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Effects of Exercise for Aged Evacuees Living in Temporary Housing after the Great East Japan Earthquake: Differences between Group and Individual Exercise Programs

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Introduction

The Great East Japan Earthquake of March 11, 2011 and the subsequent tsunami caused extensive damage that resulted in radiation leakage at the Fukushima Daiichi Nuclear Power Plant. Residents living within 20 km of the power plant were consequently forced to evacuate. The evacuated residents were scattered in and outside of Fukushima Prefecture and many are still living in temporary housing, more than 3 years after the disaster. These evacuees have lived with constant anxiety over radiation exposure and its long-term consequences, and this has impacted their lifestyles.

It has been shown that therapeutic exercise prevents disuse syndrome and falls and that it has many other positive effects on physical and mental health [1-3]. However, these studies focused on elderly subjects living in a stable community. The purpose of the current study was to clarify the effect of exercise in elderly Fukushima evacuees living in temporary housing on their well-being, pain and activity. Some of the participating evacuees declined testing and activities within an assembled community group but conceded to be tested and undertake individual exercise activities. Thus, we took the opportunity to analyze the outcome measures for all individuals combined and for the two contributing groups: the Assembled Group which participated together as a group, and the Individual Group of evacuees who participated alone outside of the group setting.

Subjects and methods

Recruiting participants

Subjects comprised evacuees living in temporary housing in Minamisoma City in Fukushima Prefecture located 25 km from the Fukushima Daiichi Nuclear Power Plant. At the beginning of the study (September 2012), there were 34 temporary housing units in Minamisoma City. Of the 6,883 individuals living in temporary housing, 2,259 were elderly individuals aged 65 years or older. Three temporary housing units were chosen for this study because they were located in the countryside of Minamisoma City and were the three units with the highest rate of elderly residents. Inclusion criteria were consenting to participate in this study, the ability to walk independently and the ability to answer a questionnaire, i.e. having normal cognitive function. The City Office employees (public health nurses) recruited the participants. A total of 71 evacuees (16 men and 55 women, mean age 75.9 ± 8.3 [SD] years) who met the inclusion criteria were included in this study. These individuals were evacuated either because their homes were washed away by the tsunami or because they lived within 20 km of the Fukushima Daiichi Nuclear Power Plant and were required to evacuate.

Sixty of the evacuees were surveyed when they gathered at the assembly hall for the temporary housing units (Assembled Group) and 11 of the evacuees were surveyed through individual visits to their residences (Individual Group). Characteristics of the subjects were shown in Table 1. The 11 subjects in the Individual group agreed to participate in this study, but refused to visit the assembly hall to engage in exercise and recreation with the others. This study was approved by the ethics committee of Fukushima Medical University (No. 1461) and written informed consent was obtained from all evacuees who participated in this study.

	Assembled Group (n=60)	Individual Group (n=11)
Age (average ± SD)	74.8 ± 8.4	82.1 ± 4.7
Male/Female	Dec-48	7-Apr
Live-in		
Alone	12	4
Husband/wife	33	5
Son/daughter	15	2
Comorbidities		
Hypertension	19	6
Hyperlipemia	10	1
Diabetes mellitus	7	1
Brain infarction	5	0
Heart disease	2	0
Others	10	4
There were no significant differences between the Assembled Group and the Individual Group.		

Table 1: Characteristics of the subjects

Intervention

This study was launched approximately 18 months after the disaster. The first session involved only an assessment, and exercise classes were held at the temporary housing once a month from the following month onwards. For the Assembled Group, each exercise class comprised a warm-up period (10 min), a mini-lecture on the usefulness of exercise (15 min), exercise instruction (20 min), a social break (10 min) and recreation (45 min). Subjects were also encouraged to walk for whole body exercise. The time required for one exercise class was approximately 1 h 40 min. The subjects in the Individual Group were given only a mini-lecture on the usefulness of exercise and were encouraged to walk.

