Validation and reproducibility of the Glittre activities of daily living test for individuals with Parkinson's disease

Dayse D.O. Silva, João C.F. Corrêa, Mariana A.F. de Sá, Valéria M.F. Normando, Soraia M. Silva, Simone dal Corso, Fernanda I. Corrêa

Aim. To investigate the validity and reproducibility of the Glittre Activities of Daily Living (Glittre-ADL) test for individuals with Parkinson's disease.

Subjects and methods. Thirty individuals with Parkinson's disease and 19 healthy individuals (control group) were evaluated. Parkinson's disease group was evaluated by the Unified Parkinson's Disease Rating Scale (UPDRS) and underwent the Glittre-ADL test, six-minute walk test (6MWT) and ten-meter walk test (10mWT). Control group performed the Glittre-ADL test. For the intraobserver analysis, two Glittre-ADL tests were performed. For the interobserver analysis, the Glittre-ADL test was repeated on a different day by a second examiner.

Results. The Glittre-ADL test was significantly correlated with UPDRS Section II, Section III, and total score. The Glittre-ADL test was inversely correlated with the 6MWT and positively correlated with the 10mWT. The time required to perform the Glittre-ADL test was shorter on the retest in the intraobserver analysis and in the interobserver analysis. The mean difference between the first and second tests, the standard error of measurement and minimum detectable change in minutes were 0.40, 0.08 and 0.24, respectively, for intraobserver, and 0.40, 0.22 and 0.62, for interobserver.

Conclusion. The Glittre-ADL test is valid and reproducible to evaluate functional capacity in individuals with Parkinson's disease.

Key words. Functional capacity. Glittre. Parkinson's disease. Reproducibility. Validation.

Department of Human Movement Sciences; Universidade do Estado do Pará; Belém (D.D.O. Silva, M.A.F. de Sá, V.M.F. Normando). Graduate Program in Rehabilitation Sciences; Universidade Nove de Julho; São Paulo, Brazil (J.C.F. Corrêa, S.M. Silva, S. dal Corso, F.I. Corrêa).

Corresponding author:
Soraia Micaela Silva MD. Rua Vergueiro, 235/249. CEP: 01504-001. Liberdade-São Paulo, SP, Brazil.

E-mail:
soraia.micaelaa@gmail.com

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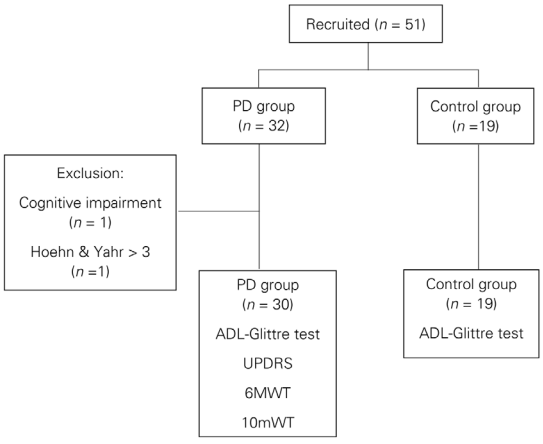
Introduction

Parkinson's disease (PD) is a progressive neurodegenerative disease that mainly affects males aged 60 years or older, who exhibit the massive loss of dopaminergic neurons of the substantia nigra, resulting in motor and non-motor impairments [1]. All these problems exert a negative impact on functional capacity and activities of daily living (ADLs) [2]. Thus, to evaluate the progression of the disease and demonstrate the effects of clinical, surgical and medicinal therapy, it is necessary to use instruments designed to assess functional capacity and ADLs that are accessible and sensitive to the different levels of functioning in PD [3].

Few assessment tools are specific to evaluate functional capacity in individuals with PD such as the Freezing of Gait Questionnaire [4], Parkinson's Disease Questionnaire [5] and Unified Parkinson's Disease Rating Scale (UPDRS) [6]. UPDRS is the most widely used to evaluate the progression of PD as well as determine the effects of interventions [6]. The UPDRS is a multidimensional, reliable, valid assessment tool that involves a pragmatic, long evaluation and requires specialized personnel. UPDRS is based on self-reports which may underestimate the assessment in cases of emotional impairment and also UPDRS does not mimic functional activities [7].

