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ORIGINAL REPORT

REPETITIVE STEP TRAINING WITH PREPARATORY SIGNALS IMPROVES STABILITY LIMITS IN PATIENTS WITH PARKINSON'S DISEASE

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Objective: **To examine the effects of repetitive volitional and compensatory step training with preparatory signals on the limits of stability, postural and gait skills, and spatiotemporal gait characteristics in patients with Parkinson's disease with no falls during the previous 12 months.**
Design: **Randomized clinical trial with assessor blinded to group assignment.**
Subjects: **Twenty-eight patients with Parkinson's disease with no falls during the previous 12 months.**
Methods: **Eligible patients were randomly assigned to an experimental group, which undertook repetitive step training with preparatory visual cues, or a control group, which undertook lower limb strength training for 4 weeks. Outcome measures included limits of stability test, postural and gait sub-scores from Unified Parkinson's Disease Rating Scale motor score (UPDRS-PG), and spatiotemporal gait characteristics. All tests were conducted before and after training at patients' peak medication cycle.**
Results: **The experimental group showed significant improvements in reaction time, movement velocity, and endpoint excursion of limits of stability, as well as UPDRS-PG score and stride length ($p < 0.05$), compared with the control group. Both groups significantly increased gait velocity ($p < 0.05$).**
Conclusion: **Repetitive step training with preparatory cues can enhance limits of stability, postural and gait skills and spatiotemporal gait characteristics in patients with Parkinson's disease with no falls during the previous 12 months.**

Key words: Parkinson's disease; balance; gait; visual cues; rehabilitation.

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INTRODUCTION

Postural instability and falls are complex and disabling features of Parkinson's disease (PD). Falls occur in 40–70% of patients with PD (1), 29% of whom have not previously experienced falls (2). Repeated falls can have devastating outcomes, such as fractures and fear of future falling, which in turn lead to physical deconditioning, functional restriction and early institutionalization (3). A history of falls has been found to be a strong predictor of future falls (1). Therefore fall prevention should be implemented as early as possible, preferably prior to the first fall.

Limit of stability (LOS) is one dimension of the postural control system, which is found to be impaired in patients with early PD, as indicated by Hoehn and Yahr stage I–II (4, 5) and in PD patients with normal "pull test" results (6). LOS can be defined, under dynamic conditions, as "the maximum displacement of the body's centre of gravity (CoG) over a fixed base of support of the feet without losing balance" (7). Statically holding the body CoG near the limits of foot support simulates functional positions that occur in fall-prone motor tasks, such as reaching in standing, gait initiation and transition from sitting to standing (8, 9). Therefore, enhancement of LOS may be important to reduce fall risks for patients with PD even with no fall history.

To our knowledge, two studies have explored the effects of training on LOS in patients with PD, but the findings are inconsistent. Jöbges et al. (10) found no improvement in LOS after repetitive step training in response to pulls and pushes. Qutubuddin et al. (11) used posturography-based step training and reported increases in LOS parameters, but LOS gains were also found in the physical therapy (control) group. These findings suggest that repetitive step training alone may not be better than conventional therapy in enhancing LOS in patients with PD (10, 11).

The use of preparatory visual cues has been found to increase the speed of sit-to-stand transfer (12) and to shorten the reaction time of gait initiation (13). However, it is not known whether preparatory cued step training could enhance LOS in patients with PD. In the present study we designed an innovative treatment strategy that included volitional and compensatory step training in response to preparatory cues. The primary objective of the study was to examine whether repetitive step training with preparatory cues enhances the LOS, postural and gait skills, and spatiotemporal gait characteristics in people with PD without falls in the previous 12 months. Our secondary objective was to investigate the association between LOS parameters and spatiotemporal gait characteristics.

