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CONTRIBUTION OF AXIAL MOTOR IMPAIRMENT TO PHYSICAL INACTIVITY IN PARKINSON'S DISEASE

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Abstract

Objective—To investigate the relationships between motor symptoms of Parkinson's disease (PD) and activity limitations in persons with PD.

Design/Methods—Cross-sectional study of persons with mild to moderate PD (N=90). Associations among axial motor features, limb motor signs, the Physical Activity Scale for Elders (PASE), the ability to perform Activities of Daily Living (ADL) and level of ADL dependency were studied. A composite score of axial motor features included the following UPDRS items: speech, rigidity of the neck, arising from chair, posture, gait and postural stability. A composite score of limb motor signs included the following UPDRS items: tremor at rest of all extremities, action tremor, rigidity of all extremities, finger taps, hand movement, rapid alternating hand movements and foot tapping.

Results—Axial motor features of PD were significantly correlated with physical inactivity ($p<.001$), decreased ADL ($p<.001$) and increase in ADL dependency ($p<.001$). Limb motor signs significantly correlated with decreased ADL ($p<.001$) and level of ADL dependency ($p=.035$), but was not correlated with physical inactivity. After controlling for age, gender, disease duration and comorbidity, axial motor features contributed significantly to physical inactivity, decreased ADL and increase in ADL dependency, whereas the limb motor signs did not.

Conclusions—Axial motor impairment contributed to physical inactivity and decreased ability to perform ADLs in persons with PD.

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Keywords

Parkinson's Disease; UPDRS; axial motor feature; limb motor sign; Physical Inactivity; Activities of Daily Living; Physical Activity Scale for Elders

Introduction

Parkinson's disease (PD) is a neurodegenerative disease characterized by clinical features including tremor, rigidity, bradykinesia and postural instability. Motor impairments occur in various parts of the body, including head, neck, trunk and limbs. These motor impairments are both composite and combined, adversely affecting patients' functional ability. [1] Tremor and rigidity are correlated with worsening manual dexterity and reduced ability to perform daily activities. [2] Moreover, gait difficulty, stooped posture, rigidity and postural instability increase the risk of falls and associated consequences that greatly impact functional ability and quality of life. [3, 4] These motor impairments can limit persons with PD from performing activities in daily life, and markedly interfere with performing functional activity.

These factors may therefore cause self-imposed restriction of daily activity, decrease in other physical activities [5] and incline persons with PD towards a sedentary lifestyle and deconditioning. [6] Patients with PD have been found to be 29% less physically active than controls. [7] Several previous studies reported that disease severity, gait impairment, freezing of gait, falls and fear of falling are associated with decreased daily physical activity in people with PD. [7-11] Although specific motor impairments of PD are well recognized, the associations of axial and limb motor impairments to level of physical activity and activity limitations are not clearly described in the literature.

Axial impairment (gait disorder and postural instability) was reported to be strongly associated with disability and poor quality of life in patients with mild to moderate PD and was found to account for 31% of the variance in the Schwab and England Activities of Daily Living Scale (SE-ADL) score. [12] However, some potential confounders were not controlled for in the study, and the independent contribution of axial and limb impairments to activity limitations could not be determined. Therefore, in this study, activity limitations were adjusted for potential confounders (i.e., age, gender, disease duration, comorbidity) and we examined the associations of axial motor features and limb motor signs of PD with physical inactivity. Understanding of the relationship of motor impairments to physical inactivity and activity limitations could encourage healthcare providers to design interventions to overcome these impairments. We hypothesized that axial motor impairment would be strongly associated with physical inactivity and activity limitations in persons with PD.

Methods

Participants

Ninety non-demented, community-dwelling persons with PD were recruited from outpatient movement disorders clinics and PD support groups in Houston and Galveston, Texas. They all were diagnosed with idiopathic PD and received pharmacological therapy. All participants were within Hoehn and Yahr stage 2-3 [13] and were able to ambulate independently. Participants completed cognitive screening and those with greater than moderate impairments on the Cognistat were excluded from the study. [14] All participants were able to follow instructions and independently respond to questionnaires.