The six-minute walk test (6MWT) and ten-meter walk test (10mWT) have also been used to evaluate functional capacity in individuals with PD because they are easy to perform and do not require expensive equipment [8,9]. However, 6MWT and 10mWT only assess the ability to walk not involving other activities commonly performed during ADLs. Therefore, walking-based tests not necessarily depict the everyday life of individuals with PD [10]. In this context, there is a need for valid, reliable instruments to measure functional capacity related to ADLs that are inexpensive and easy to execute. Functional capacity and limitations with regard to performing ADLs can be better predicted from global tests that reproduce daily activities than by tests focused on isolated components, such as gait speed or distance walked.

Figure 1. Flowchart of the study.



The Glittre Activities of Daily Living (Glittre-ADL) test was developed to evaluate functional capacity in patients with chronic obstructive pulmonary disease and was subsequently validated for individuals with cardiovascular disease [11,12] and lung disease [13], individuals in intensive care units [14] as well as individuals with obesity and those having been submitted to bariatric surgery [15]. This test is easy to administer and reliable [16]. It involves upper and lower limbs activities reproducing more daily activities.

However, there are no previous studies investigating the use of the Glittre-ADL for the population with neurodegenerative diseases. Therefore, the aim of the present study was to analyze the validity and reproducibility of the Glittre-ADL test for individuals with PD. The following two hypotheses were tested: the execution time on the Glittre-ADL test has adequate construct validity (correlated with instruments that evaluate similar constructs, such as the UPDRS, 6MWT and 10mWT); and the execution time on the Glittre-ADL test is shorter in subjects with PD in comparison with healthy individuals.

Subjects and methods

Study design

This is a psychometric study of intraobserver and interobserver, and test-retest reliability approved by the ethics committee. All participants signed a statement of informed consent. The procedure was based on the *Guidelines for Reporting Reliability and Agreement Studies* [17].

Eligibility criteria

The inclusion criteria for both groups were age 50 to 80 years, preserved cognition based on the Mini Mental State Examination [18] and independent gait as well as an absence of heart disease, lung disease and visual impairment. The PD group also needed to have a diagnosis of the disease and not have a level higher than 3 on the Hoehn and Yahr Scale for disability in PD [19].

Procedures

After inclusion in the study, participants with PD performed the Glittre-ADL test. Then, they were assessed according to UPDRS, and they performed the 6MWT and 10mWT. The control group performed only Glittre-ADL test in order to compare the performance between healthy subjects and individuals with PD. The flowchart of the study can be visualized in figure 1.

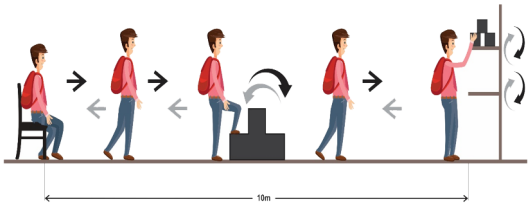
Glittre-ADL test

Glittre-ADL test was performed in accordance with the original description of the test [16]. The participant was instructed to stand up from a chair with a backpack containing a 5-kg weight for men or a 2.5-kg weight for women and walk 10 meters. In the middle of the track, the participants had to go up and down two steps and proceed to a bookshelf at the end of the 10-m track, which had three 1-kg weights on the top shelf (shoulder height). The participant placed the three objects one at a time on the second shelf (waist height) and then moved each to the ground. The participants returned the objects to the second shelf, then to the top shelf, turned around, walked back along the track over the two steps, returned to the chair and sat down (Fig. 2).

All tests were performed one hour prior to the use of medication (during the 'on' phase). For the interobserver analysis, two examiners who had previous experience with Glittre-ADL test administered the test. The tests were performed on separate days (two days apart). For the intraobserver analysis, a single examiner administered the Glittre-ADL test twice (30 minutes apart). The time required to complete the test was expressed in absolute values (seconds) and percentage of the predicted value [20].

