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Original Article

The Effects of Self-directed Home Exercise with Serial Telephone Contacts on Physical Functions and Quality of Life in Elderly People at High Risk of Locomotor Dysfunction

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Exercise is essential for maintaining quality of life (QOL) in elderly individuals. However, adherence to exercise programs is low. Here, we assessed the effectiveness of a self-directed home exercise program with serial telephone contacts to encourage exercise adherence among elderly individuals at high risk of locomotor dysfunction. We recruited community-dwelling adults (≥65 years) in Niigata, Japan, who were targets of the long-term care prevention project for locomotor dysfunction but did not participate in the government-sponsored prevention programs. The study was conducted from November 2011 to October 2012. Participants received exercise instruction and performed exercises independently for 3 months with serial telephone contacts. The single-leg stance and five-times sit-to-stand tests were used to assess physical function. The SF-8 was used to measure health-related QOL. Ninety-seven participants were enrolled in the study, representing 2.5% of eligible people; 87 completed the intervention. Scores from physical function tests were significantly improved by the intervention, as were 7 of eight SF-8 subscales. Adherence was 85.4% for the single-leg standing exercise and 82.1% for squatting. Thus, self-directed home exercise with serial telephone contacts improved physical function and health-related QOL, representing a promising model for preventing the need for long-term care due to locomotor dysfunction.

Key words: locomotor dysfunction, self-home exercise, single-leg stance test, five-times sit-to-stand test, SF-8

Locomotor dysfunction due to fractures, joint disorders, or frailty is a major health problem among the elderly. These dysfunctions cause disabilities associated with a high risk of requiring physical care and affecting quality of life (QOL). In Japan, the prevalence of locomotorium disease is high; according to a large-scale cohort study, in 2009, an estimated 47 million people or more, as well 95% or more of adults age 75 years or older, suffered from osteoarthritis or osteoporosis [1]. In 2010, locomotor dysfunction affected 34.8% of the Japanese population requiring care services, including 13.7% with frailty, 10.9% with joint disorders, and 10.2% who had falls or fractures [2]. Considering these conditions, the Japanese Orthopaedic Association proposed the con-

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cept of "locomotive syndrome," referring to conditions that cause elderly individuals to require care services or high-risk conditions under which they may soon require care services due to problems of the locomotive organs; this concept has gained popularity across Japan over the past several years [3].

The Japanese elderly population is increasing rapidly; the number of people age 65 years or older comprised 23.3% of the Japanese population in 2011 [4] and is expected to reach 39.9% in 2060 [5]. The population requiring long-term care services is also increasing, accounting for 17.3% of all people 65 years or older in 2011 [6]. A recent Japanese study reported that the incidence of certified need for long-term care services was 2.3 per 100 person-years [7]. Therefore, because of the expected increase in the elderly population in Japan, a growing number of elderly people, especially those affected by locomotor dysfunction, will require long-term care services in the coming years.

Based on this situation, a long-term care prevention project for elderly individuals at high risk of developing conditions requiring long-term care services was started in Japan in 2006, promoted by the Ministry of Health, Labour, and Welfare. In this project, at-risk elderly individuals were identified using the Basic Health Checklist for individuals over 65 years old, a 25-item questionnaire developed by the Ministry of Health, Labour, and Welfare. It was recommended that at-risk individuals attend preventive programs, which included sessions of physical exercise. In 2011, 2.6 million elderly people were identified as high-risk individuals; 1.5 million of them (5.1% of all elderly people 65 years or older) were identified due to locomotor dysfunction. However, only 8% of identified high-risk individuals attended the preventive programs in 2011 [8]. The primary reasons for this low level of attendance included the inconvenience of transport to the program location and programs that were not attractive to the targeted population [9].

Increasing participation in preventive programs is necessary to reduce the number of disabled elderly requiring long-term care. To achieve this aim, it will be necessary to develop more effective plans that are attractive to participants and easy to comply with. Therefore, in this study, we proposed a self-directed home exercise program with serial telephone contacts to encourage exercise adherence for elderly individuals at high risk of locomotor dysfunction, and assessed whether our program was feasible and could improve physical function and QOL.

