Long-Term Effect of Promoting In-Hospital Physical Activity on Postdischarge Patients with Mild Ischemic Stroke

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Background: Although there are reports on the promotion of physical activity during hospitalization, there is no evidence that promoting in-hospital physical activity continues over time after discharge. The purpose of this study was to evaluate the long-term effect of promoting in-hospital physical activity on postdischarge physical activity and self-efficacy for physical activity in patients with mild ischemic stroke. *Methods:* This was a cross-sectional study of a post hoc analysis of a previous randomized controlled trial. Patients with mild ischemic stroke were divided into the intervention group (in which physical activity was promoted during hospitalization) and a control group. To promote in-hospital physical activity, patients in the intervention group were instructed in the self-monitoring approach. After discharge, we measured physical activity and self-efficacy for physical activity by mailing a questionnaire to the patients. The average number of steps taken was used the index of postdischarge physical activity. *Results:* The study sample comprised 30 patients, with 13 patients in the intervention group and 17 patients in the control group. There were no significant differences in physical activity values (6176.8 versus 6112.8 steps/day, $P = .932$) and self-efficacy for physical activity score (66.0 versus 76.0 points, $P = .801$) between the 2 groups. *Conclusions:* This study showed that the promotion of in-hospital physical activity did not appear to increase physical activity and self-efficacy for physical activity in patients with mild ischemic stroke after discharge. Additional study is needed to establish a more specific approach to promote physical activity during hospitalization that will carry over during long-term follow-up.
Key Words: Stroke—physical activity—promotion—self-efficacy—rehabilitation

Introduction

In Japan, many patients with ischemic stroke suffer only mild disability after admission to hospital because of improvements in the management of risk factors and medications.[1] Approximately 60% of patients with ischemic stroke have mild disability (modified Rankin Scale score of 0-2) at discharge according to a major Japanese hospital-based stroke database.[1] However, patients with mild ischemic stroke are at high risk for stroke recurrence.[2,3] Kono et al[4] previously reported that

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lifestyle interventions including an increase in physical activity are beneficial to reduce the incidence of new vascular events in patients with mild ischemic stroke. Kono et al[5] also reported that among patients with mild ischemic stroke, a population with lower physical activity showed a higher incidence of new vascular events including recurrent stroke. As represented by these studies, physical activity may be key to the prevention of recurrent stroke.

Although patients with stroke vary in their level of physical activity, stroke survivors tend to be either inactive or sedentary after discharge.[6-8] Sink et al[9] indicated that physical activity intervention could not increase physical activity in sedentary older adults. Thus, once the patient is medically stable, it is apparent that the promotion of physical activity should begin early after stroke. We previously conducted a randomized controlled trial of hospitalized patients with mild ischemic stroke that showed that exercise training combined with a self-monitoring approach and goal setting effectively increased their physical activity.[10] However, there is no evidence that the promotion of in-hospital physical activity will continue over time after discharge.

After stroke, self-management is essential for increasing physical activity and prevention of secondary adverse health conditions.[11] Self-efficacy for a particular activity increases as a result of a self-management intervention.[12,13] French et al[14] reported that self-efficacy mediates the relationship between performance capacity, activity, and participation after stroke. With regard to self-efficacy for physical activity (SEPA), we previously suggested that a self-monitoring approach may increase SEPA in hospitalized patients with mild ischemic stroke.[10,15] However, patients who only underwent conventional rehabilitation including muscle strength exercise and aerobic exercise also increased their SEPA,[10] and the long-term effects of the self-monitoring approach were unclear. However, SEPA was found to predict physical function in cardiac patients.[16] Izawa et al[17,18] showed the long-term effects of the self-monitoring approach on physical activity and SEPA in cardiac patients. They also reported that SEPA showed significant positive correlation with objective physical activity.[17] However, there are no clinical data on objective physical activity in relation to SEPA after discharge in patients with stroke. If these relations are clarified, we may be able to provide an appropriate strategy for the promotion of physical activity in patients with stroke.

