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Effects of Self-Checked Monitoring Home Exercises on Gait, Balance, Strength, and Activities of Daily Living in People with Parkinson's Disease

Background: Self-checked monitoring home exercises are recommended for preventing falls among people with Parkinson's disease. However, as these home exercises are performed autonomously by patients without professional management, their accuracy and efficiency can be compromised.
Objective: To investigate the effects of providing regular training sessions to patients and caregivers and of patient self-monitoring of exercise performance following the implementation of a self-checked monitoring exercise program for people with Parkinson's disease.
Design: Randomized Pretest-Posttest Control Group Design.
Methods: We provided regular self-checked monitoring home exercise and general home exercise programs to 30 participants for 12 weeks. Once a month at the first, fifth, and ninth-week sessions, a rehabilitation team attended the Parkinson's group education. In addition to the subject in the experimental group perform the home exercises program to provide feedback regarding the home exercises program and to carry out a self-monitoring checklist performance for 12 weeks.
Results: The 10 m walk test, functional reach test, and sit to stand test and the modified Barthel index significantly improved in the self-checked monitoring home exercise group.
Conclusion: These results suggest that self-checked home exercise programs, which facilitate safety and consistent performance of exercises at home, are beneficial for people with Parkinson's disease.

Keywords: *Outpatient treatment; Parkinson's disease; Rehabilitation; Self-check monitoring home exercise*

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INTRODUCTION

The therapeutic approaches currently available to people with Parkinson's disease (PD) include medication and surgery. Although levodopa is known to be the most effective drug to correct the neurotransmitter imbalance seen in PD by ameliorating dopamine deficiency in the basal ganglia, it also has motor side effects, such as motor fluctuation and dyskinesia, as well as psychological side effects, such as hallucinations and delusions.[1] Owing to these drug related side effects, the use of surgical treatment has been increasing. Surgical treatment is currently applied preferentially in patients who can no longer be treated with levodopa owing to reduced efficacy or worsening side effects over time.[2]

As an alternative therapeutic approach, non-pharmacological, non-invasive exercise therapy is known to stimulate brain-derived neurotrophic factor (BDNF), thereby preventing brain atrophy and promoting cognitive performance improvement. In addition, BDNF promotes the secretion of glial-derived neurotrophic factor, which increases dopamine absorption and thereby prevents motor cell death.[3] In this manner, exercise therapy can help patients avoid falling accidents by improving their balance and walking ability; consequently, their quality of life can be improved.[2,4] Exercise therapy is both functionally beneficial, promoting improved movement ability, and psychologically beneficial, promoting improved attention span, cognition, and emotional control.[5,6]

However, people with PD experience severe impairments in balance and cognition, as well as depression and other complications; this renders regular visits to medical institutions for exercise therapy and exacerbates the risk of falling accidents.[7] Moreover, the burden imposed by the medical expenses associated with repeated visits to medical institutions and transportation for outpatient visits, as well as the physical and mental burden on caregivers, hinders regular outpatient treatment. Thus, these patients are likely to experience functional deterioration, worsening their physical condition and mental health.[8] In an effort to solve these problems, home exercise programs have been widely applied in people with PD to reduce the risk of falls, medical costs, and burden imposed by transportation.[9]

However, despite the several benefits of home exercise, factors that militate against the effects of home exercise have been pointed out; these include a low rate of exercise performance and incorrect exercise performance by patients in situations where it is difficult for the therapist to conduct sustainable management. Therefore, the present study attempted to demonstrate the effects of more advanced home exercises by allowing patients to check themselves daily using a self-check paper and by providing regular training to patients and their caregivers to overcome the limitations of these home exercises.