Materials and Methods

Participants. Elderly community-dwelling people age 65 years or older living in Chuo-Ku (Central Ward), Niigata City, Niigata prefecture, Japan (total population of the area: 174,604; population age 65 years or older: 39,970; aging rate: 22.9%; December 2011) who were identified as targets of the long-term care prevention project for locomotor dysfunction but did not participate in the exercise programs promoted by the municipal government were eligible for inclusion in this study. Individuals were identified based on answers provided for 3 of the 5 following items concerning locomotor function in the Basic Health Checklist: "Are you able to go upstairs without holding a rail or wall?"; "Are you able to stand up from a chair without an aid?"; "Are you able to keep walking for about 15 minutes?"; "Have you fallen during the past year?"; and "Do you worry about falling down?" [10].

To ensure that the personal identities of the subjects would be protected, we invited eligible individuals to participate in the study through comprehensive care centers in their communities, which conducted the long-term care prevention program developed by the municipal government. People were invited by mail, telephone, or home visit. We recruited eligible individuals who were identified in the 2011 Japanese fiscal year from October 2011 to March 2012, and invited a total of 2,312 eligible participants. However, according to the municipal government statistics data announced on August 2012, there were 3,904 individuals identified as targets of the long-term care prevention project for locomotor dysfunction, 51 of which participated in the exercise program promoted by the municipal government. Therefore, 3,853 individuals were considered eligible for this study. Because we could not invite the eligible participants directly, the number of invited individuals (from community comprehensive care centers) was substantially lower than the actual number of eligible participants based on the data from the municipal government.

A researcher visited the home of each respondent to explain the study purpose, procedures, and measurements, and the participants' right to withdraw at any time. Written informed consent was obtained from all participants. People were excluded if they were unable to give consent, were deemed too ill to participate, were receiving long-term care insurance services, or were involved in another exercise program. Ultimately, 97 people were recruited and participated in the study as a single group. Ethical approval for the study was obtained from the Ethics Committee of Niigata University Graduate School of Medical and Dental Sciences (no. 1267). This study was conducted from November 2011 to October 2012. We provided the intervention for about 10–30 participants a month during the study period.

Intervention. Participants received instruction in 2 types of exercise by a physiotherapist or occupational therapist at the initial home visit. One exercise was single-leg standing with eyes open, 3 sets a day of 1 min of standing on each leg per set. Participants were allowed to support themselves with their hands during the exercise for safety. The other exercise was a squatting or chair-rise exercise with or without hand support, 3 sets a day of 5 or 6 times per set. Participants performed both exercises by themselves daily and kept a compliance diary for 3 months. During this period, the experts telephoned them 3 times per week; the discussion lasted about 5 min each call and encouraged participants to continue the exercises.

Data collection and measurement. Baseline data collected by questionnaire included date of birth, sex, body weight and height, whether or not the participant lived alone, medical history (stroke, hypertension, heart diseases, osteoporosis, diabetes), symptoms of the locomotive organs (knee pain, low back pain), and health-related activities at the initial home visit. Physical function data (single-leg stance [SLS] test, five-times sit-to-stand [FTSTS] test) were measured at baseline and at the final home visit at the end of the intervention. The SLS test was measured in both legs with the eyes open and no support for as long as possible, and the better score was recorded. If participants could stand over 2 min, the test was terminated, and the data were entered as 2 min. The SLS test assesses postural steadiness in a static position [11]; therefore, longer standing on one leg implies better postural steadiness. The mean reported SLS time of elderly individuals ranges from 5 to 60 sec [12]. The FTSTS was performed as quickly as possible with the arms folded across the chest and without hand assistance. The FTSTS test assesses the function of the lower limb strength; therefore, faster FTSTS times indicate better lower limb function. The mean reported FTSTS time of elderly individuals ranges from about 8 to 21 sec [13].

