






Functional mobility in Parkinson's disease: associations with motor and non-motor symptoms

Mobilidade funcional em indivíduos com doença de Parkinson: associações com alterações motoras e não motoras

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ABSTRACT

Functional mobility (FM) is the ability of people to move in different environments, including at home, at work, and in the community, in order to perform functional activities or tasks, independently and safely. **Objective:** The aim of the present study was to investigate which motor and/or non-motor symptoms (severity of the motor symptoms, depressive symptoms, and fatigue) have the greatest impact on FM assessed by Modified Parkinson Activity Scale (mPAS) in individuals with Parkinson's disease (PD). **Method:** The outcome of interest was FM assessed by mPAS, which includes 14 activities covering three domains (chair transfers, gait akinesia, and bed mobility). Unified Parkinson's Disease Rating Scale (UPDRS) Part III, Beck Depression Inventory (BDI), and Parkinson's Disease Fatigue Scale-16 (PFS-16) were used. **Results:** Forty-four individuals (age: 65±11 years) with PD (PD duration: 7±4 years) were eligible to take part in this cross-sectional, exploratory study. The motor symptoms alone explained 36% ($F= 17.85$, $p<0.001$) of the variance in the FM scores. When depressive symptoms were included in the model, the explained variance increased to 45% ($F= 12.77$, $p<0.001$). This indicated that individuals who had lower motor and depressive symptoms were less likely to have limitations in FM. **Conclusion:** The findings of the present study demonstrated that motor symptoms were the best potential predictor of FM in individuals with PD, according to mPAS scores. Additionally, the presence of depressive symptoms should not be overlooked.

Keywords: Parkinson Disease, Mobility Limitation, Fatigue, Depression

RESUMO

Mobilidade funcional (MF) é a capacidade das pessoas de se movimentarem em diferentes ambientes, incluindo em casa, no trabalho e na comunidade, a fim de realizar atividades ou tarefas funcionais, de forma independente e segura. **Objetivo:** Investigar quais variáveis (gravidade das alterações motoras, sintomas depressivos e fadiga) têm maior impacto na MF avaliada por meio da Escala Modificada de Atividade em Parkinson (mPAS) em indivíduos com doença de Parkinson (DP). **Método:** A MF avaliada por meio da mPAS, que inclui 14 atividades em três domínios (transferências de cadeira, acinesia da marcha, mobilidade na cama). Escala Unificada de Avaliação da Doença de Parkinson (UPDRS) Parte III, Inventário de Depressão de Beck (BDI) e Escala de Fadiga da Doença de Parkinson-16 (PFS-16) foram usados. **Resultados:** 45 indivíduos (idade: 65 ± 11 anos) com DP (duração do DP: 7 ± 4 anos) participaram deste estudo transversal e exploratório. A gravidade das alterações motoras explicou 36% ($F= 17,85$, $p <0,001$) da variância nos escores de MF. Quando os sintomas depressivos foram incluídos no modelo, a variância explicada aumentou para 45% ($F= 12,77$, $p <0,001$). Isso indicou que indivíduos com menor gravidade das alterações motoras e sintomas depressivos eram menos propensos a ter limitações na MF. **Conclusão:** As alterações motoras foram o principal preditor da MF em indivíduos com DP, de acordo com os escores da mPAS. Além disso, a presença de sintomas depressivos não deve ser negligenciada.

Palavras-chaves: Doença de Parkinson, Limitação da Mobilidade, Fadiga, Depressão

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INTRODUCTION

Functional mobility (FM) is the ability of people to move in different environments, including at home, at work, and in the community, in order to perform functional activities or tasks, independently and safely.¹ FM requires complex physical processes, such as walking, transferring, and turning, when impairment increases the risk of falls, loss of autonomy, and institutionalization.¹

Several studies have proven that this ability is decreased in individuals with Parkinson's disease (PD).²⁻⁵ Multiple factors may contribute to the FM limitations in individuals with PD, including chronic medical conditions (e.g., psychiatric and musculoskeletal conditions);⁶ sedentary behavior,⁷ or disease severity.^{2,4} Bradykinesia; resting tremor; rigidity and postural instability, which are PD cardinal features; as well as changes in posture and gait contribute to FM limitations.^{2-5,8}

In addition, PD is associated with non-motor symptoms, including neuropsychiatric disorders, autonomic dysfunction, sleep disorders, and sensory impairments that can cause progressive disability and an impact on one's quality of life.⁹

However, few studies have investigated the relationship between non-motor symptoms and FM in individuals with PD.¹⁰⁻¹² In these studies, there was an isolated assessment of a non-motor symptom,^{10,11} or non-motor symptoms were assessed in a generic way, without identifying which impairment among those had the greatest impact on FM.¹²

Depression and fatigue are two of these important non-motor symptoms to investigate. Depression has been found to predict activities of daily living,¹³ and fatigue was predictor of functional capacity¹¹ in individuals with PD.