METHODS

Subjects

This is a randomized controlled trial with assessor blinded to the group assignment. Subjects were recruited from the Hong Kong Parkinson's Disease Association, a patient self-help group and the Movement Disorder Clinic at Tung Wah Hospital in Hong Kong. This project was

approved by the ethics committees of The Hong Kong Polytechnic University and Hospital Authority Hong Kong West Cluster. A total of 29 patients were recruited. They were diagnosed with PD by neurologists (14), stable on anti-Parkinsonian medications, able to walk independently for 10 metres, able to follow instructions, and had no falls during the previous 12 months. Patients were excluded if they had other neurological conditions, uncompensated cardiovascular disease, visual disturbance or recent musculoskeletal disorder in the back or lower limbs that would interfere with balance and locomotion (Fig. 1). A fall was defined as "any unexpected event that caused the person to unintentionally land on any lower surface (object, floor or ground), regardless of any sustained injury" (15).

Sample size calculation

The sample size calculation was based on the improvement in the endpoint excursion of LOS reported by Qutubuddin et al. (11). Their findings yielded a Cohen's *d* effect size of 0.8 (11). By assuming 5% type I error (alpha value), 80% power (beta level = 20%) and with pooled SD of 13.8%, the estimated sample size was 13 patients in each group, with a total of 26 patients required (16). To allow a 10% drop-out rate during the study, 29 patients with PD were recruited. All patients in our study were randomly assigned (by drawing lots) to one of two groups: a repetitive step training group (EXP, $n = 15$) or a strength training group (CON, $n = 14$). Randomization was overseen by a researcher who did not participate in any other aspect of the study. All patients provided written informed consent prior to data collection.

Outcome measures

All patients were tested at their peak medication cycle (i.e. within 2 h after taking their anti-Parkinsonian medications), and by a physiotherapist who was blinded to the group assignments (Fig. 1). Demographic data including gender, age, body height, duration of PD, severity of PD per modified Hoehn and Yahr (H&Y) staging score (4) and level of physical activity as determined by a metabolic equivalent (MET) questionnaire (17), were recorded. In addition, the daily levodopa dosage of subjects was recorded. Outcome measures consisted of limits of stability as determined by the LOS test, Unified Parkinson's Disease Rating Scale posture and gait sub-score (UPDRS-PG), spatiotemporal gait characteristics, and number of falls within the study period. The LOS test assesses the ability of an individual to initiate voluntary weight shifting to different spatial positions within the base of support without losing stability (11, 18). The LOS test was performed with the Smart-EquiTest Balance Master (NeuroCom International Inc., Clackamas, USA). Patients were instructed to move their body centre of gravity as quickly, accurately and as far as possible towards 8 pre-selected targets in response to a start cue. The feet position on the forceplate of each subject was standardized according to subject's body height, and the distance between the left and right lateral malleoli of the feet was measured as stance width. LOS parameters included reaction time (s), movement velocity (°/s), and endpoint excursion (% maximum LOS). Reaction time is the time measured from the presentation of a start cue to the onset of the voluntary shifting of the subject's CoG toward the target position (19). Endpoint excursion is the displacement of CoG during the primary attempt toward the designated target, expressed as a percentage of the maximum LOS. The endpoint is defined as the point at which the initial movement toward the target stops and the subsequent correction starts. Movement velocity is the mean speed of CoG during endpoint excursion movement (19). All subjects had 1 practice trial followed by 1 test trial.

A posture and gait sub-score from the UPDRS motor score (UPDRS-PG) was used to quantify postural and gait skills in patients with PD (20). The UPDRS-PG includes items 27–30 of UPDRS, namely rising from a chair, standing posture, gait, and postural stability, as tested by retropulsion test. The UPDRS-PG score ranges from 0 to 16, with a higher score indicating greater postural instability and gait impairment.

For spatiotemporal gait characteristics, patients were instructed to walk at their comfortable speed along a 5-metre instrumented and computerized GAITRite walkway (CIR Systems Inc., Havertown, PA, USA). Gait velocity (cm/s), stride length (cm), and cadence (steps/min) were recorded. There was 1 practical trial followed by 3 test trials and the mean values were used for data analysis.