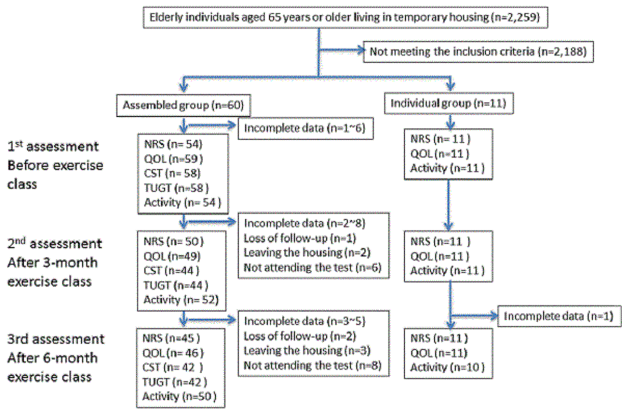

Figure 1: Flow chart of the participants of this study

NRS: Numerical Rating Scale Of Pain; QOL: Quality of Life; CST: Chair Standing Sign; TUGT: Timed Up-and-Go Test

The evacuees in the Individual group often shared their personal stories, and the time required was approximately 30 min per individual. Both the Assembled Group and the Individual Group underwent blood pressure and pulse rate measurements and health interviews with the City Office employees (public health nurses) prior to the exercise classes. The effects of the exercise classes were assessed at 3 and 6 months after the exercise classes began. The assessments were conducted before implementing the exercise program. The number of participating residents was different at each assessment time-point because some residents had left the temporary housing facilities and some were lost to follow-up (Figure 1).

Assessments

The categories assessed were pain, health-related quality of life (HRQOL), physical function and activity. For pain, the strongest pain felt within a 24-h period was assessed with the numerical rating scale (NRS) [4]. HRQOL was assessed using the Medical Outcomes Study Short-Form 36-item Health Survey (SF-36) [5,6]. Physical function was assessed using the chair standing test (CST) [7] where the standardized time for elderly Japanese is 14.2 sec for both men and women [8], and the timed up-and-go test (TUGT) [9] where the standardized time for elderly Japanese is 11 sec for both men and women [8]. Activity was quantified with a pedometer (Health Counter® HJ-720IT, Omron Healthcare Co., Ltd., Japan), the mean daily number of steps of those aged 70 years or older provided by the Ministry of Health, Labour and Welfare's National Health and Nutrition Survey: 5,263 steps/day in men and 4,323 steps/day in women [10]. While the SF-36 exam and daily number of steps using pedometer was recorded in all evacuees, the physical function tests (CST and TUGT) were only measured in the Assembled Group at the assembly hall.

Statistical analysis

The Mann-Whitney U test was used for comparisons between the Assembled Group and the Individual Group. For analysis in each group, Friedman's test was performed. When significant difference was detected, the Wilcoxon signed-rank test with Bonferroni correction was performed. The Chi-squared test was used for comparing the proportion above and below the Japanese standard value in the chair standing test, timed up-and-go test and the daily number of steps in the Assembled Group. A p-value of less than 0.05 was considered to be a significant difference. SPSS ver.21 (IBM, Chicago, IL) was used for statistical analysis.

Results

Pain

Forty-four (62.0%) residents had chronic pain. The mean NRS pain score was 2.74 (SD: 2.72) before the exercise classes. After exercise classes had begun the mean NRS score was 2.82 (SD: 2.71) at 3 months and 3.02 (SD: 2.61) at 6 months. There was no significant difference between these 3 time points (p=0.01) (Table 2).