Procedures

All participants read and signed an approved consent form prior to participation. The study was approved by the Institutional Review Boards for Human Subject Research for Baylor College of Medicine and Affiliated Hospitals and the University of Texas Medical Branch. The Unified Parkinson Disease Rating Scale (UPDRS) [15] was administered by neurologists with expertise in PD and movement disorders. A research assistant asked the participants about their medical history and administered questionnaires.

Outcome Measures

Comorbidity—The Charlson Comorbidity Index (CCI) [16] was administered as an interview to obtain information and medical history to assess risk based on all diseases or illnesses the participant has. The scale is a weighted index that takes into account the number and seriousness of each comorbid disease and the age of the person in order to predict the risk of death. The comorbid diseases are clustered based on their clinical similarities and weights are assigned using observed mortality rates. Some of the illnesses in the scale are myocardial infarction, peripheral vascular disease, cerebral vascular disease, dementia, pulmonary disease, cancer, renal disease, diabetes, metastatic tumor and AIDS. Higher index scores indicate more severe comorbidity.

UPDRS-Motor score (items 18-31)—The motor section was used to assess motor impairment. The UPDRS motor section is rated by direct examination or observation. The score enables clinicians to quantify the type, number and severity of motor impairments from PD.

Axial Motor Features—Axial motor features were quantified using a composite score of UPDRS-motor section III. The composite score included item 18 (speech), 22 (rigidity of neck), 27 (arising from chair), 28 (posture), 29 (gait) and 30 (postural stability); the composite was used to represent axial motor features. [17] The range of score is 0 to 24. A higher score indicates more severe impairment.

There are varieties of a composite score of the UPDRS for axial motor impairment reported in the literature by several investigators. [18, 19] Speech (dysarthria) is often considered as one of axial features due to its levodopa non-responsiveness feature. [18] Therefore, we included speech impairment as an axial impairment together with gait and postural instability. Due to the fact that the facial expression normally responds well to the levodopa, [19] we did not include that as the axial feature. Tremor of the chin, lips/face involves the same pathophysiology as limb tremors, and often responds well to levodopa. Considering the literature, Bejjani et al. explicitly listed items for axial and limb motor signs derived from the UPDRS, which serves our study objective. [17] As a result, we were in accord with Bejjani et al. for the UPDRS item selection.

Limb Motor Signs—Limb motor signs were quantified using a composite score of UPDRS item 20 (tremor at rest of all extremities except 'face, lips, chin'), 21 (action tremor), 22 (rigidity of all extremities except neck), 23 (finger taps), 24 (hand movement), 25 (rapid alternating hand movements) and 26 (foot tapping). [17] The range of the score is 0 to 72. A higher score indicates more severe impairment.

UPDRS-ADL Subscale (UPDRS Section II; items 5 to 17, range 0-52)—The UPDRS-ADL assesses the ability to perform a range of common ADL tasks that often are impaired in persons with PD, including salivation and sensory complaints. A higher score indicates greater difficulty in performing ADLs.

Schwab and England Activities of Daily Living Scale (SE-ADL; UPDRS Section VI).[20]—The SE-ADL is a disease-specific scale designed to measure global functional ability in ADLs in persons with PD. The scale is rated from 0% (bedridden with vegetative functioning) to 100% (completely independent without awareness of difficulty), with 10% intervals. The score provides the overall percentage of the ability to perform ADLs based primarily on independence and awareness of difficulty. The SE-ADL score is used to represent the level of ADL dependency.

Physical Activity Scale for the Elderly (PASE)—The scale was used to assess physical activity. It measures the level of physical activity in elderly persons within the previous week. The PASE consists of 12 questions regarding the frequency and duration of various activities. The two main components of the PASE are household-related activities (e.g., housework, lawn care, home repair, gardening and volunteer activity) and structured exercises (e.g., sports, jogging, swimming, strengthening and endurance exercises). The total score was calculated according to the instruction manual by multiplying the activity frequency or duration per week, or the participation in an activity (yes/no), by empirically derived weights. Total scores can range from 0 to 400, with higher scores reflecting higher levels of physical activity. The PASE reasonably represents the types of activities in which elderly persons usually participate.[21]

Statistical Analysis

All analyses were performed using IBM SPSS version 22.0. Descriptive statistics for demographic and clinical variables were calculated. Relationships of the outcome measures were indicated by Pearson correlation (r). Hierarchical multiple regression analyses were performed to determine the contribution of axial motor features and limb motor signs to the level of physical activity and ADL limitations. After controlled for age, gender, disease duration and comorbidity in the first block, axial motor features and limb motor signs were entered into the second block using a forward method. The significance level for all tests was set at $p < .05$.