In addition, the number of falls within the treatment period was recorded to explore whether training with large and rapid steps and with external perturbation would increase the risk of falls in subjects with PD. All tests with exception of fall incidence were conducted before and after the 4-week treatment period.

Interventions

Patients in both repetitive step training (experimental group; EXP) and strength training (control group; CON) groups received training for 4 weeks at a frequency of 3 times per week. Patients in the EXP group were trained to improve speed and amplitude of volitional stepping, as well as stepping response to perturbations (Appendix I). Training on the speed of voluntary stepping was provided by means of a computerized dancing

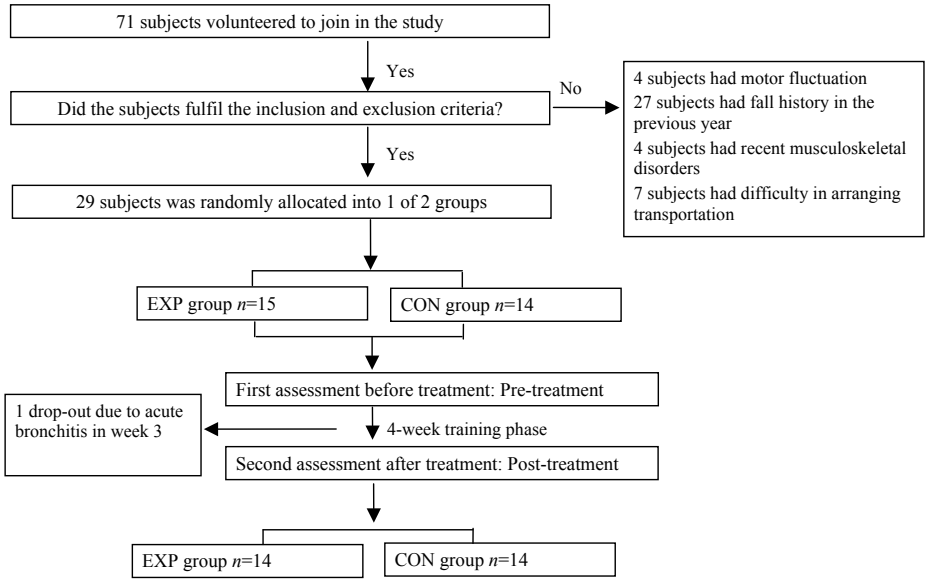

Fig. 1. Recruitment of study participants. EXP: experimental group; CON: control group.

system (KSD Technology Co. Ltd, Shenzhen, China), which consists of specific dancing software and a pressure-sensitive carpet. Patients were instructed to stand on the middle of the carpet and to look at the computer screen. In response to preparatory visual cues, patients had to step to 1 of the 4 directions (forward, backward, left or right) at a preset speed. The visual cues provided advance information about the speed and direction of the step. The training session lasted for 15 min. Training to increase step amplitude was provided with the use of the Smart-EquiTest Balance Master. Patients were instructed to stand on 1 end of a 45 × 150 cm force plate connected to a computer. A red cursor (2 × 2 cm) on the computer screen provided information about target step length. When the cursor colour changed from red to yellow, patients rapidly had to take a large step to bring their body CoG towards the cursor and to stay in the stride position until the colour of the cursor returned to red, and patients would return to their original starting position. The frequency with which the cursor colour changed from red to yellow determined the step time, and the position of the cursor on the screen determined the step amplitude. Patients had to complete the step training in 4 directions (forward, backward, left and right). The training lasted for 15 min.

A treadmill was used to train the step response to "predictable" perturbations (i.e. the direction of perturbation was known to the patients) (21). Patients initially wore a harness for safety and stood on the treadmill belt in 4 different starting positions: facing towards, backward to, left or right to the control panel of the treadmill. This allowed the patients to walk in 4 directions on the treadmill (forward, backward, sideways to the left and right). Patients were instructed that when the treadmill was turned on, they had to take as large and rapid a step as possible and continue walking on the treadmill. In response to the treadmill stopping suddenly, patients were to take a large step to stabilize their body in a standing position. The interval between sudden switching on and off of the treadmill was approximately 30 s. No advance warning was given to subjects before the treadmill was started or stopped. Patients completed walking in the 4 directions in approximately 25 min.