SUBJECTS AND METHODS

Experimental design

This study was a single-blind randomized, controlled trial. The researchers were aware of the group allocations; conversely, the subjects were blinded to them. Using a random allocation software (version 1.0),[10] 30 patients who ultimately satisfied the inclusion criteria were divided into two groups: (1) self-checked monitoring home exercise group (SHE group: 15 subjects) and (2) general home exercise group

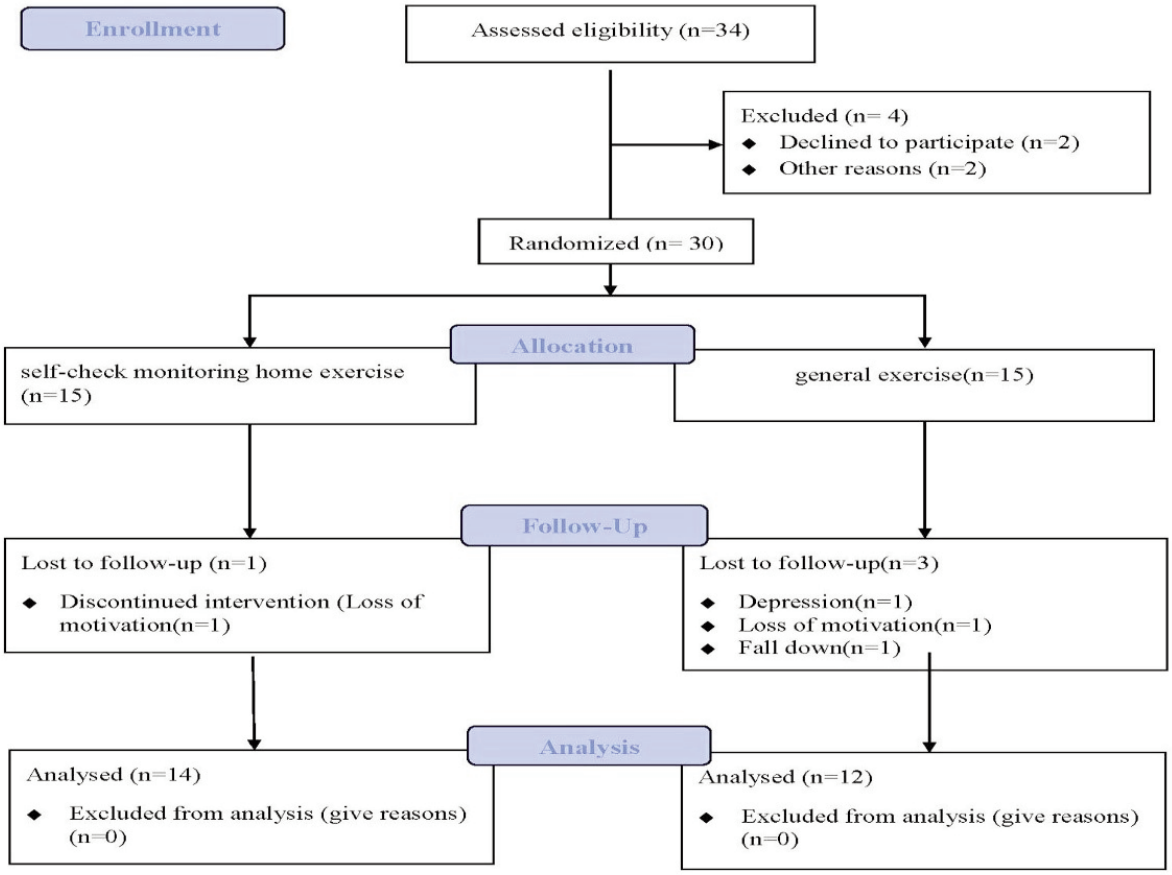

Figure 1. Flow diagram of the study. Thirty individuals were enrolled in the study and were randomly assigned to the self-checked monitoring home exercise group (n=15) or the general home exercise group (n=15).

(GHE group: 15 subjects). Toward the end of the intervention, the SHE group included only 14 patients, while the GHE group included only 12 patients. All measurements were performed at the beginning of the study and 12 weeks after the intervention (Figure 1). Different physical therapists conducted the training program and evaluation. However, the same therapist performed the evaluation to increase its reliability and accuracy.

Subjects

People diagnosed with PD at the Department of Neurology of G University Hospital were included in this study. The inclusion criteria were as follows: (1) PD diagnosed by a neurologist,[11] (2) the ability to walk at least 10 m was required (regardless of need for assistance), (3) use of anti-Parkinson drugs and "on-state" classification, indicating that the drug was effective, (4) Hoehn and Yahr scale grade of 3 or lower, and (5) understanding and agreement with the contents of this study. Conversely, the exclusion criteria were as follows: (1) orthopedic and neurosurgical surgery, (2) cardiovascular disease and high risk of falls, (3) score lower than 24 in the Mini-Mental State Examination, and (4) participation in other exercise programs.

