests used to quantify physical performance. Besides the TUG and OLS, the 6-min walk test for gait speed, the chair rise test for lower limb strength, and the functional reach test for flexibility are physical capability tests that can be used to evaluate the elderly. The three tests used in this study were chosen because of their use in clinical practice in Japan (Ito, 2008) and because they require no special equipment. However, each test has its limitations. The sensitivity of the TUG is too low to successfully identify elderly individuals with health risks among those who do not require walking aids. The OLS has a large margin of error. The correlation between grip strength and physical activity is weak. Physical performance tests that have high repeatability and association with physical inactivity are recommended in future studies.

Several limitations of the study should be noted. First, because the participants attended the program voluntarily, the number of subjects enrolled was small. Thus, our data do not account for volunteer bias and may have been exaggerated. Second, we could not perform other physical performance tests due to limited time and manpower, and as a result, we might have overlooked other physical changes. It was also not possible to include factors such as pre-earthquake health status, current health status, income, or relationship status, and this could have biased the observed association. Third, no pre-disaster data were collected, and thus the possibility of pre-existing impaired physical performance cannot be excluded. Lastly, even though the physical therapists and non-healthcare workers conducted the test in accordance with the same procedure manual, their differences in performance of the physical examination might have affected the outcome.

**Conclusion**

We showed that physical performance was impaired among elderly disaster victims 1.5 year after the Great East Japan Earthquake disaster. A poor living environment in temporary housing might affect physical performance. Disaster responders should take into account the health risks associated with living in temporary housing, and continuous monitoring and appropriate intervention are required after a disaster.

**Conflict of interest**

The authors declare that there are no conflicts of interests.

**Transparency Document**

The Transparency document associated with this article can be found, in online version.

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### Table 2

Comparison of physical scores by residential status in Soma city, Fukushima in 2012.

| Gender | Residents | Average | Coefficient | 95% CI | p |
|--------|-----------|---------|-------------|-------|---|
| Grip strength (kg) | | | | | |
| Male | TH Control | 35.2 | 1.62 | 0.92 | 2.32 | <0.01 |
| Female | TH Control | 32.2 | 1.29 | 0.88 | 1.70 | <0.01 |
| Decreased OLS score (<15 s) | | | | | |
| Male | TH Control | 64% | 5.2 | 2.97 | 9.21 | <0.01 |
| Female | TH Control | 31% | 5.4 | 3.43 | 8.49 | <0.01 |
| Increased TUG score (>11 s) | | | | | |
| Male | TH Control | 66% | 2.1 | 0.70 | 6.30 | 0.18 |
| Female | TH Control | 30% | 2.8 | 0.99 | 5.48 | 0.05 |

Abbreviations: OLS: one-leg standing test; TUG: timed up and go test; Decreased OLS: those who stood on one leg for less than 15 s; Increased TUG: those who took 11 s or more to perform the TUG.
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