



## Reliability and Minimal Detectable Change for Sit-to-Stand Tests and the Functional Gait Assessment for Individuals With Parkinson Disease

Cheryl Petersen, PT, DPT, DHS<sup>1</sup>; Teresa Steffen, PT, PhD<sup>2</sup>;  
Elizabeth Paly, PT, DPT, GCS<sup>1</sup>; Leah Dvorak, PhD<sup>1</sup>; Reid Nelson, PhD<sup>1</sup>

### ABSTRACT

**Background and Purpose:** This study examined test-retest relative (intraclass correlation coefficient [ICC]) and absolute (minimum detectable change [MDC]) reliabilities for the 5 times sit-to-stand (5×STS), 30-second sit-to-stand (30sSTS), and the functional gait assessment (FGA) tests in people with Parkinson disease (PD). In addition, correlation of these functional tests with a history of falls was examined over a 6-month period, and the internal consistency of the FGA was established.

**Methods:** Twenty-two patients with PD (Hoehn and Yahr stages 1-3) completed 3 functional tests over 2 test-retest periods of 6 to 8 days. Falls were self-reported for the prior 6 months.

**Results and Discussion:** Moderate-to-excellent test-retest ICC<sub>(2,2)</sub> and MDC<sub>95</sub> values were found for the 30sSTS (0.94, 3 times) and ICC<sub>(2,1)</sub> and MDC<sub>95</sub> values were found for the FGA (0.86, 4 points). The 5×STS demonstrated a lower ICC<sub>(2,2)</sub> and a high MDC<sub>95</sub> value (0.74, 10 seconds). A significant correlation was only found between past falls and the FGA test ( $r = -0.48$ ,  $P < .05$ ) during session 1. Cronbach  $\alpha$  values for the 10-item FGA during session 1 and session 2 were 0.75 and 0.85, respectively.

**Conclusions:** To assess for change over time, we found the 30sSTS and the FGA tests can be used reliably in patients with PD. A lower FGA score was associated with a higher chance of falls, and good internal consistency of the FGA was found.

**Key Words:** functional tests, Parkinson disease, reliability

(*J Geriatr Phys Ther* 2016;00:1-4.)

### INTRODUCTION

Parkinson disease (PD) is a progressive neurodegenerative disorder affecting more than 1 million individuals in the

United States and as many as 4 to 6 million worldwide.<sup>1</sup> It is a multisystem pathology that primarily affects dopaminergic neurons in the substantia nigra. Common clinical manifestations of PD are characterized by dysfunctional movements such as bradykinesia, gait hypokinesia, resting tremor and rigidity, muscle weakness, and freezing of gait as well as decreased speech volume.<sup>2,3</sup> People with PD have strength deficits that cause functional difficulties; 78% of those with PD have trouble walking and 81% have difficulty rising from a chair.<sup>4</sup> Individuals with PD also have a significantly higher risk for falls compared with age-matched controls.<sup>5</sup>

Early detection of changes in signs/symptoms through the use of functional measures can assist identification of disease progression, helping the clinician to devise appropriate treatment strategies. The sit-to-stand (STS) test and the functional gait assessment (FGA)<sup>6-8</sup> are useful for detecting changes in functional gait and mobility in individuals with PD. Two versions of the STS test are most often used, one consisting of a 5 times STS (5×STS) and another consisting of a 30-second STS (30sSTS). Although the movements required by each test are identical, the 2 tests differ in at least 1 important aspect: the 5×STS test measures the time required to complete 5 movements, whereas the 30sSTS test measures the number of movements that can be completed in 30 seconds. The 30sSTS test may be a more appropriate functional lower extremity endurance assessment for adults categorized with higher physical functional abilities.<sup>9</sup>

The minimal detectable change at the 95% confidence level (MDC<sub>95</sub>) provides a description of absolute reliability and allows an evaluator to assess any change resulting from therapy by distinguishing between true change and apparent change because of measurement error.<sup>10</sup> Although MDC<sub>95</sub> values have been established for the STS tests and the FGA in older adults, these values have not been described for people with PD. Minimal detectable change values would aid the clinician in recognizing true change resulting from therapeutic interventions.

<sup>1</sup>Concordia University Wisconsin, Mequon, Wisconsin.

<sup>2</sup>Form & Fitness, Grafton, Wisconsin.

The authors declare no conflicts of interest.

Address correspondence to: Cheryl Petersen, PT, DPT, DHS, Concordia University Wisconsin, Mequon, WI 53092 (Cheryl.Petersen@cuw.edu).

