

ORIGINAL ARTICLE

Impaired Executive Function Can Predict Recurrent Falls in Parkinson's Disease



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Abstract

Objective: To examine whether impairment in executive function independently predicts recurrent falls in people with Parkinson's disease (PD).

Design: Prospective cohort study.

Setting: University motor control research laboratory.

Participants: A convenience sample of community-dwelling people with PD (N=144) was recruited from a patient self-help group and movement disorders clinics.

Interventions: Not applicable.

Main Outcome Measures: Executive function was assessed with the Mattis Dementia Rating Scale Initiation/Perseveration (MDRS-IP) subtest, and fear of falling (FoF) with the Activities-specific Balance Confidence (ABC) Scale. All participants were followed up for 12 months to record the number of monthly fall events.

Results: Forty-two people with PD had at least 2 falls during the follow-up period and were classified as recurrent fallers. After accounting for demographic variables and fall history ($P=.001$), multiple logistic regression analysis showed that the ABC scores ($P=.014$) and MDRS-IP scores ($P=.006$) were significantly associated with future recurrent falls among people with PD. The overall accuracy of the prediction was 85.9%. With the use of the significant predictors identified in multiple logistic regression analysis, a prediction model determined by the logistic function was generated: $Z = 1.544 + .378$ (fall history) $- .045$ (ABC) $- .145$ (MDRS-IP).

Conclusions: Impaired executive function is a significant predictor of future recurrent falls in people with PD. Participants with executive dysfunction and greater FoF at baseline had a significantly greater risk of sustaining a recurrent fall within the subsequent 12 months.

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Falls are common among people with Parkinson's disease (PD), with a high fall incidence of 40% to 70% in this population.¹ A long-term prospective study² further reported an alarming 87% fall rate over a 20-year research period. Of the patients who had experienced a fall, 35% sustained fractures.² In addition to physical injuries, PD fallers also experience adverse psychological effects that can lead to functional restrictions, physical deconditioning, and an increased risk of institutionalization.² The identification of factors leading to falls has thus received considerable attention in recent years.

Several prospective studies have identified the fall-related risk factors in PD. The significant physical fall risk factors include postural instability,³ PD-specific impairment,⁴ gait freezing,⁵⁻⁷ and

prolonged timed Up and Go.⁶ Self-perceived fear of falling (FoF) has been found to be strongly associated with falls and reduced quality of life in people with PD.^{4,8} Cognitive impairment such as impaired selective attention has been associated with increased postural instability and fall frequency.⁹ Dementia and impaired fronto-executive function have been found to predict future falls in the PD population.⁵ Executive function is an umbrella term that encompasses a host of higher cognitive abilities required to successfully perform goal-directed activities such as walking. Impaired executive function is a common cognitive feature of PD.¹⁰ Executive dysfunction may disrupt individuals' organization abilities and performance of purposeful actions,¹¹ and it is associated with increased gait variability and reduced gait speed during dual-task walking.¹² Hence, impaired executive function may increase the risk of falling. Previous studies^{13,14} have indeed found that impaired executive function predicts future falls in

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community-dwelling older adults. To date, however, the association between executive dysfunction and falls has not been examined in people with PD. To address this research gap, this study adopted a 1-year prospective design to determine whether impaired executive function predicts recurrent falls in individuals with PD.

Methods

Participants

A total of 170 community-dwelling individuals with PD volunteered for the study, with 144 of them completing it (fig 1). Subjects were recruited from the Hong Kong Parkinson's Disease Association, a local patient self-help group, and the movement disorder clinics of 2 local hospitals. All participating patients had idiopathic PD diagnosed by a neurologist.¹⁵ To be included in the study, patients were required to be older than 40 years, medically stable, and able to walk 6m at least 3 times with or without an assistive device. Patients were excluded if they had a neurologic condition other than idiopathic PD; a Mini-Mental State Examination score <24;¹⁶ postural hypotension, visual disturbance or vestibular dysfunction affecting balance; and/or a significant cardiovascular or musculoskeletal disorder limiting locomotion or balance. Informed consent was obtained from all subjects in accordance with the 1964 Declaration of Helsinki. The experimental procedure and use of human subjects were approved by the ethics committees and institutional review boards of the university and hospitals involved.

Procedure

All assessments were carried out at the university's motor control research laboratory, with all subjects tested during the "on" phase of the anti-Parkinsonian medication cycle. Each subject underwent baseline measurements and a prospective assessment of falls.

Baseline measurements

Demographic and clinical data, including age, sex, time since PD diagnosis, and daily levodopa dosage, were recorded. Disease severity and PD-specific motor impairment and disability were assessed by the Hoehn and Yahr (HY) staging scale¹⁷ and the Unified Parkinson's Disease Rating Scale Motor Examination (UPDRS-III), respectively.¹⁸ Depressive symptoms were measured by the Chinese version of the short-form Geriatric Depression Scale (GDS),¹⁹ which contains 15 items eliciting a "yes" or "no" response. The GDS score ranges from 0 to 15, with

List of abbreviations:

ABC	Activities-specific Balance Confidence
FoF	fear of falling
FOGQ	Freezing of Gait Questionnaire
GDS	Geriatric Depression Scale
HY	Hoehn and Yahr
MDRS-IP	Mattis Dementia Rating Scale—Initiation/Perseveration
Mini-BESTest	Mini-Balance Evaluation Systems Test
PASE	Physical Activity Scale for the Elderly
PD	Parkinson's disease
RF	recurrent faller
UPDRS-III	Unified Parkinson's Disease Rating Scale Motor Examination

170 patients volunteered



23 patients were excluded

- History of stroke (n=3)
- Severe arthritis (n=5)
- Leg or lower back pain (n=10)
- MMSE < 24 (n=5)



147 patients included



3 patients lost to follow up
- 2 died and 1 moved to live in the mainland



144 patients completed 12-month follow-up

Fig 1 Flow chart of PD subject selection procedure. Abbreviation: MMSE, Mini-Mental State Examination.

a score >6 suggestive of clinical depression. Fall history was obtained in patient interviews and was recorded as the number of fall events in the past 12 months.⁷ A fall was defined as an event other than a major intrinsic event (eg, syncope, stroke, seizure) or overwhelming hazard, during which the subject came to rest on the ground or at some lower level.²⁰

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