TUG and the Modified Parkinson Activity Scale (mPAS) have been designed as validated measurements to assess FM in individuals with PD.¹⁴ Although the TUG is a widely used clinical assessment tool,¹⁰⁻¹² the mPAS is specifically designed for the PD population.¹⁴ This tool is a capacity measure that evaluates the quality of the movement while patients perform the tasks.¹⁴

The mPAS includes aspects of balance, gait, and transfers, which reflect multiple components of FM and can help predict the overall functional level of the patient's daily life.¹⁵ Thus, the mPAS gives relevant information towards goal setting and selection of the intervention.¹⁵

Considering that the FM is reduced and causes limitations in performing tasks or actions and participation restrictions in daily-life in individuals with PD,¹ the identification of motor and non-motor symptoms associated with this impairment is desirable.⁹ Furthermore, regular assessment of FM using a tool that assesses the quality of the movement is crucial, because PD is a progressive neurodegenerative disease and results in a decline in functional activities and independent daily living.

OBJECTIVE

The aim of this study was to assess which motor and/or non-motor symptoms (severity of the motor symptoms, depressive symptoms, and fatigue) have the greatest impact on mPAS scores in individuals with PD.

METHOD

This cross-sectional, exploratory study was approved by the ethics committee of the Universidade Federal de Minas Gerais, Brazil (CAAE 07798012.6.0000.5149).

Individuals with PD, diagnosed according to the United Kingdom Parkinson's Disease Society Brain Bank criteria,¹⁶ classified as stage 1-4 according to the modified Hoehn and Yahr (HY) scale,¹⁷ and able to walk independently (with or without assistive devices) over a 10-m course were recruited from the Outpatient Movement Disorders Clinic of the "Santa Casa de Belo Horizonte" Hospital in Belo Horizonte, Minas Gerais, Brazil. Participants were excluded if they had any other neurological, psychiatric, or orthopedic diseases that could affect their functional activities; cognitive decline, according to the Mini-Mental State Examination (MMSE);¹⁸ or visuoperceptual problems. Written informed consent was obtained from all subjects before their participation.

Initially, demographic and clinical data, such as sex, age, and years of schooling, time since the onset of the PD, evaluation stage, and impact of PD on daily activities of daily life were obtained for characterization purposes. All patients were evaluated in their "on" state wherein they had a good response to medication.

The Hoehn and Yahr staging scale modified (HY) was used to assess the overall status and level of disability in patients with PD, and includes stages 0 (no signs of disease) to five (needing a wheelchair or bedridden unless assisted). A version of the modified HY was used, which includes intermediate stages (1.5 and 2.5). Subjects classified in stages I, II, and III have mild to moderate disability, whereas those in stages IV and V have grave disability.¹⁷

The Unified Parkinson's Disease Rating Scale (UPDRS) is the most widely used clinical rating scale for PD. It features 42 items, which can be grouped into Part I - mental activity, behavior and mood, Part II - activities of daily living (ADL), Part III - motor examination, and Part IV - complications of drug therapy.

The scores for each item range from 0 to 4, and higher scores indicate greater impairment. The present study focused on Part I and Part II to characterize the participants.¹⁹ The Schwab and England activities of daily living (ADL) scale (SE) was used to assess the daily routine of PD patients. This measure consists of 11 scores from 0 - 100%, and higher scores indicate more dependence in ADL.

The outcome of interest was FM. Limitation in FM was assessed by the Brazilian version of the mPAS.²⁰ The mPAS has 4 items more than initial Parkinson Activity Scale (PAS)²¹ and includes 14 activities covering three domains: chair transfers (2 items), gait akinesia (6 items), and bed mobility (6 items), which evaluates the quality of the movement while patients perform the tasks.¹⁵

Santos et al.^{20,21} performed the process of the cross-cultural adaptation for both versions, PAS and mPAS, respectively, for Brazilian-Portuguese. These authors indicated appropriate convergent validity between PAS-Brazil and mPAS-Brazil ($p=0.92$, $p<0.001$).²¹ Scores range from 0 (dependent) to 4 (normal), and the highest possible score is 56.²² The maximum score indicates that there is no deficit in FM, and the minimum score refers to the worst level of FM.