Copyright © 2016 Academy of Geriatric Physical Therapy, APTA.

DOI: 10.1519/JPT.000000000000102

The present study had 3 purposes. First, to establish test-retest reliability and  $MDC_{95}$  for the 5×STS, 30sSTS, and FGA tests in people with PD, second to establish the internal consistency of the FGA. Third, the study correlated the results of these tests with falls reported for a retrospective 6-month period in individuals with PD.

**METHODS**

**Participants and Study Design**

Seven women and 15 men ( $71.5 \pm 8.5$  years) with PD (Hoehn and Yahr stages 1-3),<sup>11</sup> recruited from local PD exercise groups, participated in this study (Table 1). Participants were asked to be available for 2, 1.5-hour sessions, 6 to 8 days apart during March and April of 2013 and 2014. As primary PD medication may have an effect on cardiovascular response, testing was conducted during the participant’s “on-medication” period and during the same time of day for both test and retest sessions.

Additional medical conditions reported by participants included cholesterol abnormalities 36% (8/22), elevated blood pressure 32% (7/22), depression or anxiety 23% (5/22), a history of cardiac disease 18% (4/22), prostate problems 14% (3/22), and urinary incontinence 14% (3/22). Back pain, breast cancer, pulmonary disease, dizziness, gout, leg cramps, macular degeneration, osteoarthritis, shoulder pain, and stomach issues were reported on an individual basis. One participant had an implanted deep brain stimulator for management of his PD.

Inclusion criteria consisted of a medical diagnosis of PD and the ability to ambulate with or without an assistive device. Exclusion criteria included any contraindication for exercise according to guidelines from the American College of Cardiology and the American Heart Association.<sup>12</sup> Participants’ health histories were screened and the frequency of falls over a 6-month period was identified (Table 2).<sup>13</sup> A fall was defined as when an individual’s knee or buttock inadvertently makes contact with the floor. Safety was maintained with the use of a gait belt. University institutional review board

approval was obtained and all participants signed an informed consent form before testing.

**Functional Testing Procedures**

Two cohorts of 9 physical therapy students evaluated the participants. To improve reliability measures, each cohort received training to standardize the testing procedures and the evaluation assessment for the 3 functional tests.

Participants were informed of each of the functional test procedures and were allowed to practice the movement if needed. The chair used for STS testing was placed against a wall to improve patient safety. The order for the functional test battery proceeded as follows:

1. Two trials of the 5×STS task were performed with a 1- to 2-minute rest between trials. The participant was seated on a 47.5-cm-high wooden chair without armrests. The task was performed with arms crossed over the participant’s chest. The time to complete the 5×STS was recorded by a single tester for both sessions. Timing began with the verbal cue to begin and ended as the participant’s buttock contacted the chair.
2. Two trials of the 30sSTS task were performed with arms crossed over the chest with a 1- to 2-minute rest between trials by the same single tester for both sessions. Participants were instructed to repeat the sit-to-stand movement safely but as quickly as possible until told to stop.
3. A single trial of the FGA followed the STS tests and was administered by a third tester for both sessions of testing. Scores were recorded for each test item by 2 different testers observing and scoring the 10 items individually for both sessions.

**Statistical Methods**

The intraclass correlation coefficient ( $ICC_{(2,1)}$ ) was calculated for test-retest reliability for the FGA and  $ICC_{(2,2)}$  was calculated for 5×STS and 30sSTS.<sup>10</sup> The  $MDC_{95}$  was calculated using the formula:  $[1.96 (SD_{baseline}) \times \sqrt{2(1 - ICC)}]$ <sup>10</sup> for the 3 functional tests. Pearson correlations were used to correlate 5×STS and 30sSTS with falls, and

**Table 1. Modified Hoehn and Yahr Stage Demonstrated by 22 Study Participants**

| Description   | Score | Frequency | %    |
|---|-------|-----------|------|
| Unilateral involvement only   | 1.0   | 1         | 4.5  |
| Unilateral and axial involvement  | 1.5   | 1         | 4.5  |
| Bilateral involvement without impairment of balance                                   | 2.0   | 3         | 13.6 |
| Mild bilateral disease with recovery on pull test                                     | 2.5   | 12        | 54.5 |
| Mild to moderate bilateral disease; some postural instability; physically independent | 3.0   | 5         | 22.7 |
| Severe disability; still able to walk or stand unassisted                             | 4.0   | 0         | 0    |
| Wheelchair bound or bedridden unless aided  | 5.0   | 0         | 0    |

