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Investigation of factors impacting mobility and gait in Parkinson disease

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ABSTRACT

Mobility and gait limitations are major issues for people with Parkinson disease (PD). Identification of factors that contribute to these impairments may inform treatment and intervention strategies. In this study we investigated factors that predict mobility and gait impairment in PD. Participants with mild to moderate PD and without dementia (n = 114) were tested in one session 'off' medication. Mobility measures included the 6-Minute Walk test and Timed-Up-and-Go. Gait velocity was collected in four conditions: forward preferred speed, forward dual task, forward fast as possible and backward walking. The predictors analyzed were age, gender, disease severity, balance, balance confidence, fall history, self-reported physical activity, and executive function. Multiple regression models were used to assess the relationships between predictors and outcomes. The predictors, in different combinations for each outcome measure, explained 55.7% to 66.9% of variability for mobility and 39.5% to 52.8% for gait velocity. Balance was the most relevant factor (explaining up to 54.1% of variance in mobility and up to 45.6% in gait velocity). Balance confidence contributed to a lesser extent (2.0% to 8.2% of variance) in all models. Age explained a small percentage of variance in mobility and gait velocity (up to 2.9%). Executive function explained 3.0% of variance during forward walking only. The strong predictive relationships between balance deficits and mobility and gait impairment suggest targeting balance deficits may be particularly important for improving mobility and gait in people with PD, regardless of an individual's age, disease severity, fall history, or other demographic features.

1. Introduction

Parkinson disease (PD) is characterized by both motor and non-motor features, the presence and extent of which vary from individual to individual. In particular, mobility and gait are often impaired in people with PD, as gait requires complex coordination (Jankovic, 2015). The movement difficulty that people with PD experience in their daily lives may be caused by

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a combination of age-related changes, such as decreased muscle strength, impaired balance, and lower visual acuity, as well as disease-related issues. Pathological and compensatory changes in a variety of locomotor brain regions occur in PD and they may lead to increased variability and asymmetry, poor postural control, bradykinesia, rigidity, and freezing of gait (Peterson & Horak, 2016).

While age-related changes and disease severity are commonly known to affect mobility and gait in PD (Dewey et al., 2014; Rodriguez, Rodriguez-Sabate, Morales, Sanchez, & Sabate, 2015), recent evidence suggests that cognitive function may also play a role (Smulders et al., 2013). In contrast to other neurodegenerative conditions which primarily feature cognitive deficits (such as Alzheimer disease), the cognitive profile in PD is more heterogeneous, likely reflecting the more variable underlying neuropathology (Burdick et al., 2014; Lin & Wu, 2015). Among the cognitive impairments present in individuals with PD, executive dysfunction is of particular interest for two reasons. First, executive dysfunction is frequently observed in early stages of the disease (Lanni et al., 2014), and it may precede and foreshadow mobility impairments. Additionally, executive function plays an important role in complex situations, such as dual task walking, that require divided attention (Varalta et al., 2015). Gait performance is known to be affected in various complex situations in people with PD (Amboni, Barone, & Hausdorff, 2013).

Previous studies examined factors that may predict mobility and gait impairment in PD. Different combinations of factors including demographic characteristics, disease severity, fall history, fear of falling, other gait and mobility measures, freezing of gait, balance, balance confidence, muscle power, cognition, and depression, have been identified as significant predictors (explaining up to 30–73% of variance) of gait and mobility performance in single and dual task conditions (Falvo & Earhart, 2009; Lord, Rochester, Hetherington, Allcock, & Burn, 2010; Lord et al., 2014; Nemanich et al., 2013; Paul, Sherrington, Fung, & Canning, 2013; Rochester et al., 2008; Stegemöller et al., 2014; Strouwen et al., 2016; Varalta et al., 2015). All except one of these previous studies measured participants while on anti-parkinson medication, and the single study testing 'off' medication included a relatively small sample (Lord et al., 2010). While medications are known to impact gait and mobility as well as some of these previously identified factors (Hoskovcová et al., 2015), it is unclear whether different factors may be better predictors in the 'off' medication state when motor function is worse. Further, only one study previously examined balance as a potential predictive factor for gait or mobility in PD on medication (Falvo & Earhart, 2009), but predictive value was only assessed for the six minute walk test distance. Balance has been shown to be related to gait, even in the early stages of PD (Yang, Lee, Cheng, Lin, & Wang, 2008). Even knowing the impact that exercise has on gait and mobility (Shen, Wong-Yu, & Mak, 2015; Shu et al., 2014), no previous studies have included measures of levels of physical activity as potential predictors. As a result, balance and physical activity may be key predictors for gait and mobility outcomes, and these factors may explain variance unaccounted for in previous models.

Recognizing that several factors can affect mobility and gait in PD, we further investigated the impact of age, disease severity, balance, balance confidence, fall history, self-report physical activity, and executive function on measures of mobility and gait performance. To our knowledge, this study is the first to evaluate the relationships between common mobility and gait outcomes and key demographic and clinical characteristics, including balance and physical activity, in a large sample of people with PD tested in the 'off' medication state. Improving our understanding of the demographic and clinical factors that may contribute to mobility and gait deficits in PD may inform the development of future targeted interventions and clinical best practices to address impairments.

2. Methods

2.1. Participants

Individuals with idiopathic PD were recruited from the Movement Disorders Center at Washington University School of Medicine. All participants provided informed consent, and the protocol was approved by the Human Research Protection Office. Data were collected from 114 participants with PD during the baseline visit of a larger trial, prior to participation in an exercise intervention (Earhart, Duncan, Huang, Perlmutter, & Pickett, 2015).

This study included community-dwelling participants diagnosed with idiopathic PD (Calne, Snow, & Lee, 1992) with Hoehn & Yahr (HY) Stages I-III (Hoehn & Yahr, 1967), and scores $\geqslant$24 on the Mini-Mental State Examination (Folstein, Folstein, & Mchugh, 1975). Individuals were excluded if they had a diagnosis of atypical Parkinsonism, had dementia of any kind, or had any other neurological condition. All participants were evaluated in the 'off' medication state (i.e. at least twelve hours since the last dose of PD medication).

2.2. Outcome and predictor variables

This study examined to what extent demographic and clinical features predicted mobility and gait performance outcomes. Mobility was assessed using the Timed Up and Go test (TUG) and the six minute walk test (6MWT). The TUG (Podsiadlo & Richardson, 1991) requires participants to stand up from a seated position, walk 3 m, turn around, walk back, and sit down again. The 6MWT was used to assess endurance by measuring the maximum distance an individual was able to walk within six minutes. For the 6MWT, the participant walked back and forth along a 30 m open hallway. Participants were permitted to stop to rest and/or use their normal assistive device if needed. Time continued to elapse during any rest periods.