		Assembled Group			Individual Group		
		Men	Women	Total	Men	Women	Total
NRS	Before	0.0 (0.0-4.0)	3.0 (0.0-5.0)	2.0 (0.0-5.0)	1.0 (0.0-4.3)	5.0 (0.0-7.0)	2.0 (0.0-6.0)
	3 M	3.0 (0.0-5.0)	2.0 (0.0-5.0)	2.5 (0.0-5.0)	0.0 (0.0-3.0)	5.0 (0.0-6.0)	4.0 (0.0-6.0)
	6 M	2.0 (0.0-5.0)	3.0 (0.0-5.0)	3.0 (0.0-5.0)	2.5 (0.5-4.5)	5.0 (2.0-6.0)	4.0 (2.0-5.0)
CST	Before	15.9 (13.7-18.1)	14.1 (11.9-16.4)	14.2# (12.0-16.9)	-	-	-
	3 M	15.8 (12.6-18.0)	12.0 (10.5-14.8)	12.1#† (11.0-15.0)	-	-	-
	6 M	13.4 (11.6-17.1)	13.4 (12.2-14.7)	13.4† (11.8-15.3)	-	-	-
TUGT	Before	10.5 (8.6-11.3)	8.9 (8.3-10.0)	9.0 (8.3-11.1)	-	-	-
	3 M	10.3 (9.1-10.6)	8.4 (7.8-9.9)	9.0 (7.8-10.2)	-	-	-
	6 M	10.0 (8.5-10.4)	8.9 (8.1-9.6)	9.1 (8.2-10.1)	-	-	-
Activity	Before	4365 (3535-9131)	3296 (1985-6782)	3794‡ (2177-6920)	414 (385-5568)	1577 (971-2324)	1058‡ (401-2324)

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	3 M	5009 (2878-10234)	4218 (1605-6415)	4478* (1796-6518)	3382 (87-8368)	1437 (127-2726)	1437* (127-2727)
	6 M	2621 (2292-9598)	2795 (1215-6818)	2708§ (1257-6518)	238 (15-6227)	1017 (159-1792)	518§ (103-1791)
Data are shown as median value (interquartile range: IQR)							

Table 2: NRS, CST, TUGT and activity in the Assembled Group and the Individual Group.

In the Assembled Group, CST at “3-month” was significantly faster compared with “Before” ($^{\#}$p<0.01). However, CST at “6-month” was significantly slower compared with “3-month” (†p<0.01). Daily numbers of steps in the Individual Group were significantly less compared with the Assembled Group at all time-points (‡, *, §p<0.01).

HRQOL

On examining the Assembled and Individual Groups separately, significant improvement in the scores for “role physical” was seen 3 months after beginning the exercise classes in the Individual Group. However, no significant changes were seen 6 months after beginning the exercise classes compared with before the exercise classes (Table 3).

Group	Assembled Group			Individual Group		
Time-point	Before (n=59)	3-month (n=49)	6-month (n=46)	Before (n=11)	3-month (n=11)	6-month (n=11)
PF	43.4 32.6-54.2$^{\#}$	39.8 23.6-54.2	39.8 24.5-54.2	18.1 -3.5-36.2$^{\#}$	36.2 21.7-43.4	29.0 18.1-43.4
RP	50.8 35.8-55.7‡	42.4 29.1-55.7	44.1 32.5-55.7	29.1 12.5-49.1‡§	55.7 29.1-55.7§	35.8 15.8-45.8
BP	52.8 40.3-54.6	49.2 40.3-54.6	50.1 40.3-54.6	40.3 30.9-54.6	44.3 39.8-61.7	44.3 35.4-44.7
GH	44.2 38.9-54.8	44.2 40.5-51.1	44.2 37.8-49.5	48.4 43.1-52.2	54.8 37.8-65.5	46.9 40.5-52.2
VT	49.8 43.4-56.3	46.6 43.4-53.0	46.6 40.2-53.0	43.4 33.8-53.0	49.8 43.4-62.7	56.3 40.2-62.7
SF	50.6 37.7-57.0‡	47.4 37.7-57.0	44.1 37.7-57.0	37.7 31.2-44.1‡	44.1 31.2-57.0	50.6 44.1-57.0
RE	51.9 38.4-56.1	41.5 30.1-56.1	43.6 31.1-51.9	31.1 18.6-56.1	56.1 31.1-56.1	47.7 35.3-56.1
MH	46.5 40.4-54.5	45.2 38.4-54.5	43.8 37.1-54.5	43.8 38.4-51.8	54.5 38.4-59.9	43.8 35.7-59.9
PCS	45.6 34.9-53.5‡	41.2 29.3-53.2	43.9 30.1-52.0¶	26.1 13.9-45.3‡	42.6 22.8-56.2	27.9 14.0-38.7¶
MCS	53.0 44.6-58.0	52.3 44.4-58.3	51.2 44.6-55.7	58.0 49.1-64.6	54.2 51.0-64.0	56.5 43.4-77.2

Data are shown as median (interquartile range: IQR).