We hypothesized that promoting in-hospital physical activity would increase physical activity behavior and SEPA in patients with mild ischemic stroke after hospital discharge. The purpose of this study was to evaluate the long-term effect of promoting in-hospital physical activity on postdischarge physical activity and SEPA, and to clarify the relation between physical activity and SEPA in patients with mild ischemic stroke.

Methods

Study Design

This was a cross-sectional study of a post hoc analysis of our previous randomized controlled trial (UMIN000029120). Informed consent was obtained from each patient. The study was approved by the Itami Kousei Neurosurgical Hospital Research Ethics Committee.

Participants

In our previous randomized controlled trial conducted at Itami Kousei Neurosurgical Hospital from April 2016 to March 2017, we enrolled patients with mild ischemic stroke who could walk without assistance within 1 week of admission.[10] That study sample consisted of 48 patients, 23 who comprised the intervention group, in which instructions were given on self-monitoring approach methods during hospitalization, and 25 who comprised the control group, in which no instructions on the self-monitoring approach were given. These patients had completed all measurements of physical activity during hospitalization. Patient inclusion criteria in the present study included patients who could walk without assistance regardless of using a gait aid or orthotics after discharge, returned directly to home, and consented to measuring their physical activity after discharge. Exclusion criteria were as follows: patients who were discharged to a nursing home or admitted to another hospital for treatment of other disease such as dementia, neurological disease, musculoskeletal disease, severe cardiopulmonary disease, or psychiatric disease, and patient refusal to participate in the study.

Outcomes Measures

We evaluated the following patient clinical characteristics: age, sex, body mass index, subtypes of acute ischemic stroke according to the Trial of ORG 10172 in Acute, Stroke Treatment classification,[19] National Institutes of Stroke Scale,[20] and comorbidities. Physical therapists assessed each patient's previous exercise habits at patient enrollment and measured comfortable walking speed and Berg balance scale[21] before patient discharge. We assessed previous exercise habits according to the stages of exercise behavior change, which includes the preparation, action, and maintenance stages of exercise behavior change.[22] Comfortable walking speed was calculated from the result of a 10-m walking test as 10 m/time required in seconds.[23] We derived this speed by timing the patient's walking time over a 10-m stretch of a 14-m walkway with a stopwatch. We instructed the patients to walk at their comfortable walking speed and allowed them to use a walking aid, such as a cane, if normally required.

The primary outcome was physical activity values derived from the average number of steps taken after discharge. Secondary outcomes were other physical activity values derived from the duration of moderate-to-vigorous physical activity (MVPA) and SEPA. We measured physical activity values in the postdischarge patients with a Fitbit One 3-dimensional accelerometer (Fitbit, Inc., San Francisco, CA), which calculates steps taken, distance traveled, floors climbed, calories burned, and sleep quality and has been used previously in stroke patients.[10,15,24] The accuracy of the Fitbit Ultra model was confirmed in stroke patients,[25] and that of the Fitbit One was confirmed in older community-dwelling adults.[26] The duration of MVPA (min/day) was calculated as the sum of minutes of physical activity of greater than 3 metabolic equivalents. SEPA measures self-confidence for the performance of a given activity or task and represents the perceptions or beliefs of how capable an individual is in performing a specific activity or task.[27,28] In the present study, we used the Japanese version, whose reliability was previously validated,[28] to measure general SEPA. The SEPA score assessed self-perceived ability such as walking, climbing stairs, weight lifting, and push off at 5 different levels of intensity. We used the domain of walking as the index of SEPA in the present study. Patients were asked to indicate whether they could walk from 20 to 120 minutes, and recorded their level of confidence in this judgement on a scale ranging from 0-100. We then calculated average score of the domain of walking. Lower scores indicate a poor level of SEPA and higher scores indicate a better level. We originally measured these outcomes during hospitalization in our previous study,[10] and we measured them again at least 3 months after stroke onset after the patients had been discharged.