All subjects understood the requirements of the study and provided informed consent before their participation. All procedures were approved by our Institutional Review Board (1041449-201801-HR-001) and registered at Clinical Research Information Service, Republic of Korea (KCT0003741). In addition, this study was performed in accordance with the CONSORT guidelines (Figure 1).

Interventions

The patients in the SHE and GHE groups participated in the group exercise program for 12 weeks on a regular basis (once per month). During the first week of the program, lectures regarding performance of the home exercises, education regarding falls, and falling prevention exercises were provided. The fifth week featured refresher training and practice sessions for the home exercise program and lectures on fine hand movements and movements in daily life. In the ninth week, the home exercise program was completed again, and lectures on facial muscle movements and voice training were provided.

The patients in the SHE group voluntarily checked themselves using a photograph-based instruction brochure during the home exercise program. All programs were made available once a day at a regular time. After program completion, the number of sets (1-3) of each exercise performed was recorded in the self-checklist. In addition, the purpose and method of the self-checked monitoring home exercise program were explained to the caregivers, who were then asked to encourage the patients to complete the

Table 1. Differences in the intervention between the two groups.

Sortation	SHE group	GHE group
First session (1 week)	1. Home exercise education and practice ■ Four movements (sit down and stand up, push-up on the wall, leg lift while lying on the back, and hip lift while lying on the back) 2. Falling prevention education 3. Gait training(Floor step ladder walking training)	
Second session (5 weeks)	1. Home exercise education and practice ■ Four movements (sit down and stand up, push-up on the wall, leg lift while lying on the back, and hip lift while lying on the back) 2. Lectures on fine hand movements and movements in daily life 3. Gait training(Floor step ladder walking training)	
Third session (9 weeks)	1. Home exercise education and practice ■ Four movements (sit down and stand up, push-up on the wall, leg lift while lying on the back, and hip lift while lying on the back) 2. Lectures on facial muscle movements and voice training 3. Gait training(Floor step ladder walking training)	
For 1 to 12 weeks	▣ Provided ① Photograph-based instruction brochure regarding the home exercise program (four movements) ② Self-checklist ③ Caregivers education	▣ None provided

SHE: Self-checked monitoring home exercise, GHE: General home exercise

home exercise program actively. The patients in the GHE group performed the home exercise program but was not provided with information on such. Those in the SHE group attached stickers on the self-checklist in each set; conversely, the patients in the GHE group did not (Table 1).

Based on an exercise program to help with muscle strengthening, stretching, balance, and cardiovascular health in a previous study, the home exercise program herein consisted of four movements: sit down and stand up, push-up on the wall, leg lift while lying on the back, and hip lift while lying on the back. Each movement was performed 15 times over three sets, with a 1-minute break between sets and exercises (Figure 2). Before and after exercise, each joint (neck, shoulder, and back) was stretched for 5 minutes. Thereafter, indoor cycling was conducted for 20 minutes.