Results

The study population included 90 persons with a mild or moderate stage idiopathic PD (Hoehn and Yahr stage 2-3). Their mean UPDRS-Motor score was 19.36 ± 10.16 and the average duration of PD was 7.90 ± 5.34 years. Sixty-four participants (71.1%) were men and 26 (28.9%) were women (Table 1).

Correlations of motor signs with ADL limitations and physical activity

Pearson correlation analysis demonstrated that axial motor features significantly correlated with level of physical activity, UPDRS-ADL score and level of ADL dependency (SE-ADL). Limb motor signs significantly correlated with ADL score and level of ADL dependency, but not with the level of physical activity. Axial motor features had moderately strong correlations (medium $r = .390$ to large $r = .708$) with physical inactivity and activity limitations, whereas limb motor signs demonstrated small to medium correlations (small $r = -.025$ to medium $r = .40$) with physical inactivity and activity limitations (Table 2).

Contribution of axial motor features and limb motor signs to physical inactivity and activity limitations

A multiple regression analysis using the PASE as the dependent variable was performed. Demographics (including age, gender, disease duration and comorbidity) were entered in step 1 and explained 13% of the variation in the PASE. Axial motor features and limb motor signs were entered in step 2. Only axial motor features were included in the model and explained 20.5% of the total variation in the PASE scores. Limb motor signs were excluded from the model ($\beta = .141$, $p = .231$). Axial motor features explained a significant 7.5% of the additional variance in the PASE scores, after adjusting for age, gender, disease duration and comorbidity (Table 3).

Age, gender, disease duration and comorbidity entered in step 1 explained 9.2% of the variation in UPDRS-ADL. Axial motor features and limb motor signs were entered in step 2. Only axial motor features remained in the model and explained 51.5% of the total variation in the UPDRS-ADL scores. Limb motor signs were excluded from the model ($\beta = .105$, $p = .252$). Axial motor features explained a significant 42.3% of the additional variance in the UPDRS-ADL scores after adjusting for age, gender, disease duration and comorbidity.

With SE-ADL as the dependent variable, age, gender, disease duration and comorbidity entered in step 1 explained 5.2% of the variation in SE-ADL. Axial motor features and limb motor signs were entered in step 2. Only axial motor features were included in the model and explained 34.4% of the total variation in the SE-ADL scores. Limb motor signs were excluded from the model ($\beta = .056$, $p = .604$). Axial motor features explained a significant 29.2% of the additional variance in the SE-ADL scores after adjusting for age, gender, disease duration and comorbidity.

Discussion

This study examined the contribution of axial motor impairment and limb motor signs to physical inactivity in persons with PD. Our results demonstrated that axial motor features contributed significantly to physical inactivity and activity limitations, after adjusting for demographics and health status. Limb motor signs did not contribute significantly to physical inactivity or activity limitations. Several studies have reported the associations of falls, fear of falling and gait impairment with physical inactivity and activity limitations in people with PD. [7-11, 22, 23] However, no previous study has examined systematically the association of specific axial impairments and limb motor signs, which represent the core features of the disease, to activity limitations in PD. This study focused only on the motor aspects of PD impairments and did not include non-motor features (e.g., fatigue, falls, cognition, autonomic dysfunction, lethargy, mood, sleep disorders, pain and depression) that can potentially also contribute to activity limitations. These features also predispose people with PD to sedentary life styles. [7, 24-26] However, it was beyond the scope of this current study to investigate their relationships to physical inactivity.

Generic factors such as age, gender and health status are found to be associated with the level of physical activity in the elderly. [27] Greater comorbidity was associated with less daily physical activity in PD. [7] In this study, we adjusted for demographics (e.g., age, gender, and disease duration) and comorbidity, so that we could independently study the associations of motor impairment to the level of physical activity. As hypothesized, axial impairment contributed significantly to physical inactivity and activity limitations, a result consistent with a previous study by Muslimovic et al., in which greater severity of postural instability and gait disability was a major predictor of rapid progression of disability in PD over time. [12] Muslimovic et al. reported that axial impairment, measured by UPDRS gait and postural instability scores, comorbidity, facial expression and executive function, accounted for 46% of the variance in disability (measured by the Functional Independence Measure, FIM score), [12] and for 31% of the variance in SE-ADL score. Our results, together with those of others, indicate that axial impairment is strongly associated with disability in patients with mild to moderate PD.