**Table 2. Demographics of the Population With Parkinson Disease (N = 22)**

| Demographic                       | Mean (Standard Deviation) | Range Statistic | Minimum | Maximum |
|-----------------------------------|---------------------------|-----------------|---------|---------|
| Age, y                            | 72.0 (8.5)                | 31              | 57      | 88      |
| Falls reported over a 6-mo period | 1.4 (1.5)                 | 5               | 0       | 5       |
| Levodopa amount, mg               | 567.7 (364.4)             | 1150            | 100     | 1250    |

Spearman correlations were used to correlate FGA with falls. The Cronbach  $\alpha$  was used to confirm internal consistency for the 10-item FGA.<sup>10</sup>

## RESULTS

Participants' Hoehn and Yahr classification ranged from 1 to 3 with primarily bilateral involvement (Table 1). No adverse events occurred with any of the participants during the study procedures. The average number of falls reported for the 6-month period before testing was 1.4, with a range from 0 to 5 falls (Table 2). The average levodopa dosage of the participants was 567 mg per day (Table 2).

The 5×STS test had fair-to-good test-retest reliability ICC<sub>(2,2)</sub> of 0.74 and a high MDC<sub>95</sub> of 10 seconds. In contrast, the 30sSTS test had a test-retest ICC<sub>(2,2)</sub> of 0.94 and an average MDC<sub>95</sub> of 3 times, whereas the FGA had a test-retest ICC<sub>(2,1)</sub> of 0.86 and an average MDC<sub>95</sub> of 4 points (Table 3). Cronbach  $\alpha$  values for the 10-item FGA during session 1 and session 2 were 0.75 and 0.85, respectively.

A correlation was found between past falls and the FGA test ( $r = -0.48$ ,  $P < .05$ ) during session 1. We found no significant correlation between falls and the 30sSTS nor for the 5×STS tests.

## DISCUSSION

The goals of this study were to establish test-retest reliability and MDC<sub>95</sub> measures for functional testing, to assess the correlation of the functional test results with falls in individuals with mild to moderate PD (Hoehn and Yahr stages 1-3) during on-medication timing, and to establish the internal consistency of the FGA. The high MDC<sub>95</sub> (10 seconds) for the 5×STS may be due to the large standard deviation (SD) (15) during session 2, suggesting greater variability in this group during that functional test. For the 30sSTS, our ICC<sub>(2,2)</sub> data of 0.94 exceed an accept-

able threshold of 0.90 for reasonable validity,<sup>10</sup> indicating excellent 6- to 8-day test-retest reliability. The 30sSTS test's MDC<sub>95</sub> of 3 seconds is similar to previous research<sup>14,15</sup> and suggests that the 30sSTS may be a better functional measure to document clinical change than is the 5×STS test in individuals with PD (Table 3).

The FGA's test-retest ICC<sub>(2,1)</sub> of 0.86 is considered good, with a low MDC<sub>95</sub> value of 4 points. These results show that this test is a good explanator of falls and support the use of the FGA for functional testing in individuals with PD. Two previous studies also found the FGA to be a good predictor of falls in individuals with PD, one reporting a cut-off of 15 points while the other reported a cut-off of 18. Both of these studies demonstrated acceptable sensitivity and specificity.<sup>8,16</sup> In addition, when considering the timing of the individual's primary PD medication, Foreman et al<sup>7</sup> reported predictive validity was better during off timing than during on, and therefore recommended testing individuals with PD, off medication, to improve accuracy of fall prediction.

Study limitations include a relatively small sample size, daily timing of the individual's primary PD medication, day-to-day pathological variations of PD, upper extremity tremor, and the lack of cognitive impairment testing. The determination of falls was retrospective and based on self-reporting. Most individuals with PD possess some level of mild cognitive impairment that may affect reliability of information about falls. Generalizability of the results applies primarily to people in Hoehn and Yahr stages 2 to 3 (90% of the study population).