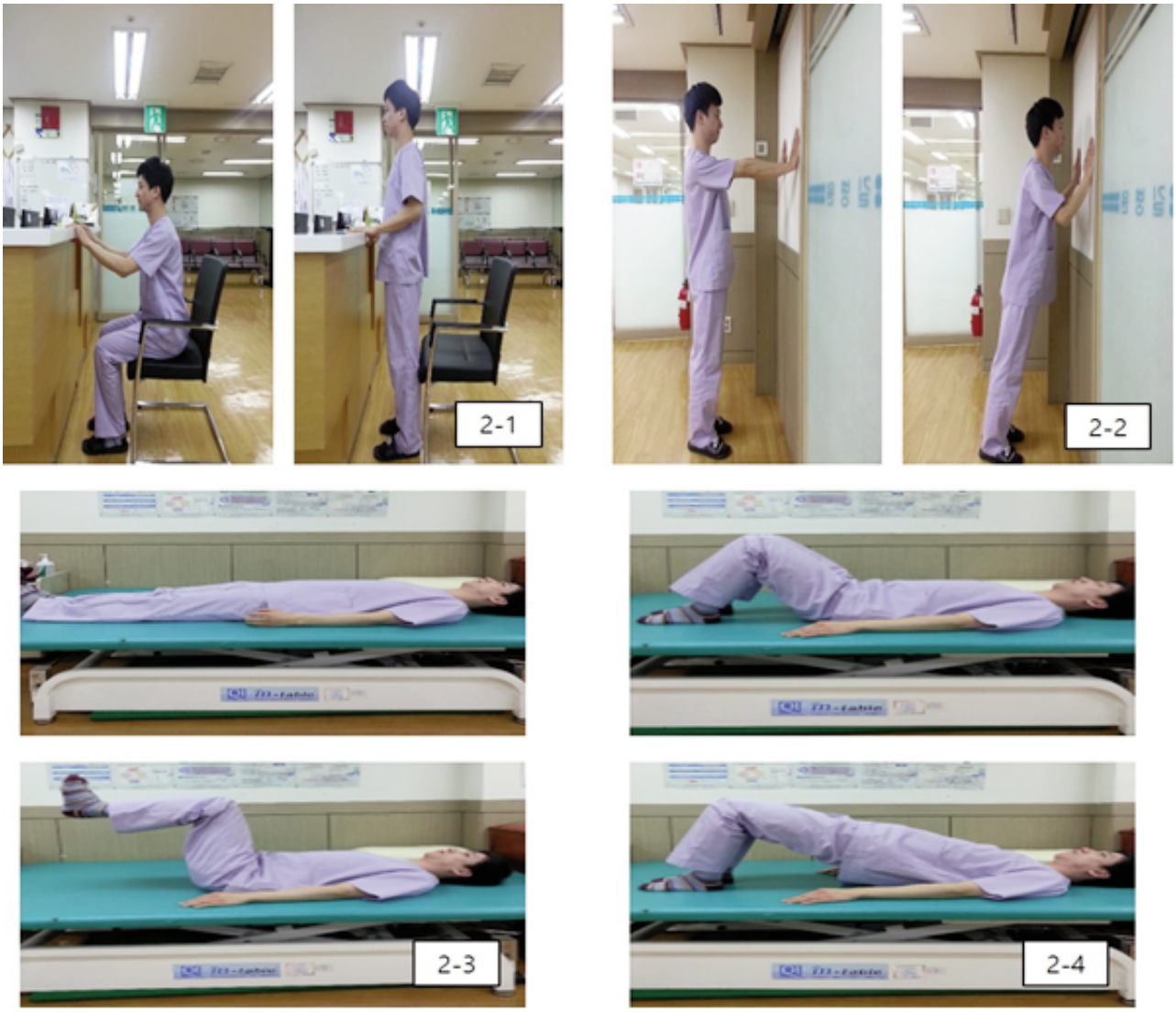

Figure 2. Home exercise program for the people with Parkinson's disease.
(1) Sit down and stand up;
(2) Push-up on the wall;
(3) Leg lift while lying on the back; and
(4) Hip lift while lying on the back.

Outcome measures

Measurement of gait ability

The 10 m walk test (10MWT) was performed, and the time required to travel 6 m (i.e., excluding the first and last 2 m) was recorded using a stopwatch (SEIKO, Seiko Instruments Inc., Japan).[12] The test-retest reliability for the 10MWT in people with PD was ICC(2,1)=.92, with an MDC95 of 0.22 m/s.[13]

Measurement of balance ability

The timed up and go (TUG) test proceeded as follows: The patients were first instructed to rise from a chair with armrests, walk for 3 m, turn around and return to the original position at a comfortable speed, and sit down on the chair. The time between the "start" signal and the patients sitting on the chair was recorded in seconds using a stopwatch (SEIKO, Seiko Instruments Inc., Japan).[14] The test-retest reliability for the TUG test in people with PD was $ICC_{(2,1)}$=.80, with an MDC_{95} of 3.5 s.[15]