Axial motor impairments are known to negatively impact general mobility and ambulation in persons with PD. They are widely presumed to adversely impact ability to perform ADLs and incline patients towards a more sedentary life. In this study, we now provide new supporting evidence to underpin this assumption, based on the analyses of their association with level of physical activity and ADL scores. Axial motor features were significant contributors to the dependent variables assessing ADL limitations (UPDRS-ADL and SE-ADL) and physical activity (PASE). After controlling for demographics and health status, axial motor features had a significant standardized coefficient (β) with all three dependent variables. Our results support the previous finding on the role of axial impairment, measured by postural instability/gait difficulty (PIGD) score, in predicting future disability in PD. [28] Patients with higher PIGD scores at baseline had more rapid progression of disability in PD than those with lower scores.

Limb motor signs did not contribute a significant variance to the physical activity and ADL limitations, even though they were significantly correlated with ADL limitations (UPDRS-ADL and SE-ADL). The correlation of limb motor signs to SE-ADL and UPDRS-ADL were small to moderate ($r = .226$ and $r = .40$, respectively) and failed to significantly contribute to the model. Results indicated that, although the limb motor signs included core features of PD (tremor, bradykinesia, rigidity), they were not a significant contributor to activity limitations. The specificity of the motor symptoms and the ADL items might explain this finding. The UPDRS-ADL consists of 13 items that include both PD-related physical impairments (e.g., handwriting, speech, salivation, swallowing) and ADL items reflecting basic function and mobility (e.g., dressing, walking, eating, freezing while walking). [29] Some of the 13 ADLs involve using of the limbs (e.g., handwriting, cutting food and handling utensils); others involve both limb and axial motor features (e.g. dressing, hygiene, turning in bed and adjusting bedclothes, freezing when walking and walking). The rest of the items are not involved with limb use (e.g., sensory, speech, swallowing and salivation). Apparently, there are more ADL items involve axial motor signs than limb motor signs. Therefore, limb motor signs did not account for the ADL limitations, whereas the axial motor signs did.

The SE-ADL reflects patients' general estimation of their ability to perform ADLs with respect to 1) level of dependency, 2) degree of slowness and 3) awareness of difficulty. The estimation is expressed as a percentage in 10% increments. Scores can range from 0% to 100%, with 100% representing complete independence without awareness of difficulty. This global estimation from the patient's perspective does not assess specific impairments of limb motor signs.

Other investigators previously reported contributors to physical inactivity in PD. Van Nimwegen et al. found that gait impairment, disability in daily life, disease severity, fear of falling, comorbidity, depression and anxiety were associated with lower levels of daily physical activity. [7] Inactivity in PD was associated with worse walking performance, more disability in daily life and greater disease severity. Specifically, time spent on daily physical activity decreased approximately 3% for each point increase in UPDRS. Skidmore et al. reported that disease severity (as measured by the UPDRS) inversely correlated with total number of steps taken during the day and average steps per minute taken during the most active hour as measured by a step activity monitor. [23] In these two studies, disease severity (UPDRS) was correlated with physical inactivity measured by daily step activity. Our results add to the literature the significant contribution of axial motor impairment on activity limitations and support the previous findings on disease severity and physical inactivity in PD.

Some limitations concerning our study should be recognized. First, the sample was a cross-sectional cohort; therefore, the causality of the relationships between motor impairments and physical inactivity and ADL limitations was precluded. Physical inactivity could have occurred before the diagnosis of PD, soon after the diagnosis of PD or later as the PD progressed. Second, since the participants were community dwelling persons with PD, the findings cannot be generalized to institutionalized persons with PD. Third, we used a validated interview-based physical activity questionnaire (PASE) to quantify the level of physical activity. However, it is a subjective method of measuring physical activity, which might be subjected to recall bias, overestimation or underestimation of actual physical activity. These potential biases were minimized by excluding demented patients with PD from the study. Future studies should use an objective measure of activity such as a step activity monitor, or a pedometer. Fourth, axial and limb motor impairments were measured by the clinical rating scale, UPDRS, which is a global evaluation of PD impairment and disease progression. It may underemphasize mobility and may be a poor indicator of ambulatory function, as reported previously. [30, 31] Interpretation of our results was based on physical activity variables used in this study, and caution should be made when generalizing to other functional mobility measures.