The potential predictors included three measures of motor and non-motor symptoms (depressive symptoms and fatigue). Motor symptoms were assessed according to the UPDRS, part III, where the maximum total score is 108 points and corresponds to greater severity of motor symptoms.¹⁹

Depressive symptoms were evaluated through the Brazilian Portuguese version of the Beck Depression Inventory (BDI).²³ It is a self-rating instrument for depressive symptoms comprising 21 items, each one ranging from 0 to 3 according to symptom severity. The cut-off score of 17/18 is used to discriminate between depressed and non-depressed patients.

Fatigue was assessed using the Brazilian Portuguese version of Parkinson Fatigue Scale-16 (PFS-16),²⁴ which is a self-reported questionnaire of 16 statements regarding fatigue, in which patients choose how much they agree or disagree with these statements. In this study, a cut-off point of 3.3 was used to identify patients with PD who perceive fatigue as a problem. Higher scores indicated more severe fatigue.²⁴

The sample size of at least 40 individuals was estimated, based upon the formula: $n = 10 * (P + 1)$, where P is the number of independent variables.²⁵ For this calculation, three independent variables (severity of the motor signs, depressive symptoms, and fatigue) were included in the multiple regression analyses.

The Shapiro-Wilk test was used to verify the normality of the data. Quantitative variables were described as mean and standard deviation (SD). Categorical variables were described by absolute and relative frequency. The Pearson correlation was performed between the FM and the severity of PD symptoms, depressive symptoms, and fatigue.

The magnitudes of the significant correlations were classified as follows: 0-0.25, very low; 0.26-0.49, low; 0.50-0.69, moderate; 0.70-0.89, high; and 0.90-1.00, very high.²⁶ All variables were set at $p < 0.2$ in the univariate model and continued the same for regression analysis. Linear regression analysis was performed to identify the contribution of each independent variable (severity of the motor symptoms, depressive symptoms, and fatigue) to explain the dependent variable (functional mobility).

All data were analyzed in the SPSS, version 19 (SPSS Inc., Chicago, IL, USA). The level of significance established for inferential statistical analyses was $\alpha = 5\%$. Plots of residuals against the predicted values and histograms of the residuals were examined to determine any violation of the assumptions for the regression analyses, mainly the normality of the residuals.

RESULTS

Ninety-two individuals with PD were invited to participate in this study, but three refused to answer it. A total of 89 individuals with PD were screened for eligibility. Of these, 12 (14%) were excluded, as they did not meet the inclusion criteria and the reasons for exclusion were: other neurological or orthopedic diseases ($n = 6$), and visuoperceptual problems ($n = 6$). Thirty-three (38%) patients declined to participate.

The reasons for declining to participate included lack of interest ($n = 14$), lives too far from the assessment site ($n = 8$), caregiver/partner did not want to accompany the participation to the assessment site ($n = 6$), and lack of money to pay for transport to the assessment site ($n = 5$).

Thus, forty-four individuals with PD were eligible to take part in the study. The sociodemographic and clinical data of the individuals with PD are described in Table 1. In summary, the sample had an average of 65 ± 11 years, most were male (75%), and the average time from disease PD diagnosis was 7 ± 4 years. Forty-one patients (93%) used levodopa.

Table 1. Descriptive characteristics of individuals with Parkinson's disease ($n = 44$)

Variables	Total ($n = 44$)
Age in years	65.1 ± 10.9
Years of schooling	6.4 ± 4.6
Physical activity (yes)	18 (40.9%)
PD duration in years	6.5 ± 3.7
MMSE	25.2 ± 3.9
UPDRS I	3.4 ± 2.2
UPDRS II	15.5 ± 5.0
UPDRS III	35.9 ± 10.3
UPDRS Total	54.8 ± 15.0
HY	
2	8 (18%)
2.5	24 (55%)
3	11 (25%)
4	1 (2%)
SE	
90%	6 (14%)
80%	12 (27%)
70%	19 (43%)
60%	6 (14%)
50%	1 (2%)
BDI	13.1 ± 9.8
PFS-16	3.0 ± 0.66
mPAS	26.3 ± 5.3

