Functional Correlates and Prevalence of Mild Parkinsonian Signs in a Community Population of Older People

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Background: Mild parkinsonian signs (MPS) are associated with incident dementia and an increased risk of mortality. To our knowledge, the functional correlates of MPS have not been studied.

Objectives: To study the functional correlates of MPS, including self-reported and performance-based measures of function, and to determine the prevalence of MPS in a cohort of community-dwelling older people (aged ≥65 years).

Design: Participants (N=1866) in the Washington Heights–Inwood Columbia Aging Project underwent a neurological assessment that included a modified motor portion of the Unified Parkinson’s Disease Rating Scale, which yielded a parkinsonian sign score (range, 0-40) and parkinsonian sign subscores (axial function, rigidity, and tremor). A functional assessment included 3 self-reported measures of function and 2 performance-based tests. Participants with Parkinson disease were excluded.

Results: Mild parkinsonian signs were present in 469 (25.1%) of the 1866 participants. The parkinsonian sign score was correlated with functional and performance-based test scores ($r=0.24-0.32$, $P<.001$). The axial function and rigidity subscores correlated to a greater extent with functional and performance-based test scores than did the tremor subscore. In analysis of covariance models, excluding participants with dementia and adjusting for age, sex, ethnicity, education, depressive symptoms, and medical illnesses (eg, arthritis), the parkinsonian sign score and age were strongly and independently associated with functional scores.

Conclusions: Mild parkinsonian signs, and particularly axial dysfunction, were associated with functional disability, including self-reported and performance-based measures of functional difficulty. Given the high prevalence of these signs in elderly persons, MPS may be a significant indicator of disability in elderly persons.

Arch Neurol. 2005;62:297-302

Mild parkinsonian signs (MPS) occur in 30% to 40% of community-dwelling older people. These signs (bradykinesia, rigidity, gait disturbance, and resting tremor) are important because they are progressive and are associated with incident dementia and an increased risk of mortality. It is unclear whether the emergence of MPS reflects an age-associated decline in nigrostriatal dopaminergic activity or the presence of emerging Alzheimer disease or subcortical cerebrovascular disease.

Regardless of their pathogenesis, to our knowledge the functional correlates of these MPS have not been studied. Given the manifestation of these signs as bradykinesia, rigidity, and gait disturbance (ie, slowness, stiffness, and difficulty walking), our hypothesis is that these signs are associated with functional impairment. Given the high prevalence of these signs in elderly persons, MPS could be a significant indicator of disability in elderly persons.

The prevalence of MPS in community-dwelling older people living in the Washington Heights–Inwood area of New York City in 1992 was previously reported. We now report the results of a new cohort of older people from the same community who were examined in 2002 and 2003. The primary goal of the present study was to examine the functional correlates of MPS, including self-reported and performance-based measures of function. A secondary goal was to report the prevalence of MPS in a new cohort of community-dwelling older people examined in 2002 and 2003.
Participants in the second Washington Heights–Inwood Columbia Aging Project cohort were drawn by random sampling of healthy Medicare beneficiaries 65 years and older residing within a geographically defined area of northern Manhattan in New York City. Recruitment of participants between October 5, 1999, and April 15, 2001 (n = 2081 baseline assessments), was achieved by contacting a stratified random sample of 50% of all persons 65 years and older obtained from the Health Care Finance Administration (Center for Medicare Services). Because the first follow-up examination (May 13, 2002–January 2, 2004) included an extensive functional assessment, this was the focus of this article. As of January 2, 2004, data were available on 2029 participants who had completed their first follow-up examination. The mean ± SD age of the 2029 participants was 79.4 ± 6.7 years, their mean ± SD education was 10.0 ± 4.9 years, 1403 (69.1%) were women, and 810 (39.9%) were Caribbean Hispanic. As outlined earlier, data were excluded for 163 (8.0%) of the 2029 participants who had the first follow-up examination (41 participants taking neuroleptic medications, 33 with Parkinson disease [PD], and 89 with incomplete data), resulting in a final sample of 1866 participants (Figure).