Patients in the CON group underwent strength training of the hip muscles (flexion, extension, abduction) and knee muscles (flexion, extension) using dynamometers and leg-press machines (Appendix I). The initial resistance of each exercise was set at 60% of 1 repetition maximum, and 2 sets of 15 repetitions were performed during each session. In addition, a rowing machine, 6-inch curb and 1–1.5 kg sandbag were used to strengthen the leg muscles, including hip, knee and ankle muscles, by functional movements. Patients were required to complete each exercise within 3 min. The duration of strength training in the CON group was approximately 60 min, which was similar to that in the EXP group. Details of the training programme and the progression of both the EXP and CON groups are shown in Appendix I.

Data analysis

Data were analysed with the Statistical Package for Social Sciences (SPSS, version 17.0). The Shapiro-Wilk test was used to evaluate data normality of variable within each group at each assessment interval. For variables without normal distribution, non-parametric tests were used for statistical analysis, including the χ^2 test to analyse gender differences between groups, the Wilcoxon test to analyse treatment effects in each group, and the Mann-Whitney *U* test to analyse group differences at each assessment interval. For variables with normal distribution, parametric tests were used for statistical analysis, including *t*-tests to analyse group differences in demographic variables. Two-way repeated measures analysis of variance (ANOVA) was used to analyse the treatment effect, with time (pre- and post-treatment) as a within factor and groups (EXP and CON) as a between factor. In the case of an interaction being found, post-hoc t-tests were used to determine the significant between- and within-group differences. The significance level was set at 5%.

RESULTS

One patient in the EXP group did not complete the training due to acute bronchitis. Therefore, data for 14 patients in each group were analysed (Fig. 1). There was no significant difference between the EXP and CON groups for the demographic data (gender, age, body height, stance width between the two feet), duration of PD, severity of PD indicated by H&Y staging score, daily levodopa dosage, and physical activity level (Table I). Neither were there any differences in the pre-treatment test scores between the two subject groups (Table II). None of the patients underwent any change in medication during the study period. Furthermore, there was no group difference in exercise compliance (EXP 100%, CON 97%, $p > 0.05$).

Within the EXP group, there were significant increases in LOS – movement velocity (by 43%) and LOS – endpoint excursion (by 13%), as well as a significant decrease in LOS – reaction time (by 18%). In contrast, there was no significant change in the LOS test results in the CON group after 4 weeks of treatment. The post-pre comparisons between groups revealed the EXP group improved significantly more in LOS – reaction time and LOS – movement velocity than the CON group ($p < 0.05$). In addition, the UPDRS-PG score, only decreased significantly in the EXP group (by 30%), implying an improvement in postural stability and gait skills. For the spatiotemporal gait characteristics, there was no time × group interaction for gait velocity ($p = 0.784$), close to significant interaction for stride length ($p = 0.090$), and significant interaction for cadence ($p = 0.007$). At the end of the 4-week training, gait velocity increased significantly by 5% in the EXP group and by 6% in the CON group ($p < 0.05$). Stride length increased significantly (by 8%) in the EXP group, whilst cadence increased significantly (by 4%) in the CON group. In addition, no patient in the EXP group reported any fall during the training period, but a CON subject sustained one fall at home when he put on his pants in a single-leg-standing position.

We further found that, for the EXP group, the gait velocity had a moderate correlation with LOS – reaction time ($r = –0.536$) and LOS – movement velocity ($r = 0.557$), and a strong correlation with LOS – endpoint excursion ($r = 0.855$) (Table III). Stride length was moderately correlated with LOS – movement velocity ($r = 0.686$) and strongly correlated with LOS – endpoint excursion ($r = 0.835$) (Table III). No significant association was found for the CON group.