Protocol

Except when bathing, the patients wore an accelerometer on their waist belt 24 hours/day until discharge. Patients in the intervention and control groups underwent 40-120 minutes of supervised rehabilitation 5-6 times a week that included physical therapy, mainly composed of body stretches, body weight resistance exercise, aerobic exercise, and a cool-down period, and occupational therapy. Patients in the intervention group were instructed in the methods of the self-monitoring approach to promote hospitalized physical activity in addition to participating in the supervised rehabilitation program. Although patients in the control group also continued to undergo the supervised rehabilitation program, they were not instructed on methods to promote physical activity.

The method used to promote physical activity with the directed self-monitoring approach was described in detail by Kanai et al[10] and Izawa et al.[17,18] A physical therapist asked all patients in the intervention group to record the number of steps shown on the accelerometer and specific voluntary activity such as resistance training and stair climbing, if they did it, on an exercise calendar. We based our self-monitoring approach on the self- efficacy theory of Bandura,[27] who argued that the performance of a specific behavior is strongly influenced by the confidence an individual has in his or her ability to perform that behavior.[28] Based on the physical therapist's advice, the patients determined their feasible physical activity target including steps/day or objective activity and long-term goals necessary to enhance self-efficacy. For example, the therapist would encourage the patient to walk 100-500 steps farther than the previous day, and patients could confirm the number of steps taken in real time to attain their target step count. The physical therapist praised the patient if the target was attained, and if not, the therapist discussed modifying the physical activity target with the patient while viewing the patient's self-monitoring log. Thus, we expected that the patients would maintain their performance of physical activity and adopt other positive health behaviors.

At discharge, physical therapists instructed the patients in both groups that 150 min/week of moderate-intensity activity in bouts of 10 minutes or more are recommended for adults as described in the global recommendations on physical activity,[29] that continue taking home exercise such as resistance training and aerobic exercise as possible, and that excessive rest or sedentary behavior is associated with poorer health condition.

At the postdischarge measurement made at least 3 months after stroke onset, we measured outcomes by mailing a questionnaire to the patients who had consented to participate. Patients filled in their answers on the questionnaire by themselves. We asked them to return the Fitbit One and questionnaire by mail after they had completed wearing of the accelerometer for more than 7 days.

Statistical Methods

Normality of the distributions of all data was tested by the Shapiro-Wilk test. Continuous variables are expressed as mean ± standard deviation or median (interquartile range). Category variables are expressed as numbers (%). We used the first 7 days (1 week) of continuous data as the physical activity values in the present study. The average number of steps and duration of MVPA were calculated. The unpaired t test, Mann-Whitney U test, and χ^2 test were used to compare patient characteristics and outcomes between groups. The relation between physical activity values and SEPA was assessed by Spearman partial correlation coefficient adjusted by age and sex. A P value of $< .05$ was considered to indicate statistical significance. Statistical analyses were performed with IBM SPSS 25 statistical software (IBM SPSS Japan, Inc., Tokyo, Japan).

Results

Participant flow through this study is shown in Fig 1. After excluding patients who could not walk without assistance or gait aid and did not consent to measurement

