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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 Tachiya [g]

[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 Social Communication System for Advanced Clinical Research, the Institute of Medical Science, University of Tokyo, Minato-ku, Tokyo, Japan
[f] Division of Rehabilitation, Fukuoka Houeikai Hospital, Fukuoka, Fukuoka, Japan
[g] City Office of Soma, Soma, Fukushima, Japan

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ABSTRACT

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.

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 m^2 in area

* Corresponding author at: Department of Orthopaedic Surgery, Soma Central Hospital, 3-5-18 Okinouchi, Soma City, Fukushima 976–0016, Japan. Fax: +81 244 35 4234.
E-mail address: takeaki_ishii@hotmail.co.jp (T. Ishii).

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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 radiocontaminated 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
	Male (N = 82)	Female (N = 125)	Male (N = 669)	Female (N = 974)	
Mean age	73.7	73.6	73.7	73.1	**73.4**
(median)	(71.5)	(72)	(73)	(72)	**(73)**
65–69 yr	31	45	193	282	**583**
(%)	(38)	(36)	(29)	(29)	**(30)**
70–74 yr	19	31	192	318	**578**
(%)	(23)	(25)	(29)	(33)	**(30)**
75–80 yr	11	22	145	244	**442**
(%)	(13)	(18)	(22)	(25)	**(23)**
>80 yr	21	27	139	130	**336**
(%)	(26)	(22)	(21)	(13)	**(17)**
Total	**82**	**125**	**669**	**974**	**1939**

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	35.2	1.62	0.92	2.32	<0.01
		Control	32.2				
	Female	TH	23.7	1.29	0.88	1.70	<0.01
		Control	21.3				
			Percentage	Odds ratio	95% CI		p
Decreased OLS score (<15 s)	Male	TH	64%	5.2	2.97	9.21	<0.01
		Control	31%				
	Female	TH	66%	5.4	3.43	8.49	<0.01
		Control	30%				
Increased TUG score (>11 s)	Male	TH	6.7%	2.1	0.70	6.50	0.18
		Control	2.8%				
	Female	TH	9.2%	2.3	0.99	5.48	0.05
		Control	2.8%				

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.

As the global population ages, disaster planning should include measures to protect senior citizens from requiring care. However, it is difficult to identify those at higher risk in a pre-hospital situation via ordinary health check-ups, because they are not already sick. In this study, we identified high-risk individuals through mass-screening using simple tests. Decreased physical performance is associated with an increased risk of falling, a major cause of both fatal and nonfatal injuries among the elderly (Mertz et al., 2010). In addition, physical performance is reported to be a potential predictor of all-cause mortality (Cooper et al., 2010), and maintaining good physical performance is important for a better quality of life. Physical performance tests and appropriate intervention could be options to protect the elderly after a disaster.

This study also revealed discrepancies in grip strength (better in the TH group) and standing stability (worse in the TH group), implying that the non-antigravity muscles were preserved and the antigravity muscles weakened in the TH group. This observation is consistent with a previous report on the influence of immobilization (de Boer et al., 2008). Thus, we presume that physical inactivity was the most likely reason for the decreased standing stability in the TH group.

Two major factors are associated with physical inactivity among those residing in temporary housing. First, a poor living environment has been cited as a possible cause (McKee et al., 2015). In addition to a small interior space, the neighborhood environment might affect physical activity. Most temporary accommodations are separated from pre-existing communities and do not possess commercial areas such as shops, leading to a much less active lifestyle among residents and thus to poor physical performance (Saelens et al., 2003). Second, a fear of radiation exposure might decrease outdoor physical activity. Ambiguous official information following the nuclear incident confused the inhabitants and forced them to stay indoors. In addition, many evacuees lost their jobs after the nuclear disaster, possibly contributing to decreased physical activity. In future disasters, temporary housing developments should be constructed near other facilities, such as grocery stores or restaurants. In cases of nuclear disasters, immediate access to real-time contamination data is essential.

We assumed that the TH group had greater grip strength than the control group before the earthquake and that this strength was maintained after evacuation. A number of temporary housing residents had been physically active workers; thus, it is unlikely that the TH group exhibited weaker physical performance than that of the control group before evacuation. It is also unlikely that grip strength increased while standing stability deteriorated in the TH group. In addition, the control group did not suffer drastic lifestyle changes; thus, physical performance was considered to have been maintained in the control group during this period. Therefore, the most likely reason is that grip strength was greater in the TH group before evacuation and remained the same after evacuation.

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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