Table I. *Subject characteristics*

	EXP ($n = 14$)	CON ($n = 14$)	*p*-values
Gender (M:F)[a]	9:5	7:7	0.588
Age, years, mean (SD)	63.0 (8.5)	66.5 (8.6)	0.326
Body height, cm, mean (SD)	161.3 (8.8)	161.8 (10.5)	0.917
Stance width between 2 feet during LOS test, cm, mean (SD)	27.5 (1.9)	27.8 (2.1)	0.676
PD duration, years, mean (SD)	7.1 (3.2)	5.8 (2.2)	0.278
H&Y stage (0–5,) mean (SD)	2.2 (0.5)	2.3 (0.5)	0.832
Daily levodopa dosage, mg, mean (SD)	267.0 (177.2)	289.3 (249.7)	0.787
Physical activity level (METs), mean (SD)	3.5 (0.0)	3.5 (0.0)	1.000

[a]χ^2 test.

H&Y: Hoehn andYahr; MET: metabolic equivalent; 1 MET = 1 kcal/min = 3.5 ml/kg/min; SD: standard deviation; M: male; F: female; PD: Parkinsons's disease; EXP: experimental group; CON: control group.

Table II. *Comparison of outcome measures between experimental (EXP) and control (CON) groups*

	EXP (n=14) Mean (SD)	CON (n=14) Mean (SD)	p[b]
Limit of stability[a]			
Reaction time (s)			
Pre	1.1 (0.3)	1.0 (0.2)	0.646
Post	0.9 (0.3)	1.1 (0.3)	0.154
Post–pre	–0.2 (0.3)	0.1 (0.2)	0.007**
p[c]	0.048*	0.221	
Movement velocity (°/s)			
Pre	2.8 (1.3)	3.6 (1.5)	0.168
Post	4.0 (1.2)	3.5 (1.7)	0.154
Post–pre	1.2 (1.3)	–0.2 (1.4)	0.013*
p[c]	0.008**	0.363	
Endpoint excursion (%LOS)			
Pre	58.0 (16.6)	63.3 (11.4)	0.291
Post	65.5 (15.0)	65.2 (11.9)	0.713
Post–pre	7.5 (10.1)	1.9 (8.1)	0.215
p[c]	0.026*	0.379	
UPDRS-PG (/16)[a]			
Pre	4.0 (1.2)	4.2 (1.5)	0.603
Post	2.7 (1.4)	3.3 (1.9)	0.376
Post–pre	–1.2 (1.9)	–0.8 (1.9)	0.511
p[c]	0.044*	0.085	
Walking test			
Gait velocity (cm/s)			
Pre	100.2 (8.4)	97.5 (13.6)	0.545
Post	104.8 (18.3)	103.4 (17.8)	0.545
Post–pre	4.6 (12.9)	5.8 (10.5)	0.730
p[c]	0.027*	0.027*	
Stride length (cm)			
Pre	112.7 (13.0)	114.7 (15.6)	0.479
Post	121.9 (18.1)	117.0 (18.1)	0.720
Post–pre	9.2 (12.2)	2.3 (8.0)	0.090
p[c]	0.014*	0.302	
Cadence (steps/min)			
Pre	106.2 (8.9)	103.0 (9.9)	0.314
Post	103.6 (7.6)	107.0 (9.7)	0.429
Post-Pre	–2.6 (5.4)	4.0 (6.6)	0.007**
p[c]	0.093	0.004**	

*p<0.05, **p<0.01.
[a]Non-parametric tests; [b]Comparison between EXP and CON group; [c]Comparison between pre- and post-treatment.
Interaction (time × group): gait velocity, p=0.784; stride length, p=0.090; cadence, p=0.007**.

Table III. *Relationship between limits of stability (LOS) and Unified Parkinson's Disease Rating Scale motor score (UPDRS-PG) and spatiotemporal gait variables in the experimental (EXP) group*

	LOS – reaction time	LOS – movement velocity	LOS – endpoint excursion
UPDRS-PG	r=0.298	r=–0.389	r=–0.489
	p=0.301	p=0.159	p=0.076
Gait velocity	r=–0.536*	r=0.557*	r=0.855**
	p=0.048	p=0.038	p=0.000
Stride length	r=–0.504	r=0.686**	r=0.835**
	p=0.066	p=0.007	p=0.000
Cadence	r=–0.296	r=0.048	r=0.215
	p=0.304	p=0.871	p=0.460

*p<0.05, **p<0.01.