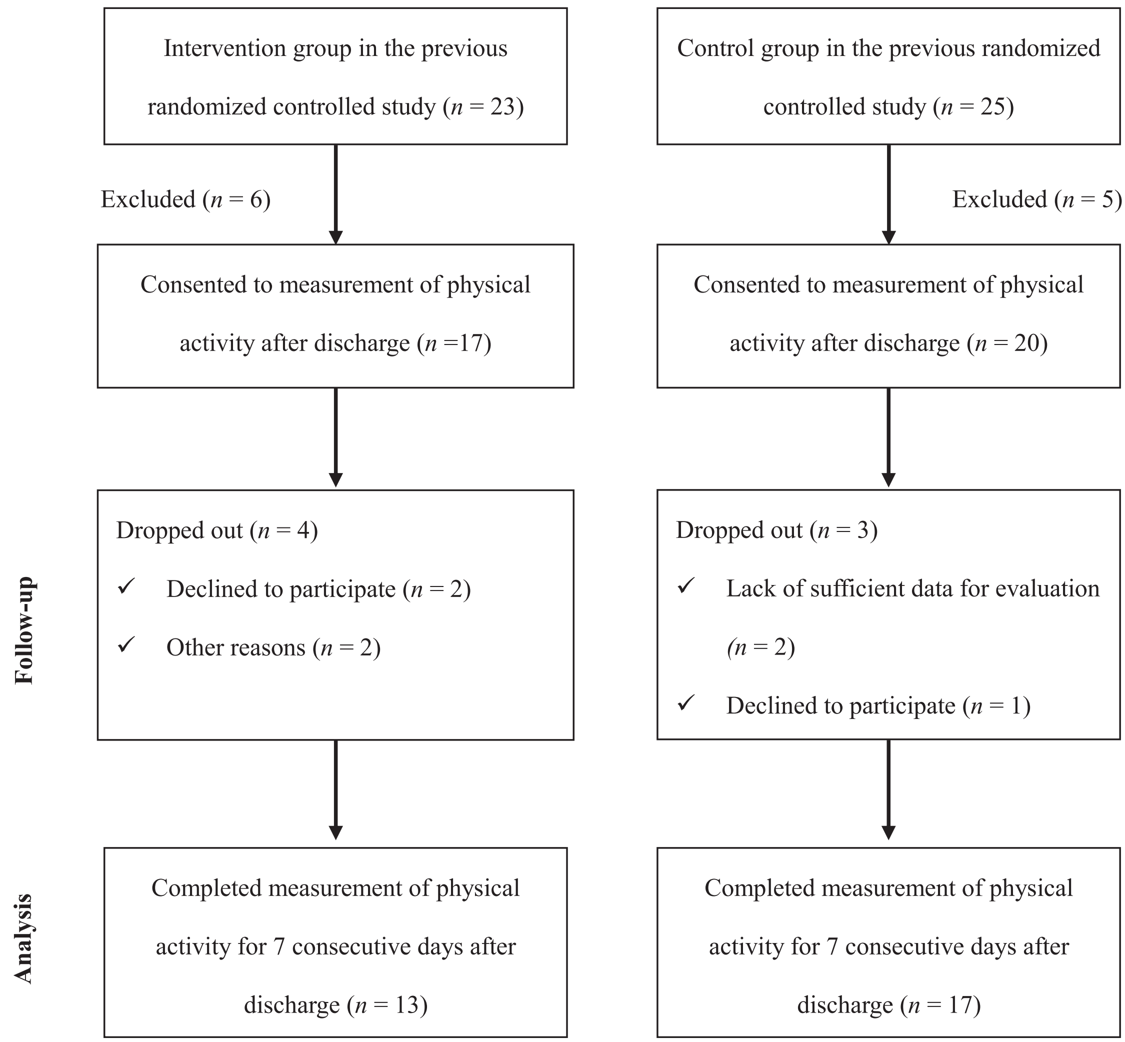

Fig 1. *Participant flow in the study.*

of physical activity after discharge, 37 patients were included in this study. However, 7 patients later dropped out due to unwillingness to participate (2 patients in the intervention group, 1 patient in the control group), lack of sufficient data for evaluation (2 patients in the control group), or other reasons (2 patients in the intervention group). Therefore, the study sample consisted of 30 patients, of whom 13 patients comprised the intervention group and 17 patients comprised the control group.

Clinical characteristics of the patients are shown in Table 1. There were no significant differences in characteristics between the 2 groups.

Differences in physical activity outcomes and SEPA score after discharge in the 2 groups are shown in Table 2. There were no significant differences in these outcomes between the groups. We also evaluated the correlations between physical activity outcomes and SEPA scores for all patients. A significant positive correlation was observed between the average number of steps and SEPA score ($\rho = .385$, $P = .043$) (Fig 2) and between the duration of MVPA and SEPA score ($\rho = .407$, $P = .031$) (Fig 3).