The functional reach test (FRT) was able to predict the likelihood of falls in the elderly owing to the significant relationship between its outcomes and dynamic balance.[16] The patient is instructed to next to, but not touching, a wall and position the arm that is closer to the wall at 90 degrees of shoulder flexion with a closed fist. The assessor records the starting position at the 3rd metacarpal head on the yardstick. Instruct the patient to "Reach as far as you can forward without taking a step." The location of the 3rd metacarpal is recorded. Scores are determined by assessing the difference between the start and end position is the reach distance, usually measured in inches. Three trials are done and the average of the last two is noted. The test-retest reliability for the FRT in people with PD was $ICC_{(2,1)}$=.74, with an MDC_{95} of 11.5 cm.[17]

Measurement of strength

In the sit to stand (STS) test, the number of repetitions that the subjects were able to sit down on and rise from a chair (height: 45 cm, with armrests, no backrest) within 30 s was recorded.[18] The test-retest reliability for the STS test in people with PD was $ICC_{(2,1)}$=.94, with an MDC_{95} of three times.[19]

Measurement of performance of activities of daily living (ADLs)

The Korean version of the modified Barthel index (K-MBI) assesses the level of independence when performing basic ADLs as its evaluation criterion. The K-MBI has 10 items that cover personal hygiene, bathing, feeding, toilet use, stair climbing, dressing, bowel control, bladder control, walking, and chair/car and chair/bed transfer.[20]

Sample size estimation

An a priori power analysis was performed using the G*Power software (ver. 3.12; Franz Faul, University of Kiel, Kiel, Germany) on the data of a pilot study (SHE and GHE groups, both n=3). With a power of 80% and significance level of .05, a paired t-test determined the effect size to be .68. Both groups required 14 subjects; we recruited 15 subjects to each to take dropouts into account.

Statistical analysis

Data were analyzed using SPSS version 18.0 for Windows (SPSS Inc., Chicago, IL, USA). To compare the pre- and post-test data for the two groups, a repeated measures analysis of variance (2×2) with a between subject factor was used. To compare the pre- and post-intervention differences between the two groups, the paired t-test was used. Independent t-tests were performed to compare the pre- and post-test scores and the difference by time for the two groups. A p value of <.05 was considered to indicate a statistically significant difference.

RESULTS

There were no significant differences in the general baseline characteristics of the participants in the SHE and GHE groups (Table 2).

Gait ability

10MWT

There was a significant difference in the 10MWT scores before and after the exercise programs in both groups (P<.05) and in the 10MWT scores between the groups (P<.05) (Table 3).

Balance ability

TUG test

There was a significant difference in the TUG test scores in the SHE group before and after the exercise (P<.05); however, no significant difference was observed in the GHE group (Table 4).

Table 2. General characteristics of the two randomized groups.

	SHE group (n=15)	GHE group (n=15)	*P*
Sex (male/female)	7/8	7/8	1.00[a]
Age (years)	71.49 ± 3.14	71.43 ± 6.72	.95[b]
Height (cm)	158.50 ± 8.36	159.25 ± 7.18	.81[b]
Weight (kg)	58.50 ± 6.81	58.15 ± 13.59	.95[b]
Duration Parkinson's Disease (years)	5.64 ± 3.24	5.84 ± 2.47	.59[b]
Hoehn and Yahr scale grade	1.32 ± 2.02	1.20. ± 1.81	.59[b]

Data are expressed as means ± standard deviations.
SHE: Self-checked monitoring home exercise, GHE: General home exercise
[a]The *P* value was obtained using the χ^2 test- 〉 χ^2 test.
[b]The *P* value was obtained using independent t-tests.

Table 3. Pre- and post-program changes in gait ability.

		SHE group (n=14)	GHE group (n=12)	Intergroup (*P*)
10MWT (sec)	Pre	6.46 ± 2.22	7.56 ± 3.44	.001[b]
	Post	5.82 ± 2.13	7.38 ± 3.39	
	P	.001[a]	.003[a]	
	Post-Pre	-.64 ± 0.46	-.17 ± 0.23	

Values are presented as means ± standard deviations.
SHE: Self-checked monitoring home exercise, GHE: General home exercise,
10MWT: 10-m walk test
[a]*P*〈.05. The *P* value was obtained using a paired t-test
[b]*P*〈.05. The *P* value was obtained using an independent t-test

Anterior and posterior FRT

The anterior and posterior FRT scores were measured before and after the exercise. A significant increase was observed only in the SHE group (*P*〈.05).