The SF-8 Health Survey (SF-8), Japanese version [14] was used to assess physical and mental wellbeing at baseline and at the end of the study. The original SF-8 instrument was developed in English and derived from the SF-36 Health Survey [15], which measures general aspects of health-related QOL [16]. This survey, which was subsequently translated into Japanese, comprises 8 subscales (Physical Functioning; Role-Physical, which reflects role limitations due to physical problems; Bodily Pain; General Health; Vitality; Social Functioning; Role-Emotional, which reflects role limitations due to emotional problems; and Mental Health) and 2 summary scores (the physical health component summary score and the mental health component summary score). The SF-8 is scored using a normative algorithm based on the general Japanese population, and both physical and mental component summary scores were calculated by weighting each SF-8 item. Higher scores indicate better QOL. Scores above and below 50 were considered above and below the average in the general Japanese population. The SF-8 is popular for assessing health-related QOL due to its ease of administration and good data integrity.

A questionnaire about changes to physical condition and health-related behavior was also given at the end of the visit. The main outcomes were changes in physical function (SLS test, FTSTS test) and SF-8 scores between baseline and the end of the study.

Analysis. Pre- and post-intervention data were compared using a nonparametric test, the Wilcoxon signed-rank test. Differences with p values of less than 0.05 were considered significant. IBM SPSS ver. 20 was used to perform the analysis. Adherence was assessed as a ratio of the number of exercise sets performed as follows: the total number of actual practice sets recorded in the compliance diary was divided by the total number of possible sets for the period. We also calculated the ratio of participants among eligible people.

Results

Overall, 97 participants were assigned to the intervention, and 87 (89.7%) completed the program (Fig. 1). The participants represented 2.5% of eligible people, for a recruitment rate of 4.2%. Participants' demographic and clinical characteristics are summarized in Table 1. Many had locomotor symptoms, with 67 (69.1%) reporting low back pain, and 56 (57.7%) reporting knee pain; 57 (58.8%) had expressed interest in participating in routine exercise.

SLS test results (Table 2) were significantly improved between pre-intervention and post-intervention measurements in all participants (23.2 sec vs. 29.0 sec, a 25% increase; $p=0.002$). When stratified according to sex or age, this significant difference was also detected in female participants ($p=0.006$) and participants age 75 years or older ($p=0.012$), but not in male participants ($p=0.185$) or participants under 75 years old ($p=0.106$). FTSTS test results (Table 3) also significantly improved post-intervention compared to pre-intervention in all participants (14.7 sec vs. 11.6 sec, a 21% reduction; $p<0.001$); improvement was seen in male participants ($p=0.002$), female