Finally, the sample consisted of persons with mild to moderate PD, thus limiting generalizations of the findings to persons with PD in either very early (HY stage 1) or in advanced stages (HY 4 to 5) of the disease. Our sample comprised community dwelling persons with mostly well preserved independence in their ADLs (approximately 85% of SE-ADL).

In this study, we demonstrated that axial motor features explained 7.5%, 42.3% and 29.2% of the variance in the level of physical activity (PASE), UPDRS-ADL and SE-ADL, respectively. Still, a large amount of variance was not explained by the motor impairments investigated in this study, indicating a need for further investigation and suggesting that other factors contribute to the variability in physical activity. Other potential factors include concomitant non-motor features of PD, psychiatric symptoms, socioeconomic status, family support and education. These variables were beyond the scope of this study.

Conclusion

Activity limitations and physical inactivity were significantly correlated with axial motor impairments from PD. The clinical implication is that clinicians should be aware of physical inactivity and ADL limitations associated with axial motor impairment. Interventions to increase or promote physical activity in persons with PD should take into consideration the extent of axial motor impairment.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

References

1. Borrione P, Tranchita E, Sansone P, Parisi A. Effects of physical activity in Parkinson's disease: A new tool for rehabilitation. World J Methodol. 2014; 4(3):133–43. [PubMed: 25332912]
2. Rahman S, Griffin HJ, Quinn NP, Jahanshahi M. Quality of life in Parkinson's disease: the relative importance of the symptoms. Mov Disord. 2008; 23(10):1428–34. [PubMed: 18543333]
3. Bloem BR, Hausdorff JM, Visser JE, Giladi N. Falls and freezing of gait in Parkinson's disease: a review of two interconnected, episodic phenomena. Mov Disord. 2004; 19(8):871–84. [PubMed: 15300651]
4. Grimbergen YA, Munneke M, Bloem BR. Falls in Parkinson's disease. Curr Opin Neurol. 2004; 17(4):405–15. [PubMed: 15247535]
5. Bloem, BR.; Bhatia, KP. Gait and balance in basal ganglia disorders. In: Bronstein, AM.; Brandt, T.; Nutt, JG.; Woollacott, MH., editors. Clinical disorders of balance, posture and gait. Arnold; London: 2004. p. 173-206.
6. Speelman AD, van de Warrenburg BP, van Nimwegen M, Petzinger GM, Munneke M, Bloem BR. How might physical activity benefit patients with Parkinson disease? Nat Rev Neurol. 2011; 7(9): 528–34. [PubMed: 21750523]
7. van Nimwegen M, Speelman AD, Hofman-van Rossum EJ, Overeem S, Deeg DJ, Borm GF, van der Horst MH, Bloem BR, Munneke M. Physical inactivity in Parkinson's disease. J Neurol. 2011; 258(12):2214–21. [PubMed: 21614433]