DISCUSSION

To the best of our knowledge, this is the first study to show that 4-week repetitive step training using preparatory cues enhances LOS, postural and gait skills and spatiotemporal gait characteristics in people with PD.

In the present study, LOS improved only in patients in the EXP group, as reflected by the significant changes in reaction time, movement velocity and endpoint excursion. The results of the present study are in contrast to Jöbges et al. (10) and partly in agreement with those reported by Qutubuddin et al. (11). Variations in the findings could not be related to measurement protocol, since all studies, including ours, employed the Balance Master to measure the LOS parameters (10, 11). Although Qutubuddin et al. (11) reported an improvement in LOS, they failed to reveal a between-group difference for all LOS variables whilst we demonstrated that EXP group had significantly more improvements in LOS – reaction time and LOS – movement velocity than control subjects. Since the subjects in the study by Qutubuddin et al. (11) received only volitional step training, our pre-cued compensatory and volitional step training may be more effective in enhancing LOS.

Postural strategies of LOS have been found to comprise a postural preparatory and an executive phase (22, 23). Postural preparation or anticipatory postural adjustment (APA) enables a person to achieve the stability limits with short latency responses and fast speed (23). Reduced LOS in persons with PD has been attributed to impaired APA as well as deficits in movement execution (23). The use of preparatory visual and instructional cues could have facilitated the postural preparation of the stepping tasks, because PD patients have the capacity to use advance information to improve motor preparation (24, 25). The enhancement of postural preparation could have led to a shortened reaction time and increased movement speed during LOS test (22). APA has been found to stabilize the body CoG over the stance limb in preparation for a voluntary step (26), and pre-programme the step response to minimize the influence of predictable perturbation on postural stability (27). The practice of both voluntary stepping and treadmill-based stepping response to "known" directions of perturbation could have facilitated APA and leads to increased LOS in EXP subjects. Further studies using electromyography or force plates are needed to confirm the changes of APA after step training. Apart from poor postural preparation, patients with PD are known to have bradykinesia, which impairs the execution phase of stability limit. All 3 of our stepping tasks required patients to shift their CoG repeatedly in a rapid, accurate and stable manner. The intensive practice could have helped to push the patients' body CoG to greater stability limits, leading to improvements in movement speed and endpoint excursion during the LOS test (18).

The CON group focused on strengthening the muscles of lower extremities, since impaired leg muscle strength has been found to be associated with postural instability and gait difficulty (28, 29). We adopted the training protocol that has been found to improve posture, balance and gait of individuals with PD (30, 31) and older individuals (32, 33). Progression was made at the end of the second week by increasing the resistance

determined by subjects' 1 repetition maximum. Given that the EXP subjects could progress in each treatment session, the less frequent training progression in the CON group could partly contribute to a lack of LOS change. In addition, training in CON group emphasized increasing muscle strength, whilst the EXP group focused on increasing the speed and amplitude of steps and weight shifting to subjects' postural stability limits. The specificity of our step training programme could explain why the EXP group outperformed the CON group in LOS outcomes.

The slower and smaller LOS of patients with PD may have been related to the perceived difficulty of moving their CoG towards the targets during the LOS test (34). During training, patients in the EXP group progressed to perform volitional stepping from slow to fast speed and from small to large amplitude as well as step response to perturbation in a more timely and stable manner. The improved motor performance could have increased patients' self confidence and hence increased their LOS. In addition to LOS, the improvement of UPDRS-PG was found only in patients of the EXP group, indicating that they had better postural stability and gait performance. The enhancement of LOS could have facilitated the stability performing fall-prone functional activities, such as sit-to-stand and walking, and this might reduce their fall risk (35).