PF: Physical Functioning; RP: Role Physical; BP: Bodily Pain; GH: General Health; VT: Vitality; SF: Social Functioning; RE: Role Emotional; MH: Mental Health; PCS: Physical Component Summary; MCS: Mental Component Summary

When compared the values between the Assembled Group and the Individual Group in “Before”, PF value in the Individual Group was significantly lower compared with the Assembled Group ($^{\#}$p<0.01). RP, SF and PCS values in the Individual Group were significantly lower compared with the Assembled Group (‡p<0.05). When compared the values in “6-month”, PCS value in the Individual Group was significantly lower compared with the Assembled Group (¶p<0.05).

When compared the values in each group, RP at “3-month” was significantly higher than RP at “6-month” in the Individual Group (§p<0.05).

Table 3: SF-36

On comparing the Assembled and Individual Groups, the summary scores for “physical component summary” and the subscales “physical functioning,” “role physical” and “social functioning” was significantly lower in the Individual Group than the Assembled Group before the exercise classes. No subscales or summary scores with significant differences were observed 3 months after beginning the exercise classes. However, summary score for “physical component summary” was significantly lower in the Individual Group than the Assembled Group 6 months after beginning the exercise classes (Table 3).

Physical function

CST: A significant improvement was seen 3 months after beginning the exercise classes (p=0.001). However, the value in 6-month was significantly slower compared with 3-month (Table 2). Compared with the standardized time for Japanese elderly [8], 29 subjects (50%) were faster than the standardized time and 29 (50%) were slower before beginning the exercise classes. At three months and six months after beginning the exercise classes, proportions above the standardized time were 29 (66%) and 25 (60%), respectively. There was no significant difference (p=0.11 and p=0.35, respectively).

TUGT: No significant improvement was seen three months and six months after beginning the exercise classes. Compared with the standardized time for Japanese elderly [8], 43 subjects (74%) were faster than the standardized time and 15 (26%) were slower before beginning the exercise classes. At three months and six months after beginning the exercise classes, proportions above (faster) the standardized time were 39 (89%) and 38 (90%), respectively. Proportion above the standardized time at three months showed no significant difference (p=0.07). However, proportion above the standardized time at six months was significantly faster than before beginning the exercise class (p=0.04).

Activity

An increasing tendency in the level of activity was seen in 3-month compared with before exercise classes, but no significant difference was observed (Table 2, p=0.64 in the Assembly Group and p=0.09 in the Individual Group). Compared with the mean daily number of steps of those aged 70 years or older provided by the Ministry of Health, Labour and Welfare's National Health and Nutrition Survey [10], 24 subjects (37%) took more steps and 41 (63%) took fewer steps than the standardized mean before beginning the exercise classes. At three months and six months after beginning the exercise classes, proportions above the standard mean daily number of steps were 24 (46%) and 19 (38%), respectively. There was no significant difference (p=0.71 and p=0.63, respectively).

The activity of the Individual Group was significantly lower than that of the Assembled Group at all time-points (Table 2).

Discussion

This study revealed that exercise classes have an improving effect on the physical function of evacuees living in temporary housing, but only for a short duration. These classes did not improve pain and QOL at the 6-month observation point. Before beginning this study, we hypothesized that the QOL could be improved through implementing exercise classes. The data did not support the hypothesis, but some insight into group dynamics and factors contributing to the problem were revealed.