PD group also performed the 6MWT and 10mWT. In the 6MWT, patients walk back and forth in a 30-meter hallway as far as possible for 6 minutes. The patient was allowed to decrease the speed of walking and even stop to rest if necessary, but it was recommended to return walking as soon as possible. The distance on the 6MWT was expressed in absolute values (meters) and percentage of the predicted value [21]. The 10mWT assesses walking speed, in meters per second, over a short distance [22], and patients walked at their normal comfortable speed. Both tests (6MWT and 10mWT) have been previously used in subjects with PD.

Figure 2. Glittre-ADL test.



Data analysis

The Shapiro-Wilk test was used to determine the adherence of the data to the Gaussian curve. Data with parametric distribution were expressed as mean and standard deviation and non-parametric data were expressed as median and interquartile range. Categorical variables were expressed as percentage values.

The construct validity of the Glittre-ADL test was determined by comparing the performance of the participants in the PD group and control group. Convergent validity was determined by correlating (Spearman's correlation coefficients) the data obtained on the Glittre-ADL test with the results of the UPDRS (Sections II, Section III and total), distance walked in the 6MWT and execution time in the 10mWT. The best result (shortest time) on the Glittre-ADL test was considered for these analyses. The correlations was classified as follows: < 0.39, weak correlation; 0.40-0.69, moderate correlation; > 0.70, strong correlation [23].

For the comparisons between groups, the *t*-test for independent samples was used for parametric variables and the Mann-Whitney *U* test was used for nonparametric variables.

Intraobserver and interobserver reliability was analyzed using the intraclass correlation coefficient (ICC) and respective 95% confidence intervals. The ICC was interpreted as follows: < 0.40, low reliability; 0.40-0.75, moderate reliability; 0.75-0.90, substantial reliability; > 0.90, excellent reliability. As examiner 1 administered two Glittre-ADL tests, the second was used for the interobserver analysis.

Intraobserver and interobserver agreement was analyzed using the standard error of measurement (SEM), minimum detectable change (MDC) and Bland-Altman plots [24]. The SEM was calculated by the ratio between the standard deviation (SD) of the mean of the differences and the square root of 2. The MDC was calculated using the formula: $MDC = 1.96 \times \sqrt{2} \times SEM$.

The MedCalc Statistical Software was used for the graphic representations of the Bland-Altman plots and the SPSS v. 24.0 was used for all other analysis. The sample power and effect size were calculated a posteriori for the main outcome (execution time on Glittre-ADL test) using the G*Power statistical program. The level of significance was set to 5% ($p < 0.05$).

Results

Thirty-two subjects with PD were consecutively recruited. One was excluded due to cognitive impairment and one for having a level higher than 3 in the Hoehn and Yahr Scale. As expected, a difference in the execution time in the Glittre-ADL test was found between groups, with percentages higher than the predicted in the PD group (Table I). The sample power and effect size for the execution time on the Glittre-ADL test were 85.9% and 0.88, respectively.

Table II displays the data related to validation, ranging from weak, but statistically significant, to strong correlations between the Glittre-ADL and UPDRS, 6MWT, and 10mWT.

Table III displays the results of the intraobserver and interobserver reliability analysis for each trial of the Glittre-ADL test. In the intraobserver comparison, the execution time was always significantly shorter on the retest, independently of the trial analyzed. No significant difference in execution time was found in the interobserver comparison.

Table IV displays the results referring to intraobserver and interobserver agreement regarding execution time on the Glittre-ADL test.

Figure 3 displays the Bland-Altman plots of intraobserver and interobserver agreement.

Table I. Clinical and anthropometric data and results of tests.