At the first follow-up examination, demographic data were collected. Each participant also underwent a structured interview of health and function, which included a questionnaire about medical illnesses (eg, arthritis and diabetes mellitus), and a standardized neurological examination, which included an abbreviated (10-item) version of the motor portion of the UPDRS. We excluded data from 41 participants who were taking a neuroleptic medication because parkinsonian signs can result from the use of these medications. We assigned a diagnosis of PD or Parkinson plus syndrome based on research criteria, and participants were considered to have PD or Parkinson plus syndrome if they had (1) previously received a diagnosis of PD or Parkinson plus syndrome or (2) 2 or more cardinal signs of parkinsonism on the standardized neurological examination. Cardinal signs were bradykinesia, rigidity, postural instability, and rest tremor. A cardinal sign was considered present when one UPDRS rating was 2 or higher. Of the remaining 1988 participants, 33 (1.7%) had a diagnosis of PD or a Parkinson plus syndrome, which is consistent with a prevalence of PD that has been reported for persons 65 years or older in northern Manhattan. These 33 participants were excluded because our intention was to study a community population of older people without these diseases. We also excluded 89 participants with incomplete UPDRS data. In total, 163 participants were excluded (Figure).

The final sample, 1866 participants, had a mean ± SD age of 79.4 ± 6.3 years and a mean ± SD education of 10.2 ± 4.9 years; 1283 (68.8%) were women, and 730 (39.1%) were Caribbean Hispanic. Most analyses were performed on 1666 of these participants who did not have dementia (Table 1). The study was approved by our institution’s internal review board, and written consent was obtained from all participants.

### Functional Assessment

A detailed functional assessment included 3 self-reported measures of function, the Blessed Functional Activities Scale (range, 0 [bedridden] to 100 [functionally normal]), the Schwab and England Activities of Daily Living Scale (range [in units of 10], 0 [bedridden] to 100 [functionally normal]), and the Active Life Expectancy Scale. The Active Life Expectancy Scale was developed to overlap with existing scales like the Blessed Functional Activities Scale but also to capture additional subclinical or precursor adaptations to functional limitations that are not necessarily picked up by the Blessed Functional Activities Scale. There are 6 items that appear on the Active Life Expec-
tancy Scale and the Blessed Functional Activities Scale and 5 items that are unique to the Active Life Expectancy Scale. The Active Life Expectancy Scale, which assesses the ability to perform 11 activities (eg, walk outdoors, get out of a chair, bathe and shower, or comb or brush hair), can be scored from 0 (normal function) to 11 (maximally impaired).

Two simple and easy-to-administer performance-based measures of function were devised. These were a timed gait task and a timed chair stand test. For the timed gait task, a tape measure was laid out on the floor, establishing a 4-m course, and the time (recorded in seconds with a stopwatch) to complete the trial was recorded. If the subject used a cane or walker, the subject was allowed to use the cane or walker during the timed task. For the timed chair stand test, the time (in seconds) required to complete 5 chair stands (standing up from a seated position) was recorded.

### STATISTICAL ANALYSES

Analyses were cross-sectional, and were performed using a commercially available software program (SPSS, version 11.0; SPSS Inc, Chicago, Ill). Most analyses were performed after having excluded the 200 participants with dementia (Table 1), because dementia is a confounder in the association between MPS and function. In some analyses (Table 2), the parkinsonian sign score was stratified into subscores, based on a factor analysis. The subscores were the axial function subscore (speech, facial expression, posture, and axial bradykinesia; range, 0-16), the rigidity subscore (rigidity rated separately in the neck and in each limb; range, 0-20), and the tremor subscore (range, 0-4). The correlation between the parkinsonian sign score, the parkinsonian sign subscore, and the functional and performance-based test scores was assessed with the Spearman correlation coefficient (Table 2). In some analyses (Table 3), the parkinsonian sign score was stratified (0, 1, 2, 3, 4, 5, 6, and ≥7), with scores of 7 or greater collapsed into 1 stratum because of the few participants with scores of 7 or greater. The association between increasing parkinsonian sign score and functional and performance-based test scores was assessed with a test for linear trend. We examined the association between functional and performance-based test scores and the parkinsonian sign score after adjusting for other covariates using analysis of covariance models (Table 4). Covariates were chosen if they were associated with functional disability and MPS. In each of the 5 analyses of covariance models, a functional or performance-based test score was a dependent variable, and the parkinsonian sign score was an independent variable, adjusted for the covariates listed in Table 4.
The score was the dependent variable and covariates were parkinsonian sign score, age (in years), sex, ethnicity, education (in years), Center for Epidemiologic Studies Depression Scale score, and medical illnesses that were each coded as present vs absent by self-report (diabetes mellitus, myocardial infarction, congestive heart failure, chronic obstructive pulmonary disease, peripheral vascular disease, seizures, and arthritis). Finally, in a single general linear model in which we adjusted for the covariates previously listed, we tested whether the parkinsonian sign score was independently associated with the functional and performance-based test scores (dependent variables).