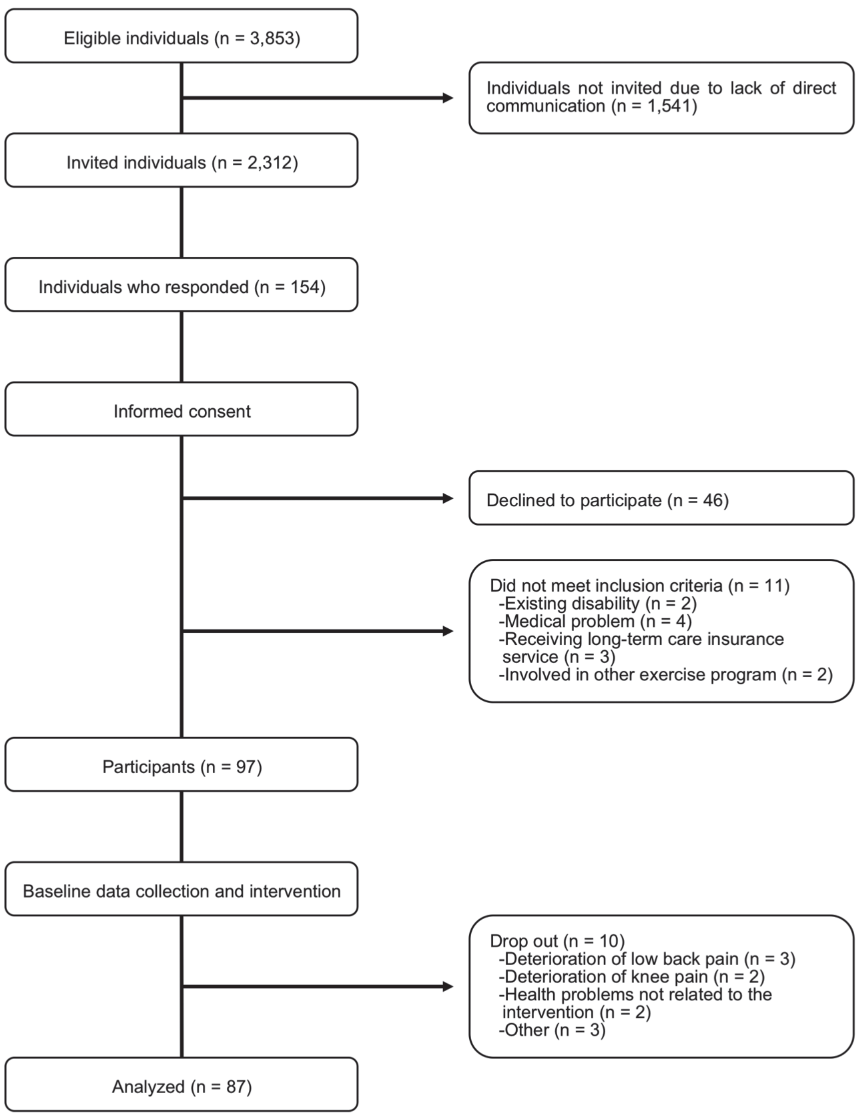

Fig. 1 Flow chart of participants' involvement in the study.

participants ($p < 0.001$), participants under 75 years old ($p < 0.001$), and those 75 years or older ($p < 0.001$) when analyzed separately.

All SF-8 subscales except the Role-Emotional domain (RE) were significantly improved after the intervention (Table 4). Although the physical component summary score was still low compared with the overall Japanese population, it significantly improved ($p = 0.001$). The mental component summary score exhibited no significant difference ($p = 0.156$); however, the Mental Health domain scores were significantly improved ($p = 0.004$).

In the post-intervention questionnaire (Tables 5 and 6), 40.2% of participants reported a gain in physical strength. Locomotor symptoms and health-related behaviors did not change substantially with the intervention: 73.6% of respondents reported no changes in low back pain, and 67.8% reported no changes in knee pain, while 82.8% reported no changes in opportunities for going out, and only 37.9% reported changed exercise habits. Adherence to the intervention was good, with 85.4% of participants completing the planned single-leg standing exercises, and 82.1% of participants completing the planned squatting exercises.

Table 1 Baseline demographics and clinical characteristics of the participants

Participants (n = 97)	
Age (years), mean (SD)	76.8 (5.8)
Male/Female	77.9 (5.1)/76.3 (6.1)
Female, number (%)	68 (70.1)
Body mass index (kg/m^2), mean (SD)	22.7 (3.3)
Living alone, number (%)	24 (24.7)
Medical history	
Stroke, number (%)	13 (13.4)
Hypertension, number (%)	52 (53.6)
Heart disease, number (%)	13 (13.4)
Diabetes, number (%)	20 (20.6)
Osteoporosis, number (%)	34 (35.1)
Low back pain, number (%)	67 (69.1)
Knee pain, number (%)	56 (57.7)
Health-related behavior	
Exercise, number (%)	57 (58.8)
Nutrition, number (%)	47 (48.5)
Rest, number (%)	18 (18.6)
Other, number (%)	10 (10.3)

SD: standard deviation

Discussion

The purpose of this study was to assess whether self-directed home exercise with serial telephone contacts was feasible, as well as whether it could improve the physical function and health-related QOL of elderly people at high risk of locomotor dysfunction. Our results demonstrated the beneficial effects

Table 2 Change in the single leg stance (SLS) test (sec) pre- and post-intervention

	Pre-Mean (SD)	Post-Mean (SD)	*p*
Total (n = 87)	23.2 (31.2)	29.0 (33.0)	0.002
Male (n = 27)	10.5 (11.8)	16.2 (19.4)	0.185
Female (n = 60)	28.9 (35.3)	34.6 (36.2)	0.006
< 75 years old (n = 32)	39.0 (43.8)	45.7 (44.6)	0.106
≥ 75 years old (n = 55)	13.9 (14.5)	19.9 (19.7)	0.012

Table 3 Change in the five-time sit-to-stand (FTSTS) test (sec) pre- and post-intervention