	PD group (n = 30)	Control group (n = 15)	p [d]
Age (years) [a]	62.1 ± 8.6	63.9 ± 8.9	0.52
Body weight (kg) [a]	69.8 ± 14.7	69.5 ± 10.6	0.96
Height (m) [a]	1.62 ± 0.11	1.63 ± 0.06	0.83
Body mass index [a]	26.4 ± 4.0	25.9 ± 3.3	0.81
6MWT (m) [a]	387.7 ± 82.7	–	–
6MWT (% of predicted) [a]	71 ± 15	–	–
Glitter-ADL test (min) [b,c]	3.69 (2.96-4.48)	3 (2.57-3.48)	0.02
Glitter-ADL test (% of predicted) [b]	122.8 (100.9-150.9)	101.8 (89.5-112)	0.007
10mWT (m/s) [b]	0.15 (0.11-0.23)	–	–
Duration of disease (months) [b]	54 (22.5-120)	–	–
Hoehn and Yahr (stage) [b]	2 (1-2.5)	–	–
UPDRS Section II [b]	9.5 (4.75-16.75)	–	–
UPDRS Section III [b]	10 (7-15.25)	–	–
UPDRS Total [b]	24.5 (17.5-36)	–	–

6MWT: Six-Minute Walk Test; 10mWT: Ten-Meter Walk Test; PD: Parkinson's disease; UPDRS: Unified Parkinson's Disease Rating Scale. [a] Mean ± standard deviation; [b] Median (interquartile range); [c] Shortest execution time on Glittre-ADL test selected among three tests (two administered by examiner 1 and one by examiner 2); [d] Mann-Whitney U (82.5).

Table II. Correlations between execution time on Glittre-ADL test and UPDRS scores, distance travelled on 6MWT and execution time on 10mWT among individuals with Parkinson's disease (n = 30).

	r	p
UPDRS Section II	0.37	0.046
UPDRS Section III	0.65	< 0.001
UPDRS Total	0.52	0.003
6MWT (m)	–0.81	0.001
10mWT (m/s)	0.84	0.001

6MWT: Six-Minute Walk Test; 10mWT: 10-Meter Walk Test; UPDRS: Unified Parkinson's Disease Rating Scale.

Discussion

The Glittre-ADL test exhibited adequate correlations with instruments that measure similar constructs, with the exception of Section II of the UPDRS. The Glittre-ADL test also exhibited adequate intraobserver and interobserver reproducibility, with a small learning effect on the retest (interobserver analysis) and no difference in comparison to the third test administered by the examiner.

The weak correlation with Section II of the UPDRS was likely due to the fact that this section includes constructs specific to PD that are not part of the Glittre-ADL test, such as salivation, swallowing, cutting and handling food, dressing, hygiene, falls and sensory complaints related to PD. Moreover, Section II does not actively evaluate the capacity to perform activities of daily living using the upper and lower limbs simultaneously as occurs in the Glittre-ADL test. Section III of the UPDRS evaluates the severity of motor symptoms in PD such as postural tremor, stiffness, hand movements, lower limb agility, standing up from a chair, posture, gait and postural stability as well as bradykinesia and hypokinesia. These aspects are important during the execution of the Glittre-ADL test. Haaxma et al [25] report similar findings when comparing Section III to a timed motor battery composed of nine items.

In the present study, 6MWT [8] and 10mWT [21] used to assess functional capacity and validated for PD [8,20,25] were correlated with the execution on the Glittre-ADL test. Peters et al [9] used the 10mWT on individuals with PD and considered the test to be reliable and reproducible for assessing gait speed and step frequency. The execution time in the Glittre-ADL test was directly proportional to the execution time in the 10mWT, which reflects the capacity of the Glittre-ADL test to determine the gait status of individuals with PD. However, the time required to execute the Glittre-ADL test is inversely proportional to the distance walked in the 6MWT, demonstrating that a better functional capacity (reflected in the greater distance in the 6MWT) translates to a better performance on the Glittre-ADL test (less time required to complete the test). Similar results have been described for other health conditions [26,27].

In the present study, we analyzed the capacity of the Glittre-ADL test to differentiate individuals with and without PD [22]. The group with PD had a significantly poorer performance on the test compared to the control group, which was matched for age, sex and body mass index. Based on these findings, the Glittre-ADL test has adequate capacity to differentiate healthy individuals from those with PD.

Table III. Intraobserver and interobserver agreement on each trial of Glittre-ADL test among individuals with Parkinson's disease (min/trail).