Notes: SD, standard deviation; PD, Parkinson's Disease; MMSE, Mini Mental State Examination; UPDRS, Unified Parkinson's Disease Rating Scale; HY, modified Hoehn and Yahr staging scale; SE, modified Schwab and England activities of daily living (ADL) scale; BDI, Beck Depression Inventory; PFS-16, Parkinson's Fatigue Scale-16; mPAS, modified Parkinson Activity Scale. Values are presented as means \pm standard deviations, or number cases (percentage)

The correlation between the FM and severity of the motor symptoms, depressive symptoms, and fatigue are described in Table 2.

Table 2. Correlations among functional mobility (mPAS) and severity PD signs and symptoms, depressive symptoms, and fatigue ($n = 44$)

	mPAS	
	r	p Value
UPDRS III	-0.598	< 0.001
BDI	-0.462	0.006
PFS-16	0.292	0.094

Notes: UPDRS, Unified Parkinson's Disease Rating Scale; BDI, Beck Depression Inventory; PFS-16, Parkinson Fatigue Scale-16; mPAS, Modified Parkinson Activity Scale; r, Pearson Correlation

The FM showed a negative correlation of moderate magnitude with the UPDRS III (Figure 1) and a negative correlation of low magnitude with depressive symptoms (Figure 2). No correlation with fatigue ($r = -0.292$, $p = 0.094$) was found.

The regression analysis showed that two predictors (motor and depressive symptoms) were kept in the model (Table 3). The motor symptoms alone explained 36% ($F = 17.85$, $p < 0.001$) of the variance in the FM scores. When depressive symptoms were included in the model, the explained variance increased to 45% ($F = 12.77$, $p < 0.001$). This indicated that individuals who

had lower motor and depressive symptoms were less likely to have limitations in FM (Table 3).

Table 3. Linear regression analysis

Variable	Independent variable	B	SE	β	t	R2	F	p
Model 1	UPDRS III	- 0.350	0.083	- 0.598	-4.224	0.358	17.845	<0.001
Model 2	UPDRS III	- 0.298	0.081	- 0.509	-3.670	0.452	12.767	<0.001
	BDI	- 0.158	0.068	- 0.319	-2.301			

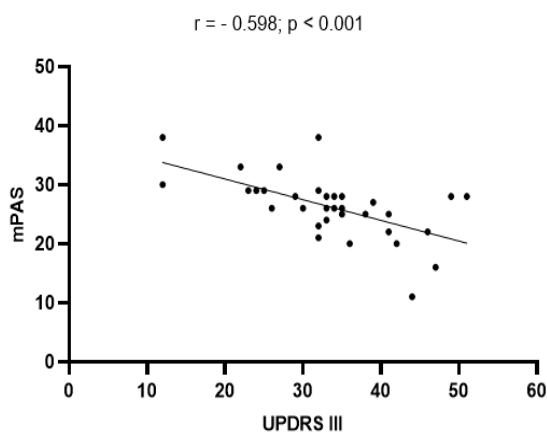


Figure 1. Correlation of moderate magnitude between mPAS and UPDRS III

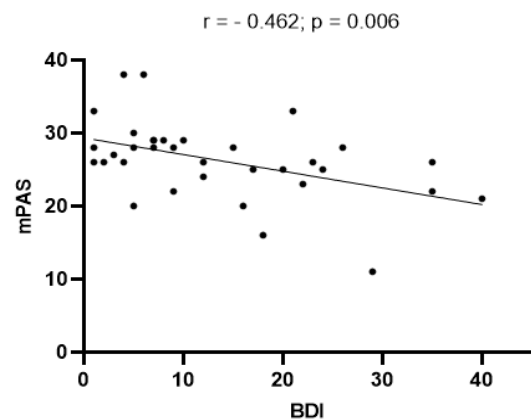


Figure 2. Correlation of low magnitude between mPAS and BDI

DISCUSSION

The aim of the present study was to investigate which motor and/or non-motor symptoms (severity of the motor symptoms, depressive symptoms, and fatigue) have the greatest impact on FM assessed by mPAS in individuals with PD.

The findings showed that the FM was predicted by the motor symptoms (UPDRS III) and depressive symptoms (BDI).