## CONCLUSIONS

The results of this study suggest that during on-medication timing in individuals with PD (Hoehn and Yahr stages 1-3) who are actively involved in exercise, the 30sSTS test can be used to assess change over time with treatment interventions. The MDC<sub>95</sub> calculated for both the 30sSTS and the FGA (3 times

**Table 3. Test-Retest Reliability and Detectable Change for 5 Times Sit-to-Stand, 30-Second Sit-to-Stand, and the Functional Gait Assessment Tests With Parkinson Disease (N = 22)**

| Functional Test                 | Mean (Standard Deviation)<br>Session 1 | Mean (Standard Deviation)<br>Session 2 | Test-Retest Reliability   | MDC <sub>95</sub> |
|---------------------------------|--|--|---------------------------|-------------------|
| 5 times sit-to-stand, s         | 12.7 (7.3)                             | 14.1 (15.2)                            | ICC <sub>(2,2)</sub> 0.74 | 10.3              |
| 30-s sit-to-stand (repetitions) | 14.4 (4.7)                             | 14.8 (5.3)                             | ICC <sub>(2,2)</sub> 0.94 | 3.3               |
| FGA (points)                    | 21.4 (4.1)                             | 21.1 (5.0)                             | ICC <sub>(2,1)</sub> 0.86 | 4.3               |

Abbreviations: FGA, functional gait assessment; ICC, intraclass correlation coefficient; MDC<sub>95</sub>, minimum detectable change at the 95% confidence level.

standing and 4 points, respectively) indicates that these tests can be used to determine whether change in the test scores occur due to error or as a result of treatment intervention. The FGA also showed a correlation with falls in this study.

## REFERENCES

1. Carter J. Overview of Parkinson disease. <http://www.parkinson.org/understanding-parkinsons>. Published 2013. Updated 2016. Accessed April 4, 2016.
2. Morris ME. Movement disorders in people with Parkinson's disease: a model for physical therapy. *Phys Ther*. 2000;80(6):578-597.
3. Lang A, Lozano A. Parkinson's disease: second of two parts. *New Eng J Med*. 1998;339(16):1130-1143.
4. Bord M, Mendelsohn GA, Roberts B. Patient's experiences of Parkinson disease. *J Gerontol B Psychol Sci Soc Sci*. 1998;53(4):213-222.
5. Latt M, Lord S, Morris J, Fung V. Clinical and physiological assessments for elucidating falls risk in Parkinson's disease. *Mov Disord*. 2009;24(9):1280-1289.
6. Duncan RP, Leddy AL, Earhart GM. Five times sit-to-stand test performance in Parkinson's disease. *Arch Phys Med Rehabil*. 2011;92(9):1431-1436.
7. Foreman K, Addison O, Kim H, Dibble L. Testing balance and fall risk in persons with Parkinson disease, an argument for ecologically valid testing. *Parkinsonism Rel Disord*. 2011;17(3):166-171.
8. Leddy A, Crowner B, Earhart G. Functional gait assessment and balance evaluation system test: reliability, validity, sensitivity, and specificity for identifying individuals with Parkinson disease who fall. *Phys Ther*. 2011;91(1):102-113.
9. McCarthy EK, Horvat MA, Holtsberg PA, Wisenbaker JM. Repeated chair stands as a measure of lower limb strength in sexagenarian women. *J Gerontol A Biol Sci Med Sci*. 2004;59(11):1207-1212.
10. Portney L, Watkins M. *Foundations Of Clinical Research Applications to Practice*. 3rd ed. Upper Saddle River, NJ: Pearson Prentice Hall; 2009.
11. Goetz C, Poewe W, Rascol O, Sampaio C, et al. Movement disorder society task force report on the Hoehn and Yahr staging scale: status and recommendations. *Mov Disord*. 2004;19(9):1020-1028.
12. Gibbons RJ, Abrams J, Chatterjee K, et al. ACC/AHA 2002 guideline update for the management of patients with chronic stable angina-summary article: a report of the American College of Cardiology/American Heart Association Task Force on practice guidelines (Committee on Management of Patients With Chronic Stable Angina). *Circulation*. 2003(1);107:149-158.
13. Stankovic I. The effect of physical therapy on balance with Parkinson's disease. *Int J Rehabil Res*. 2004;27(11):53-57.
14. Gill S, McBurney H. Reliability of performance-based measures in people awaiting joint replacement surgery of the hip or knee. *Physiother Res Int*. 2008;13(3):141-152.
15. Jones C, Rikli R, Beam W. A 30-s chair-stand test as a measure of lower body strength in community-residing older adults. *Res Q Exerc Sport*. 1999;70(2):113-119.
16. Yang Y, Wang Y, Zhou Y, Chen C, Xing D, Wang C. Validity of the functional gait assessment in patients with Parkinson disease: construct, concurrent, and predictive validity. *Phys Ther*. 2014;94(3):393-400.