Discussion

The findings of this study show that promoting in-hospital physical activity did not increase objective physical activity such as number of steps taken and the duration of MVPA and SEPA in patients with mild ischemic stroke after hospital discharge. However, a positive correlation existed between physical activity outcomes and SEPA score for all patients after discharge, even after adjustment for age and sex.

The average number of steps taken by all patients in the present study was 6140.5 steps/day, and the duration of MVPA was 19.1 min/day. Although stroke severity varied between different studies, Field et al[30] reported in a systematic review that stroke patients averaged 4355.2 steps/day. When focusing only on patients with mild stroke, Moore et al[31] reported that stroke patients took 5763 steps/day at 3 months and 5927 steps/day at 6 months after stroke onset. In Japan, Kono et al[3] reported that patients with mild ischemic stroke took 6446 steps/-day, and a physical activity level of less than 6025 steps/-day resulted in a higher incidence of new vascular

Table 1. *Clinical characteristics*

	All patients (n = 30)	Intervention group (n = 13)	Control group (n = 17)	t or z or χ^2 value	*P* value
Age (y)	68.5 (58.8-74.3)	74.0 (62.0-76.0)	67.0 (56.5-69.5)	−1.66	.098
Sex (male), n (%)	18 (60.0)	8 (61.5)	10 (58.8)	.02	.999
Body mass index (kg/m^2)	23.7 ± 3.2	24.1 ± 3.5	23.4 ± 3.0	.62	.539
TOAST classification of subtypes of acute ischemic stroke, n (%)	–	–	–	2.23	.525
Large-artery therosclerosis	6 (20.0)	3 (23.0)	3 (17.6)	–	–
Cardioembolism	1 (3.3)	1 (7.6)	0 (0)	–	–
Small-vessel occlusion	22 (73.3)	9 (69.2)	13 (76.5)	–	–
Undetermined	1 (3.3)	0 (0)	1 (5.9)	–	–
NIHSS (score)	0 (0-1)	0 (0-1)	0 (0-1)	−1.04	.297
Comorbidity, n (%)					
Hypertension	19 (63.3)	9 (69.2)	10 (58.8)	.33	.708
Diabetes mellitus	7 (23.3)	3 (23.1)	4 (23.5)	.01	.999
Previous exercise habits	26 (86.7)	12 (92.3)	14 (82.4)	.63	.409
Walking speed (m/s)	1.2 (1.1-1.3)	1.2 (1.1-1.3)	1.3 (1.1-1.4)	−.38	.706
Berg balance scale (score)	56.0 (55.0-56.0)	56.0 (55.0-56.0)	56.0 (54.5-56.0)	−.55	.582
Time since stroke (mo)	4.0 (3.6-4.2)	4.1 (3.6-4.5)	3.9 (3.7-4.2)	−1.05	.293

Abbreviations: NIHSS, National Institutes of Health Stroke Scale; TOAST, Trial of ORG 10172 in Acute Stroke Treatment.
Values are shown as mean ± SD, median (interquartile range), or ordinal variables and counts (%) for categorical variables.

events.[5] Although the average number of steps attained in the present study was equivalent to the values in these studies, it was below the recommended steps/day for people with chronic illness/disability (6500-8500 steps/day).[32] Moreover, patients in the present study could not achieve the recommend level of MVPA, which was also not achievable in a report on community-dwelling stroke patients by English et al (4.9 min/day[7] and 7.4 min/day[33]). Lacroix et al[34] reported that stroke patients in rehabilitation units performed 39 minutes of physical activities (≥3 metabolic equivalents); however, they only took 783 steps/day. The wide variability in MVPA might depend on the measuring devices used. Regardless, it is important to incorporate MVPA into the discharge guidelines and to emphasize the importance of MVPA during hospitalization to ensure that the patients will continue physical activity after discharge.