8. Tan DM, McGinley JL, Danoudis ME, Iansek R, Morris ME. Freezing of gait and activity limitations in people with Parkinson's disease. Arch Phys Med Rehabil. 2011; 92(7):1159–65. [PubMed: 21704798]
9. Ellis T, Cavanaugh JT, Earhart GM, Ford MP, Foreman KB, Fredman L, Boudreau JK, Dibble LE. Factors associated with exercise behavior in people with Parkinson disease. Phys Ther. 2011; 91(12):1838–48. [PubMed: 22003171]
10. Hiorth YH, Lode K, Larsen JP. Frequencies of falls and associated features at different stages of Parkinson's disease. Eur J Neurol. 2013; 20(1):160–6. [PubMed: 22816560]
11. Nilsson MH, Drake AM, Hagell P. Assessment of fall-related self-efficacy and activity avoidance in people with Parkinson's disease. BMC Geriatr. Oct 25.2010 10:78. [PubMed: 20973974]
12. Muslimovic D, Post B, Speelman JD, Schmand B, de Haan RJ, CARPA Study Group. Determinants of disability and quality of life in mild to moderate Parkinson disease. Neurology. 2008; 70(23):2241–7. [PubMed: 18519873]
13. Hoehn MM, Yahr MD. Parkinsonism: onset, progression and mortality. Neurology. 1967; 17(5): 427–42. [PubMed: 6067254]
14. Oehlert ME, Hass SD, Freeman MR, Williams MD, Ryan JJ, Sumerall SW. The Neurobehavioral cognitive status examination: accuracy of the 'Screen-Metric' approach in a clinical sample. J Clin Psychol. 1997; 53:733–7. [PubMed: 9356903]
15. Fahn, S.; Elton, RL.; Members of the UPDRS Development Committee. Unified Parkinson's Disease Rating Scale. In: Fahn, S.; Marsden, CO.; Calne, DB.; Goldstein, M., editors. Recent Developments in Parkinson's Disease. Macmillan Health Care Information; Florham Park, NJ: 1987. p. 153-64.
16. Charlson ME, Sax FL, MacKenzie CR, Fields SD, Braham RL, Douglas RG Jr. Assessing illness severity: does clinical judgment work? J Chronic Dis. 1986; 39(6):439–52. [PubMed: 3086355]
17. Bejjani BP, Gervais D, Arnulf I, Papadopoulos S, Demeret S, Bonnet AM, Cornu P, Damier P, Agid Y. Axial parkinsonian symptoms can be improved: the role of levodopa and bilateral subthalamic stimulation. J Neurol Neurosurg Psychiatry. 2000; 68(5):595–600. [PubMed: 10766889]
18. Bonnet AM, Loria Y, Saint-Hilaire MH, Lhermitte F, Agid Y. Does long-term aggravation of Parkinson's disease result from nondopaminergic lesions? Neurology. 1987; 37(9):1539–42. [PubMed: 3627454]
19. Hiorth YH, Larsen JP, Lode K, Pedersen KF. Natural history of falls in a population-based cohort of patients with Parkinson's disease: an 8-year prospective study. Parkinsonism Relat Disord. 2014; 20(10):1059–64. [PubMed: 25048614]
20. Schwab, RS.; England, ACJ. Projection technique for evaluating surgery in Parkinson's disease. In: Gillingham, FJ.; Donaldson, IML., editors. Third Symposium on Parkinson's Disease. E & S Livingstone; Edinburgh, Scotland: 1969. p. 152-7.
21. Washburn RA, Smith KW, Jette AM, Janney CA. The Physical Activity Scale for the Elderly (PASE): development and evaluation. J Clin Epidemiol. 1993; 46(2):153–62. [PubMed: 8437031]
22. Rahman S, Griffin HJ, Quinn NP, Jahanshahi M. On the nature of fear of falling in Parkinson's disease. Behav Neurol. 2011; 24(3):219–28. [PubMed: 21876261]
23. Skidmore FM, Mackman CA, Pav B, Shulman LM, Garvan C, Macko RF, Heilman KM. Daily ambulatory activity levels in idiopathic Parkinson disease. J Rehabil Res Dev. 2008; 45(9):1343–8. [PubMed: 19319758]
24. Weintraub D, Moberg PJ, Duda JE, Katz IR, Stern MB. Effect of psychiatric and other nonmotor symptoms on disability in Parkinson's disease. J Am Geriatr Soc. 2004; 52(5):784–8. [PubMed: 15086662]
25. Boonstra TA, van der Kooij H, Munneke M, Bloem BR. Gait disorders and balance disturbances in Parkinson's disease: clinical update and pathophysiology. Curr Opin Neurol. 2008; 21(4):461–71. [PubMed: 18607208]
26. Roshanaei-Moghaddam B, Katon WJ, Russo J. The longitudinal effects of depression on physical activity. Gen Hosp Psychiatry. 2009; 31(4):306–15. [PubMed: 19555789]