	Pre-Mean (SD)	Post-Mean (SD)	*p*
Total (n = 87)	14.7 (7.5)	11.6 (4.4)	<0.001
Male (n = 27)	16.9 (6.3)	13.1 (5.0)	0.002
Female (n = 60)	13.7 (7.9)	11.0 (4.0)	<0.001
< 75 years old (n = 32)	12.5 (5.2)	9.8 (3.6)	<0.001
≥ 75 years old (n = 55)	16.0 (8.4)	12.6 (4.6)	<0.001

Table 4 Change in the SF-8 scores pre- and post-intervention (n = 87)

	Pre-Mean (SD)	Post-Mean (SD)	*p*	Japanese population norm Mean (SD)
PCS	41.9 (8.9)	45.0 (7.4)	0.001	49.8 (6.0)
MCS	51.7 (6.8)	52.8 (5.4)	0.156	50.1 (6.0)
PF	43.8 (9.1)	47.5 (7.8)	0.002	50.9 (4.8)
RP	45.2 (8.5)	48.4 (7.2)	0.002	50.7 (5.22)
BP	45.5 (9.4)	47.5 (8.6)	0.016	51.4 (8.4)
GH	46.6 (5.6)	49.1 (6.2)	0.005	51.0 (7.0)
VT	47.0 (6.0)	49.1 (7.0)	0.011	51.8 (6.0)
SF	49.0 (8.2)	51.3 (7.3)	0.010	50.1 (6.9)
RE	49.7 (6.4)	51.1 (5.1)	0.077	50.9 (5.1)
MH	50.8 (7.0)	52.8 (6.4)	0.004	51.0 (6.5)

Japanese population norm: the score from large general population sample [4]. PCS, physical component summary score; MCS, mental component summary score; PF, physical functioning domain; RP, role-physical domain; BP, bodily pain domain; GH, general health domain; VT, vitality domain; SF, social functioning domain; RE, role-emotional domain; MH, mental health domain.

Table 5 Questionnaire results concerning changes in physical condition (n = 87)

	Getting better Number (%)	No change Number (%)	Getting worse Number (%)	No answer Number (%)
Change of general condition				
Physical condition	34 (39.1)	51 (58.6)	1 (1.1)	1 (1.1)
Physical strength	35 (40.2)	52 (59.8)	0 (0)	0 (0)
Sleep	12 (13.8)	72 (82.8)	1 (1.1)	2 (2.3)
Appetite	8 (9.2)	74 (85.1)	4 (4.6)	1 (1.1)
Opportunity to go out	7 (8.0)	72 (82.8)	8 (9.2)	0 (0)
Change in locomotor symptoms				
Low back pain	11 (12.6)	64 (73.6)	2 (2.3)	10 (11.5)
Knee pain	15 (17.2)	59 (67.8)	1 (1.1)	12 (13.8)

Table 6 Questionnaire results concerning changes in health-related behaviors (n = 87)

	Number (%)	Number (%)
Change in health-related behavior	Yes = 44 (50.6)	No = 43 (49.4)
Exercise*	33 (37.9)	—
Nutrition*	8 (9.2)	—
Rest*	2 (2.3)	—
Other*	7 (8.0)	—

*Multiple answers of “yes” were allowed.

of the 3-month intervention, which included single-leg standing and squatting exercises, and participants exhibited improved physical function in both the SLS and FTSTS tests.

Comparable results have been reported in previous studies of similar aging populations [17-19], although some involved longer intervention periods or stronger exercises to achieve these effects [17, 20]. Therefore, the present study demonstrated adequate effects with minimal time and intensity. Interestingly, in male participants and participants less than 75 years old, although SLS test results tended to improve, no significant changes were observed. This may have been due to the small sample sizes in these groups (n = 27 and n = 32, respectively). The SLS test is an assessment of postural steadiness [11] and is reportedly related to mortality [21, 22], fall status [23, 24], and activities of daily living [25, 26]. The FTSTS test is an assessment of lower limb muscle strength [27], which reflects ability and mobility [28]. Thus, these results support the possibility that our intervention may improve lower limb function and activities of daily living, and reduce falls, which are a concern for locomotor dysfunction in the elderly.

The intervention also significantly benefitted health-related QOL, as measured by the SF-8. Many reports have indicated that exercise intervention improves health-related QOL in the elderly [20, 29], and the results of this study support these findings. Indeed, significant improvement was observed in the Mental Health domain; however, significant improvement was not observed in the Role-Emotional domain, indicating that while this intervention may improve participants' emotional wellbeing, it may not alleviate limitations in social activities.