The mobility-related limitation in individuals with PD has been reported in the literature.¹ However, the relationship between FM, assessed by an instrument that evaluates the quality of the movement while patients perform the tasks, and other motor and non-motor symptoms has not been adequately studied in the literature. Furthermore, several studies use the TUG to assess FM.^{4,5,7} Although the TUG has been extensively employed in the examination of elderly people and individuals with neurological conditions, it is limited as its only outcome is the time to complete the test. It is important that measures ensure the examination of different domains of mobility, including task execution quality measurements.

Considering that FM involves the ability to move safely in a variety of environments, in order to perform functional tasks independently,¹ it is important to assess the quality of FM. The mPAS assesses limitations of FM, including aspects of balance, gait, and transfers, which can be used to identify and evaluate physical therapy goals in PD.^{15,27}

Studies have proven the effect of health-related conditions and PD progression on FM, such as multiple-system comorbidity,²⁴ sedentary behavior,⁷ and severity of PD symptoms.^{2,4} Linear and angular acceleration were reduced in individuals with PD when compared to healthy subjects, which determined a diminished movement smoothness and more time to complete TUG.⁴

In addition, a reduction in the trunk flexion, extension, and right/left rotation active range of motion affected the time spent on the TUG.⁵ Results in the present study corroborated data in the literature, showing that motor impairment is an important factor that predicts the FM limitation. UPDRS assesses cardinal PD signs, which are bradykinesia, rigidity, tremor, and postural instability,¹⁹ which affect complex movements and center of mass control, which are necessary to perform tasks evaluated by mPAS.²⁷

Along with the motor symptoms, non-motor symptoms are highly prevalent in PD and can be correlated with the time spent to perform the TUG test.^{10,12} However, to the best of our knowledge, the present study is the first to investigate the effects of depression on FM, using mPAS. The results demonstrate that depression explained 9% of the FM variance.

Although it is unclear how depression affects FM, psychological, behavioral, and physiological factors may be involved. Depression in individuals with PD manifests in physical and psychological aspects, such as apathy, insomnia or excessive sleep, and lack of motivation and energy.²³ Therefore, these manifestations can lead to poor self-efficacy, a sedentary lifestyle, and a low level of FM.

Previous reports have determined that the subjective feeling of fatigue in mobility tasks required for independent community living is related in general populations of older adults²⁸ and increases the time to perform the TUG test in individuals with multiple sclerosis.²⁹ However, a few studies have investigated the effect of the fatigue on FM in individuals with PD. Kader et al.³⁰ found that fatigue was the third strongest factor related to the perception of gait difficulty in PD.

Although Carvalho et al.¹¹ has shown a correlation between PFS-16 and mobility, gait speed, and walking capacity, linear

regression analysis revealed that this non-motor symptom explained only the variance of the distance covered during the 6-minute walk test (6MWT). It is important to highlight that mPAS includes chair transfers, gait akinesia, and bed mobility, which may have contributed to these different results. We believe that fatigue may not have influenced mPAS scores, as these are short-term tasks.

The findings of the present study may have implications for clinical practice. Given the heterogeneity of motor and non-motor symptoms observed in individuals with PD, the results showed that the motor symptoms, including bradykinesia, tremor, rigidity, postural instability, and depressive symptoms were the most relevant impairments.

However, the selected variables, when considered together, were able to explain 45% of the variance in the FM model, suggesting that the FM could also be explained by other variables, such as cognitive impairment, and personal and environmental factors, which were not included in the analyses.

The strength of the study was that measures of motor and non-motor symptoms, which can be addressed during rehabilitation interventions, were included as predictors. In addition, the use of an instrument to assess FM emphasizes the quality of the movement and supports detailed insight into the most important activity limitations in individuals with PD, which can be targeted by physical therapy.²⁷ The limitations in this study included the lack of a control group and evaluations in patients only in the 'on' phase.

CONCLUSION

FM is decreased in individuals with PD and multiple factors may contribute to this limitation. The findings of the present study showed that the FM was predicted by the motor symptoms and depressive symptoms assessed by UPDRS (Part III) and BDI, respectively. UPDRS assesses cardinal PD signs, which are bradykinesia, rigidity, tremor, and postural instability, which affect complex movements and center of mass control, which are necessary to perform tasks evaluated by mPAS.

Depression in individuals with PD manifests in physical and psychological aspects. These manifestations can lead to poor self-efficacy, a sedentary lifestyle, and a low level of FM. These variables should be part of the assessment of individuals with PD.

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