Living as a refugee in unfamiliar places is thought to have a negative impact on physical and mental health, although few studies have examined the physical and mental health of evacuees in Fukushima [11,12]. Among the studies on evacuees living in temporary housing, Kobayashi et al. reported that various problems such as onset of depression and dementia arise due to evacuation and living in temporary housing [13]. Yabe et al. conducted a mental health survey of evacuees in Fukushima Prefecture and reported that evacuees had serious mental health problems [12]. Sakai et al. compared blood data of evacuees following the Fukushima Daiichi Nuclear Power Plant accident with those before the accident and were the first to show that the evacuation caused polycythemia [14]. These studies reveal that evacuation has negative impacts on the physical and mental health of evacuees. Surveys on the evacuees of the Chernobyl Nuclear Power Plant accident that occurred in 1986 have been reported, and Bromet et al. reported that evacuees still require mental health care even 25 years after the disaster [15].

Various exercise programs for elderly individuals have been offered. Overall, an improvement in balance function and a reduction in the risk of falls and fear of falling were most notable. In recent years, functional decline in elderly individuals has come to be understood from studies of sarcopenia and frailty; the reported incidence of sarcopenia in Japan is 13.4% in men and 14.9% in women [16]. Resistance training is recommended to improve sarcopenia and frailty.

Although exercise is effective in improving health and well-being, a problem is in maintaining an exercise program. Ansai et al. pointed out that many individuals aged 80 years or older do not continue exercising [17]. Meanwhile, Midlov et al. cited low educational levels, obesity, smoking, and poor self-reported health as factors in the low rate of exercise continuation [18]. Franco et al. revealed that elderly individuals preferred home-based exercise to being in a group that required transportation. In another study, exercising at home improved the ability to do daily tasks by 60%, had no costs, and decreased the chances of falling to 0% [19]. Goodman et al. showed that the frequency of exercise can be increased by developing new infrastructure for walking and cycling [20]. Cheng et al. divided 924 elderly, community-dwelling Chinese individuals into five groups based on their social network type (diverse, friend-focused, family-focused, distant family and restricted) and reported that physical and social activity was partly responsible for the differences between social network types [21]. Thus, we suggest that to encourage elderly individuals to continue exercising, the appropriate equipment and social network should be provided, and suitable exercise should be repeatedly encouraged.

The current study showed that exercise class improved physical function for a short period of time, a finding that is similar to previous studies [17-20]. However, we were unable to show an improvement in the QOL with the exercise program undertaken in the present study. Physical and mental QOL assessments are complex. It has been shown that chronic disease, taking a walk, visual ability, sleep quality, marital status, alcohol consumption, hearing ability, smoking, neighborhood relationships, filial piety, ethnicity and regular diet are associated with both mental and physical QOL in elderly individuals [22]. It has been emphasized that the evaluation of HRQOL be stratified by gender as well as by consideration of the different levels and intensities of physical activity [23].

Limitation

This study has several limitations. The first is that there was no control group from outside the evacuee population except for historical controls of the broad population. The second is that the subject sample was small. At the time the exercise classes began, 2,259 elderly evacuees were living in temporary housing in Minamisoma City. The present study comprised just 71 subjects, which was 3.1% of all elderly evacuees living in temporary housing. Thus, our results may thus not reflect the state of evacuees overall. The third is that the study period was short at only 6 months. Finally, the fourth is that the effect of exercise classes conducted only once a month was examined. More frequent and/or more vigorous classes may have had a different effect.

Summary

Assembled Group: Pain, HRQOL and activity showed no significant improvement after 6-months exercise classes. On CST, a significant improvement was seen 3 months after beginning the exercise classes. However, the value at 6 months was significantly slower compared with 3 months.

Individual Group: Role physical significantly increased at 3 months but was not significantly different from baseline at 6 months.

Between-group differences: On the SF-36, physical function, role physical, social functioning and physical component summary were greatly decreased in the Individual group at the beginning of the study. The physical component summary was significantly lower in the Individual group at both the beginning and end of testing. Daily numbers of steps in the Individual group were significantly less compared with the Assembled group at all time-points.

Conclusions

The exercise classes implemented in the present study resulted in improved physical function for a short period of time, but did not bring about any significant improvements in pain, QOL, physical function or level of activity when evaluated at 6 months.

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