The rate of recruitment in this study was 4.2%, which is very low compared with that in other reports. A systematic review reported a median inclusion rate for exercise interventions aimed at fall prevention in community settings of 64.2%; the lowest reported recruitment rate was 9.7% [30]. The Ministry of Health, Labour, and Welfare reported that only 89,971 of 1,510,880 people (6.0%) who were identified as targets of the long-term care prevention project for locomotor dysfunction participated in the municipal government-promoted exercise program in 2011 [31], similar to the rate in this study. In our study, 93.3% of invited individuals did not respond. We invited elderly people who had previously failed to respond to exercise programs promoted by the municipal government, potentially affecting their likelihood to respond in this case. This high refusal rate suggests that most people with high risk of locomotor dysfunction may not be aware of their physical problems or the need to exercise. Therefore, in order to increase participation in the preventive exercises, it is necessary to educate elderly individuals who are at high risk of locomotor dysfunction about the need for physical exercise and ways to prevent dysfunction. Furthermore, by explaining the risks of locomotor dysfunction by telephone or during interviews, we will be able to increase participation in preventive exercises.

However, the attrition of participants in this study was only 8.2%, and adherence rates of 85.4% and 82.1% were achieved for the single-leg standing exercise and squatting exercise, respectively. A systematic review [27] estimated a 10% attrition rate and reported that median adherence to an individually targeted 2-month exercise program reached only 82.0% [27]. Therefore, we achieved better attrition and adherence rates than expected.

In this study, we provided telephone contacts 3 times per week during the intervention, which may have played an important role in maintaining adherence. Previous studies reported no difference in effect between individual and group exercise interventions. However, telephone contact has been reported to help people adopt a home-based exercise-training program [32]. Therefore, telephone contacts are useful for motivating participants to continue the exercises.

This study is of major interest to the development of population-based approaches and targeted strategies for people at high risk of locomotor dysfunction. Most previous intervention studies were targeted to populations with specific diseases. To the best of our knowledge, no studies have focused on elderly at a high risk of locomotor dysfunction living in the general population. The design of this study, which targeted functional improvement, is useful for interventions among the community-dwelling elderly.

This study had some limitations. First, we had no control group. The effects of exercise intervention in elderly people have been studied extensively [29]. Therefore, we focused on assessing the effect of the self-directed home exercise program with serial telephone contacts to encourage exercise adherence among elderly people at high risk of locomotor dysfunction. We could not find any studies that reported exercises for elderly individuals at high risk of locomotor dysfunction who previously rejected an exercise intervention, making this study a good example of how intervention can help elderly people. The possibility of bias in participant recruitment was also a limitation. We could recruit only 4.2% of eligible people. Although all invited people were identified as being at high risk of locomotor dysfunction, people who were interested and ultimately participated in the study may have had higher physical function than those who did not respond. Thus, the results of the study may not reflect the status of all people at high risk of locomotor dysfunction. Fifty-seven participants (58.8%) answered that they were interested in participating in routine exercise in the questionnaire administered at the beginning of the study. Therefore, the participants may have had more interest in exercise than the rest of the eligible population, leading to less attrition and better adherence. Another possible source of bias was measurement error in the results of the questionnaire and adherence. The participants may have supplied more optimistic answers than their actual condition to questions associated with health-related behavior. Moreover, they may have improperly recorded the number of the exercises they performed, leading to the appearance of better adherence.

Finally, we did not describe the cost-effectiveness of this intervention. We expect that this intervention would reduce the number of individuals requiring long-term care, thereby reducing long-term care costs with a relatively low-cost method. In this study, we found that the participants maintained better adherence and improved physical function requiring only encouragement by telephone 3 times a week, which is inexpensive. Thus, further studies would be required to analyze the cost-effectiveness of this intervention.

In summary, this intervention had beneficial effects on physical function, health-related QOL, and exercise adherence among elderly people who did not attend other preventive group exercise and were at risk of locomotive disorders. Therefore, the intervention described in this work should be considered more widely as an option in preventive initiatives.

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