The mean difference in the FRT scores before and after the exercise was significant between the two groups (*P*〈.05) (Table 4).

Strength of the lower limbs

STS test

The STS test score in the SHE group (*P*〈.05) significantly increased after the exercise in comparison with that before the exercise; however, this finding was not observed in the GHE group. The mean difference in the STS test score before and after the exercise was significant between the two groups (*P*〈.05) (Table 5).

Performance of ADLs

K-MBI

There was a significant difference in the K-MBI before and after the exercise in both groups (*P*〈.05). Further, there was a significant difference in the K-MBI between the groups (*P*〈.05) (Table 6).

Table 4. Pre- and post-program changes in balance ability.

		SHE group (n=14)	GHE group (n=12)	Intergroup (*P*)
TUG test (sec)	Pre	12.88 ± 3.66	16.42 ± 6.23	.094
	Post	12.23 ± 3.86	16.23 ± 6.37	
	P	.010[a]	.081	
	Post-Pre	-.64 ± 0.84	-.19 ± 0.34	
FRT (anterior) (cm)	Pre	16.15 ± 5.96	14.90 ± 5.66	.001[b]
	Post	19.00 ± 7.01	14.91 ± 5.18	
	P	.001[a]	.951	
	Post-Pre	2.85 ± 2.92	.01 ± 0.70	
FRT (posterior) (cm)	Pre	8.82 ± 5.97	8.41 ± 5.21	.021[b]
	Post	11.30 ± 7.12	8.49 ± 4.54	
	P	.024[a]	.767	
	Post-Pre	2.47 ± 3.50	.07 ± 0.83	

Values are presented as means ± standard deviations.
SHE: Self-checked monitoring home exercise, GHE: General home exercise, TUG: Time up-and-go, FRT: Functional reach test
[a]*P*<.05. The *P* value was obtained using a paired t-test
[b]*P*<.05. The *P* value was obtained using an independent t-test

Table 5. Pre- and post-program changes in muscle strength in the lower limbs.

		SHE group (n=14)	GHE group (n=12)	Intergroup (*P*)
STS test (number)	Pre	24.43 ± 6.81	21.75 ± 10.61	.020[b]
	Post	27.71 ± 7.05	22.33 ± 9.68	
	P	.001[a]	.370	
	Post-Pre	3.29 ± 3.36	.58 ± 2.19	

Values are presented as means ± standard deviations.
SHE: Self-checked monitoring home exercise, GHE: General home exercise, STS: Sit to stand
[a]*P*<.05. The *P* value was obtained using a paired t-test
[b]*P*<.05. The *P* value was obtained using an independent t-test

Table 6. Pre- and post-program changes in the performance of activities of daily living.

		SHE group (n=14)	GHE group (n=12)	Intergroup (*P*)
K-MBI (score)	Pre	77.86 ± 16.50	73.00 ± 20.24	.020[b]
	Post	85.21 ± 12.75	74.50 ± 20.74	
	P	.001[a]	.024[a]	
	Post-Pre	7.36 ± 6.83	1.50 ± 2.06	

Values are presented as means ± standard deviations.
SHE: Self-checked monitoring home exercise, GHE: General home exercise, K-MBI: Korean version of the modified Barthel index
[a]*P*<.05. The *P* value was obtained using a paired t-test
[b]*P*<.05. The *P* value was obtained using an independent t-test

DISCUSSION

The purpose of this study was to evaluate the effects of a home exercise program for people with PD who have a difficulty in performing ADLs and in receiving regular treatment at medical institutions because of serious deterioration of balance, cognitive impairment, depression, and other complications. To date, home exercises have been difficult to manage systematically because of the low rates of exercise performance and incorrect exercise performance. Thus, the present study attempted to create a table for patients to self-check themselves and overcome any limitations by educating them and their caregivers on a regular basis.