Gait speed increased significantly after training in both subject groups. The increase in gait speed in the CON group could be related to strength and functional training, as previously reported (31, 36). The increase in gait speed in the EXP group also concurs with previously reported findings resulting from training with volitional stepping or step response to perturbation as we did (10, 21, 37). The associations between LOS variables and gait velocity and stride length in the EXP subjects suggest that a larger LOS could contribute to better gait performance. The increase in gait velocity by 5 cm/s in both groups was similar to that reported in a recent meta-analysis of 747 patients with PD (38), and this increase has been shown to be clinically meaningful in older adults (39). We further noted that stride length increased significantly only in our EXP group patients. The 9 cm increase in stride length in our EXP group was much larger than the 3 cm increase reported in the fore-mentioned meta-analysis study (38). Our focus on increasing the step amplitude in the EXP group could have alleviated their bradykinetic movements associated with PD. These findings suggest that both repetitive step training and strength training translate to better walking performance in patient with PD.

We were concerned whether step training at fast speed and with external perturbation would increase the risk of falling, therefore we recorded any adverse events or fall incidence during the training period. There was no fall recorded in the both subject groups during training, but one subject in the CON group fell at home. The finding suggests that preparatory cued step training may be safe and feasible for persons with PD.

The present study had several limitations. First, the sample size was small, and all patients were community-dwelling, with mild to moderate disease, and none had fallen in the previous 12 months. Therefore, its results cannot be generalized to patients with a fall history, patients with advanced-stage PD or patients who are institutionalized. Secondly, the EXP subjects received volitional step training and LOS assessment using the Balance Master. Although the set-up and protocol of step training were different from those of assessment, familiarity with the instrument might have contributed to better LOS. Thirdly, we employed an active control group so that both subject groups received similar duration of treatment intervention and similar amount of supervision by therapists. However, the lack of a non-treatment group could not answer whether our treatment would benefit the patients over and above the change of the disease over time. Fourthly, we assessed the patients immediately after treatment. The lack of follow-up assessments did not allow us to examine the long-term effects of our training programme. Nevertheless, the positive results of this randomized controlled trial support the establishment of a large-scale study with a larger sample size, a longer treatment period and a longer follow-up period.

In conclusion, both preparatory cued repetitive step training and strength training improve spatiotemporal gait characteristics in PD non-fallers. However, only repetitive step training with preparatory cues improves limits of stability, postural and gait skills. The positive results of this randomized controlled trial provide evidence for the use of repetitive step training with preparatory cues to enhance limits of stability, postural and gait skills as well as spatiotemporal gait characteristics in PD non-fallers.

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APPENDIX I. Training protocols for experimental (EXP) and control (CON) groups

Group	Training components and progression
EXP	Voluntary stepping with the computerized dancing system 8 trials/session Difficulty level: 1–8 by reducing step time Start with level 1 and progress to a higher level when subjects achieved 80% accuracy for 2 consecutive trials Voluntary stepping with the Smart-Equitest Balance Master 1 trial in each of the 4 directions Difficulty level: 1–8 by reducing the step time and increasing the step amplitude Start with level 1 and progress to a higher level when subjects performed without any physical assistance and achieved over 80% of accuracy for both step time and amplitude Stepping response to perturbation with treadmill 10 trials in each of the 4 directions, 40 trials/session Difficulty level: from subjects' baseline walking speed to highest tolerated walking speed at 0.2 km/h increase at each interval Progress to a faster walking speed when subjects respond rapidly to perturbation with large steps and good stability
CON	Strength training of the hip and knee muscles using dynamometers and leg-press machines Two sets of 15 repetitions for each muscle group Difficulty: 60% of one repetition maximum Progression: One repetitive maximum was re-assessed after 2 weeks of training Strength training of leg muscles using functional movements Hip and knee extensions using a rowing machine Repetitive stepping on and off a 6-inch curb Overground walking with a 1–1.5 kg sandbag strapped to each ankle Duration: 3 min for each exercise Progress to have more repetitions within the pre-set duration