	Intraobserver agreement			Interobserver agreement		
	Glittre-ADL test 1	Glittre-ADL test 2	ICC (95% CI)	Examiner 1 [a]	Examiner 2	ICC (95% CI)
1st trial	1.03 (0.72-1.22)	0.88 (0.65-1.00) [b]	0.95 (0.65-0.98) [c]	0.88 (0.65-1.00)	0.83 (0.64-1.07)	0.98 (0.96-0.99) [c]
2nd trial	1.96 (1.43-2.38)	1.69 (1.28-1.91) [b]	0.96 (0.67-0.99) [c]	1.69 (1.28-1.91)	1.58 (1.25-2.04)	0.98 (0.95-0.99) [c]
3rd trial	2.86 (2.15-3.50)	2.48 (1.87-2.81) [b]	0.97 (0.58-0.99) [c]	2.48 (1.87-2.81)	2.28 (1.85-2.98)	0.98 (0.95-0.99) [c]
4th trial	3.73 (2.81-4.64)	3.30 (2.55-3.73) [b]	0.97 (0.63-0.99) [c]	3.30 (2.55-3.73)	3.00 (2.45-3.86)	0.95 (0.90-0.97) [c]
5th trial	4.58 (3.50-5.72)	4.08 (3.03-4.63) [b]	0.97 (0.56-0.99) [c]	4.08 (3.03-4.63)	3.69 (3.08-4.71)	0.97 (0.94-0.99) [c]

CI: confidence interval; Glittre-ADL test: Glittre Activities of Daily Living Test; ICC: intraclass correlation coefficient. [a] Second Glittre-ADL test; [b] $p < 0.001$ versus Glittre-ADL test 1; [c] $p < 0.0001$ for all ICCs.

This was further confirmed by the higher value than the percentage of the predicted value for the Glittre-ADL test among the patients with PD, demonstrating a poorer performance. Corrêa et al [28] concluded that patients with chronic obstructive pulmonary disease have a poorer performance than healthy individuals on the Glittre-ADL test, with greater shortness of breath and a similar heart rate. Arikan et al [13] compared the performance of healthy individuals and those with cystic fibrosis and found that the time required to complete the Glittre-ADL test as well as the increase in the perception of dyspnea recorded during the test were significantly higher among the patients with cystic fibrosis.

In relation to reproducibility, ICC values were high (0.92 in the intraobserver analysis and 0.86 in the interobserver analysis) and the SEM values were low (0.08 in the intraobserver analysis and 0.22 in the interobserver analysis). Such results (high ICC and low SEM) reveal a minimal systematic error and indicate good intraobserver and interobserver reliability. While the SEM values are not relevant to the determination of the reliability of the test, such values are of extreme clinical usefulness. A change found on a retest that is lower than the MDC reflects a measurement error, meaning there was no clinical change in the variable being evaluated. The SEM is also related to a measurement error and not a change in the clinical status of the patient. In a previous study using PD assessment tools, the results revealed a low probability of a random systematic error when the SEM is lower than the MDC [29].

In the present study, the execution time on the Glittre-ADL test was significantly shorter in the retest (ranging from 9 to 30 s shorter) independently of the trial. In the interobserver comparison, the results during the evaluation of the second examiner were significantly shorter than those found during the evaluation performed by the first examiner (range: 12.5 to 53.5 s shorter). These significant differences may be attributed to the learning effect or may stem from the different levels of functional impairment, as the patients were in different stages, ranging from 1.1 to 2.5 (median: 2) on the Hoehn and Yahr scale. A learning effect in the Glittre-ADL test has been also recorded in individuals with community-acquired pneumonia [26]. Evaluating the reproducibility of the Glittre-ADL test, Tufanin et al [30] found similar cardiopulmonary responses as well as the perception of shortness of breath and lower limb fatigue between the two tests.

The Glittre-ADL test simulates the execution of activities of daily living, as it enables the evaluation of mobility, upper and lower limb activities, walking and going up and down stairs by recreating activities that are similar to common actions. Few studies [27,28] besides the original [16] have used the Glittre-ADL test as a field test. Moreover, only one study used test-retest measures to examine its reproducibility and variability, which were established for individuals in a hospital setting for acute and exacerbated chronic lung disease [26]. Thus, the present investigation is the first study to evaluate the reproducibility of this test on individuals with PD and produced results of clinical importance, offering data on means and differences as well as the limits of agreement between the evaluations.