Contrary to our hypothesis, we could not show that the promotion of in-hospital physical activity with a directed self-monitoring approach increased physical activity behavior and SEPA in patients with mild ischemic stroke after discharge, even though a positive effect of the self-monitoring approach was shown to continue over time in previous studies of patients with heart disease.[17,18] In addition, a recent meta-analysis[35] was conducted with 269 patients including only randomized controlled studies with step counts in the intervention group and the control group, and self-monitoring significantly increased physical activity (95% confidence interval, 1916-3090 steps per day). With regard to stroke patients, individualized coaching on physical activity and exercise partly increased self-reported physical activity after subacute stroke.[36] This intervention continued every month for 18 consecutive months. Compared to these studies,[17,18,36] our intervention was shorter and conducted only during hospitalization. Additionally, patients in both groups had high rates of exercise prior to their stroke. In other words, their prestroke habit of physical activity was high. Prestroke physical activity, which is important for being active after stroke and is considered a potential predictor

Table 2. *Physical activity outcomes and self-efficacy for physical activity after discharge*

	All patients (n = 30)	Intervention group (n = 13)	Control group (n = 17)	t or z value	*P* value
Number of steps (/day)	6140.5 ± 1974.4	6176.8 ± 1650.3	6112.8 ± 2240.8	.086	.932
Duration of moderate to vigorous physical activity (min/day)	19.1 ± 14.3	22.0 ± 14.4	16.8 ± 14.3	.988	.332
Self-efficacy for physical activity (score)	70.0 (42.0-98.0)	66.0 (54.0-89.0)	76.0 (39.0-99.0)	−.25	.801

Values are shown as mean ± SD or median (interquartile range).

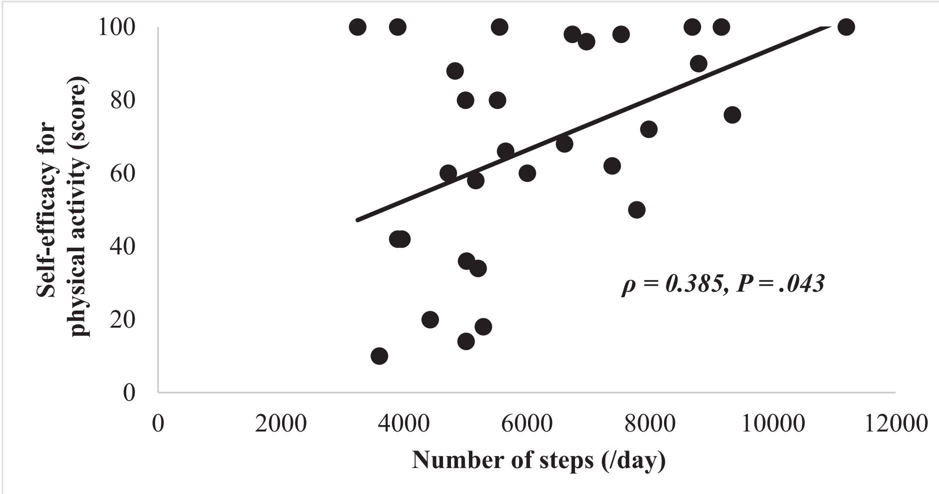

Fig 2. *Relation between the average number of steps and self-efficacy for physical activity score.*

for long-term outcome of physical activity,[37] might have affected the participants' knowledge of physical activity and its beneficial health effects after stroke in both groups.

Fulk et al[38] indicated that walking endurance, motor function, and balance play important roles in community walking activity after stroke. They also suggested that a comfortable walking speed of .93 m/s discriminated between limited community and full community ambulators. Because almost all patients in both groups of the present study achieved this cut-off value at discharge (intervention group: 1.2 m/s, control group: 1.3 m/s), this may be 1 reason why physical activity outcomes were not significantly different between the 2 groups after discharge.