Muscle strengthening exercises can enhance motor function in patients with mild to moderate PD.[21,22] Further, a combination of intensive resistance training and balance training improved muscle strength and balance ability.[23] The present study showed that daily performance of muscle strengthening exercises for the upper/lower limbs and trunk, in addition to stretching exercises for all joints and periodic delivery of information on the exercises via monthly group meetings, significantly improved walking and balance abilities, muscle strength in the lower limbs, and performance of ADLs in people with PD.

White et al[24] reported that 6 weeks of interdisciplinary rehabilitation in people with PD improved walking activity (time spent walking and number of 10-second walking periods) in the home and community settings over a 24 hour period and endurance (the two-minute walk test) depending on baseline walking levels. In agreement with a previous study, we found that balance and gait ability improved in PD.

The TUG test score increased in the SHE group, but not in the GHE group, after the exercise. People with PD have a difficulty in walking, particularly turning.[25] Various specific exercises have been shown to be effective in improving the turning ability of people with PD. When gait training was performed at a constant constant speed in this study, the TUG test score did not change significantly; however, when performed at a gradually increasing speed, the TUG test score significantly improved.[26] This result suggests that progressive changes in task intensity improve walking and turning abilities. The present study focused on muscle strengthening exercises rather than exercises pertaining specifically to turning; this may explain why we did not detect any significant differences in the TUG test scores. In future studies, we plan to implement self-checked home exercise programs to improve the performance of ADLs in people with PD in the local community and their walking ability; the programs will focus on exercises specifically related to walking in different environments.

Ashburn et al[27] reported that a home based exercise program to reduce the risk of falling among people with Parkinson's disease. There was a positive effect of exercises at 6 months on Functional Reach and quality of life but, the Berg Balance Test, PD Self-assessment Scale, and the Euro Quol were not improved. These results were the same as the FRT in our study. In functional ability, we showed improvement in K-MBI but no difference in BBS from previous studies.

In a study that measured changes in balance and functional ability after using a program that can improve dynamic and static balance, strength, and endurance using Nintendo's wii-fit balance board for 6 weeks at home for Parkinson patients and the normal adults. The results of sit to stand test, time up and go test, and community balance and mobility assessment were statistically significant in both groups.[28] Another study, Parkinson patients were treated in groups (group exercise three times a week), individuals (three times a week for one-on-one patients and therapists), and home (therapist's education and precautionary handouts). As a result, there was a statistically significant improvement in physical function and balance in the one-person group, an improvement in walking ability in the group program, and all measured in the home group.[7]

Rehabilitation exercise programs are created to improve the functional abilities of patients with diverse diseases using various methods.[26,29] Exercise programs can improve the functional ability of patients and their speed of return to ADLs. However, not all exercise programs guarantee an improvement in abilities; in some cases, the same exercise program can produce different outcomes in different individuals. A study of subjects with turtle neck syndrome showed that when materials pertaining to and self-checked programs for muscle strengthening and stretching exercises were provided to subjects to help them complete the exercises at home, there were significant positive effects[29] that were not observed in a study without a self-checked program.[30] Further, a group of patients with knee osteoarthritis who completed an exercise program in a hospital and self-checked exercises at home using a photograph-based instruction brochure and audio and video feedback materials achieved significant exercise effects.[31] It is difficult to conclude that the exercises alone were responsible for the functional changes in the patients in our study. However, previous studies have demon-

strated that patients need exercises that can be performed at home, in addition to treatment received at the hospital; furthermore, exercise programs with a self-checked element that are completed under the management and supervision of medical institutions have a positive effect. Many previous studies have suggested that home exercises for people with PD have positive effects on body function; however, there has been limited research showing increased rates of performance of home exercises. The results of the present study suggest that consistent execution of home exercise programs including a self-checked element may greatly facilitate enhancement of the functional abilities of people with PD.

The main limitation of this study is that the long term effects of the self-checked monitoring home exercise program were not monitored. Therefore, the long term effect of increasing such training in people with PD should be determined in a future study. Another limitation is the relatively small number of subjects.

CONCLUSION

The results of this study suggest that a self-checked monitoring home exercise program can help people with PD to avoid the need for, and therefore the limitations associated with, outpatient treatment; thus, their functional ability can be improved through consistent performance of safe exercises.

CONFLICT OF INTEREST

The authors declare no conflicting interests.

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