The main limitation of the present study is the considerable variability in disease diagnosis. Despite of that, the present study has important clinical rel-

Figure 3. Bland-Altman plots of intraobserver (a) and interobserver (b) agreement.

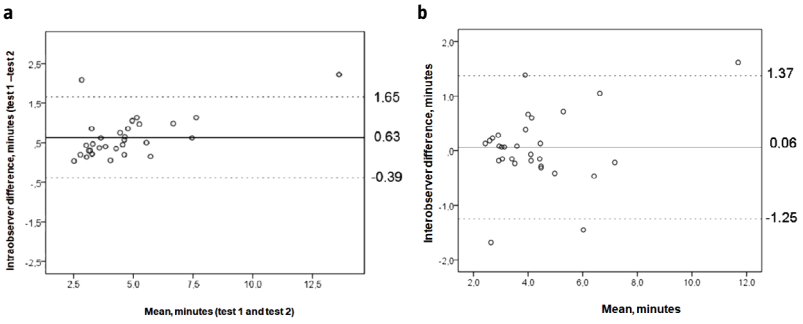


Table IV. Measures of intraobserver and interobserver agreement regarding execution time on Glittre-ADL test ($p < 0.0001$).

	Intraobserver ($n = 30$)	Interobserver ($n = 30$)
Mean of differences (95% CI)	0.63 (–0.39 a 1.65)	0.06 (–1.25 a 1.31)
Standard error of measurement (min)	0.08	0.22
Minimum detectable change (min)	0.24	0.62

CI: confidence interval.

evance because it validates the use of the Glittre-ADL test in individuals with PD. Glittre-ADL test can be used to quantify functional impairment in clinical practice.

In conclusion, Glittre-ADL test is valid to assess functional capacity in individuals with PD. The longer the distance walked in the 6MWT and the shorter the 10mWT time, the better the performance (shorter time) in the Glittre-ADL test. The better performance in the second Glittre-ADL test indicates that at least two tests should be performed in this population.

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Validación y reproducibilidad de la prueba Glittre de actividades de la vida diaria en personas con enfermedad de Parkinson

Objetivo. Investigar la validez y la reproducibilidad de la prueba Glittre de actividades de la vida diaria (AVD-Glittre) para personas con enfermedad de Parkinson.

Sujetos y métodos. Se evaluó a 30 pacientes con enfermedad de Parkinson y 19 sujetos sanos (grupo de control). El grupo con enfermedad de Parkinson fue evaluado con la *Unified Parkinson's Disease Rating Scale* (UPDRS) y sometido a la prueba AVD-Glittre, la prueba de marcha de seis minutos (6MWT) y la prueba de marcha de 10 metros (10mWT). El grupo de control realizó la prueba AVD-Glittre. Para el análisis intraobservador se realizaron dos pruebas AVD-Glittre, y para el análisis interobservador, la prueba se repitió otro día con un segundo examinador.

Resultados. La prueba AVD-Glittre se correlacionó significativamente con la sección II, la sección III y la puntuación total de la UPDRS. Se correlacionó inversamente con la 6MWT y positivamente con la 10mWT. El tiempo requerido para realizar la prueba AVD-Glittre fue más corto en la nueva prueba en el análisis intraobservador y en el análisis interobservador. La diferencia de medias entre la primera y la segunda pruebas, el error estándar de medición y el cambio mínimo detectable en minutos fueron 0,40, 0,08 y 0,24, respectivamente, para el análisis intraobservador, y 0,40, 0,22 y 0,62, respectivamente, para el análisis interobservador.

Conclusión. La prueba AVD-Glittre es válida y reproducible para evaluar la capacidad funcional en personas con enfermedad de Parkinson.

Palabras clave. Capacidad funcional. Enfermedad de Parkinson. Glittre. Reproducibilidad. Validación.