Although self-efficacy may increase physical activity after stroke, as shown in a systematic review,[39] there was no significant difference in SEPA scores between the 2 groups in the present study. Thus, our intervention was not sufficient to enhance SEPA during hospitalization[10] or after discharge. The ceiling effect or the variability of the SEPA score might have somehow affected the present results.

The present study is the first study, to our knowledge, to clarify the relation between objective physical activity and SEPA score within the domain of walking-in patients with mild ischemic stroke. The results suggested that the higher patients with stroke perceived their SEPA, the more they walked and the more active they were. This supports the result of a previous study in cardiac patients.[17] Self-efficacy mediates the relation between activity and participation after stroke.[14] The present results also indicate that we need to reconsider the methods of promoting physical activity particularly in patients with a lower SEPA score. Askim et al[36] also indicated that coaching should probably be even more personalized and multimodal. Our intervention partially included personalized coaching, but we could not include multimodal intervention. Additional study is needed to establish a more specific approach to improve self-efficacy to promote

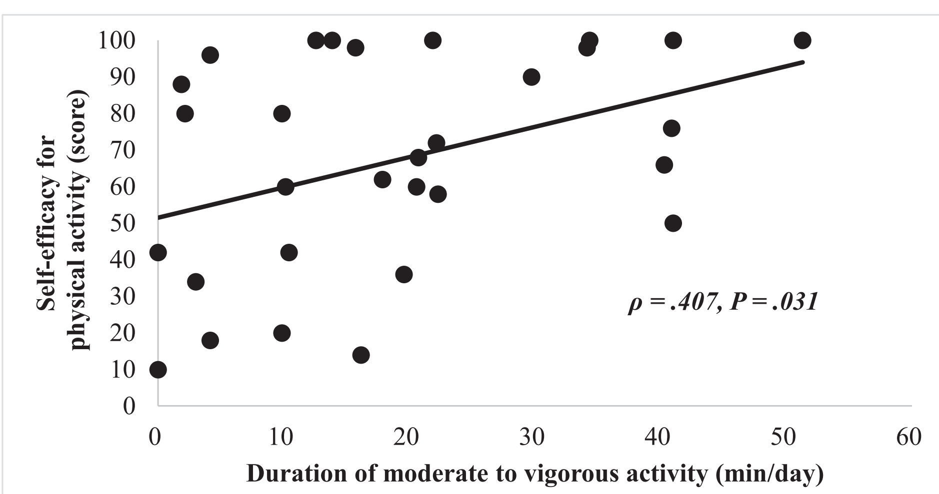

Fig 3. *Relation between the duration of moderate to vigorous activity and self-efficacy for physical activity score.*

physical activity from hospitalization through long-term follow-up.

There are several limitations in this study. First, because we could not follow up all patients after the randomized controlled trial, the sample population was small. Second, we followed up the patients at only 1 point after discharge and did not follow them at half-year or 1-year time points after stroke onset. Although some reports showed that physical activity level[31] or sedentary behavior[8] did not change over time following stroke onset in observational longitudinal studies, our intervention might have had an impact on physical activity behavior if longer-term follow-up were conducted. Third, although we clarify the relation between objective physical activity and SEPA score, we could not conclude whether self-efficacy actually mediated physical activity because of cross-sectional design of the present study. Finally, we did not evaluate other factors associated with poststroke physical activity such as depression, anxiety, quality of life, and environmental characteristics. To eliminate these problems, we are now conducting another intervention to address these limitations.

In conclusion, the present study indicates that the promotion of in-hospital physical activity did not increase objective physical activity and SEPA in patients with mild ischemic stroke after hospital discharge. However, it provides further evidence for a relation between objective physical activity outcomes and SEPA. These results may help in developing an appropriate strategy for the promotion of physical activity during hospitalization that will carry over during the long-term follow-up of patients with mild ischemic stroke.

Supplementary Materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.jstrokecerebrovasdis.2018.12.029.

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