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27. Chad KE, Reeder BA, Harrison EL, Ashworth NL, Sheppard SM, Schultz SL, Bruner BG, Fisher KL, Lawson JA. Profile of physical activity levels in community-dwelling older adults. Med Sci Sports Exerc. 2005; 37(10):1774–84. [PubMed: 16260980]
28. Post B, Merkus MP, de Haan RJ, Speelman JD, CARPA Study Group. Prognostic factors for the progression of Parkinson's disease: A systematic review. Mov Disord. 2007; 22:1839–51. [PubMed: 17595026]
29. Hariz GM, Lindberg M, Hariz MI, Bergenheim AT. Does the ADL part of the unified Parkinson's disease rating scale measure ADL? An evaluation in patients after pallidotomy and thalamic deep brain stimulation. Mov Disord. 2003; 18(4):373–81. [PubMed: 12671942]
30. Ivey FM, Katzel LI, Sorkin JD, Macko RF, Shulman LM. The Unified Parkinson's Disease Rating Scale as a predictor of peak aerobic capacity and ambulatory function. J Rehabil Res Dev. 2012; 49(8):1269–76. [PubMed: 23341319]
31. Herman T, Weiss A, Brozgol M, Giladi N, Hausdorff JM. Gait and balance in Parkinson's disease subtypes: objective measures and classification considerations. J Neurol. 2014; 261(12):2401–10. [PubMed: 25249296]

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Table 1

Clinical characteristics of persons with PD (N=90). Figures are mean and standard deviation unless indicated otherwise.

Subject Characteristics	Mean ± SD	Range
Age (years)	69.82 ± 8.84	42
Gender (N and %) Male Female	64 (71.1%) 26 (28.9%)	
Year since diagnosis of PD	7.90 ± 5.34	22
Motor impairment (UPDRS-Motor)	19.36 ± 10.16	63
Physical activity (PASE)	99.74 ± 62.61	294
Daily activity limitations (UPDRS-ADL)	12.63 ± 5.55	28
Percentage of daily activity limitations (SE-ADL; N=88)	84.60 ± 10.97	60

PD = Parkinson's Disease

HY = Hoehn and Yahr Scale

UPDRS = Unified Parkinson's Disease Rating Scale.

PASE = Physical Activity Scale for the Elderly

SE-ADL = Schwab and England Activities of Daily Living Scale

Table 2

Correlation between axial motor feature, limb motor signs, PASE, UPDRS-ADL and SE-ADL.

Variables	Axial feature	P-value	Limb sign	P-value
Physical Activity (PASE)	−.390	<.001	−.025	.813
UPDRS-ADL	.708	<.001	.400	<.001
SE-ADL	−.561	<.001	−.226	.035

PASE = Physical Activity Scale for the Elderly

UPDRS-ADL = Unified Parkinson's Disease Rating Scale- Activities of Daily Living

SE-ADL = Schwab and England Activities of Daily Living Scale

Table 3

Multiple regression analysis assessing the variance in PASE, UPDRS-ADL and SE-ADL scores explained by axial motor features and limb motor signs.

Dependent Variable	Independent Variable	B	SE	β (P-value)	R^2	ΔR^2	F of ΔR^2 (df)	P-value
PASE Model Excluded variable	Axial feature * Limb signs **	−5.742	2.045	−.296 (.006) .141 (.231)	.205	.075	7.881 (1,84)	.006
UPDRS-ADL Model Excluded variable	Axial feature Limb signs	1.213	.142	.706 (<.001) .105 (.252)	.515	.423	73.275 (1,84)	<.001
SE-ADL Model Excluded variable	Axial feature Limb signs	−1.972	.326	−.587 (<.001) .056 (.604)	.344	.292	36.50 (1,82)	<.001

UPDRS-ADL = Unified Parkinson’s Disease Rating Scale- Activities of Daily Living

SE-ADL = Schwab and England Activities of Daily Living Scale

*Axial feature = UPDRS item 18 (speech), 22 (rigidity of neck), 27 (arising from chair), 28 (posture), 29 (gait), and 30 (postural stability).

**Limb sign = UPDRS item 20 (tremor at rest of all extremities except ‘face, lips, chin’), 21 (action tremor), 22 (rigidity of all extremities all extremities except neck), 23 (finger taps), 24 (hand movement), 25 (rapid alternating hand movements), and 26 (foot tapping).