## RESULTS

There were 1866 participants, of whom 200 (10.7%) had dementia and 1666 (89.3%) did not have dementia (Table 1). Mild parkinsonian signs (parkinsonian sign score, ≥1) were present in 469 (25.1%) of the 1866 participants, including 365 (21.9%) of the 1666 participants without dementia and 104 (52.0%) of the 200 participants with dementia. Of the 1666 participants without dementia, 234 (14.0%) had an abnormality in axial function, 212 (12.7%) had rigidity, and 22 (1.3%) had tremor. In terms of axial function and rigidity, 88 (5.3%) of the 1666 participants without dementia had an abnormality in axial function and rigidity, 146 (8.8%) only had an abnormality in axial function, and 124 (7.4%) only had rigidity. Participants with dementia reported more functional difficulty and performed more slowly on performance-based tests than did participants without dementia (Table 1).

The remaining analyses (Tables 2-4) were performed only on the 1666 participants without dementia. The parkinsonian sign score was correlated with each of the

### Table 3. Functional and Performance-Based Test Scores, Stratified by Parkinsonian Sign Score, in the 1666 Participants Without Dementia

<table>
<thead>
<tr>
<th>Parkinsonian Sign Score</th>
<th>Blessed Functional Activities Scale Score*</th>
<th>Schwab and England Activities of Daily Living Scale Score†</th>
<th>Active Life Expectancy Scale Score‡</th>
<th>Timed Gait Test Score, s</th>
<th>Chair Stand Test Score, s</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 (n = 1301)</td>
<td>0.63 ± 0.97</td>
<td>93.69 ± 11.17</td>
<td>1.19 ± 1.78</td>
<td>5.33 ± 4.07</td>
<td>15.85 ± 7.32</td>
</tr>
<tr>
<td>1 (n = 111)</td>
<td>1.33 ± 1.54</td>
<td>87.43 ± 13.18</td>
<td>2.43 ± 2.34</td>
<td>7.57 ± 5.52</td>
<td>17.30 ± 5.19</td>
</tr>
<tr>
<td>2 (n = 69)</td>
<td>1.33 ± 1.82</td>
<td>86.91 ± 14.40</td>
<td>2.05 ± 2.08</td>
<td>7.55 ± 4.55</td>
<td>18.90 ± 7.02</td>
</tr>
<tr>
<td>3 (n = 56)</td>
<td>1.35 ± 1.40</td>
<td>86.61 ± 14.68</td>
<td>2.41 ± 2.38</td>
<td>7.98 ± 5.86</td>
<td>19.14 ± 5.03</td>
</tr>
<tr>
<td>4 (n = 25)</td>
<td>1.50 ± 1.54</td>
<td>84.80 ± 21.63</td>
<td>3.00 ± 2.62</td>
<td>7.46 ± 4.14</td>
<td>20.89 ± 6.38</td>
</tr>
<tr>
<td>5 (n = 40)</td>
<td>1.91 ± 2.31</td>
<td>83.75 ± 21.34</td>
<td>2.47 ± 3.31</td>
<td>7.64 ± 3.10</td>
<td>22.84 ± 8.13</td>
</tr>
<tr>
<td>6 (n = 30)</td>
<td>1.57 ± 2.06</td>
<td>89.33 ± 15.52</td>
<td>2.61 ± 2.38</td>
<td>8.23 ± 5.20</td>
<td>19.44 ± 6.40</td>
</tr>
<tr>
<td>≥7 (n = 34)</td>
<td>1.93 ± 1.69</td>
<td>76.03 ± 19.22</td>
<td>3.53 ± 2.62</td>
<td>9.39 ± 5.41</td>
<td>16.90 ± 5.34</td>
</tr>
</tbody>
</table>

*P value for trend

- Including those with a parkinsonian sign score of 0: .001
- Excluding those with a parkinsonian sign score of 0: .03

*The range is from 0 (normal) to 17.
†The range is from 0 to 100 (normal).
‡The range is from 0 (normal) to 11.

### Table 4. ANCOVA Models: Association of Functional and Performance-Based Test Scores and the Parkinsonian Sign Score After Adjusting for Other Covariates in the 1666 Participants Without Dementia*

<table>
<thead>
<tr>
<th>Covariate</th>
<th>Model 1: Blessed Functional Activities Scale Score</th>
<th>Model 2: Schwab and England Activities of Daily Living Scale Score</th>
<th>Model 3: Active Life Expectancy Scale Score</th>
<th>Model 4: Timed Gait Test Score</th>
<th>Model 5: Chair Stand Test Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, y</td>
<td>53.59†</td>
<td>49.19†</td>
<td>49.92†</td>
<td>51.38†</td>
<td>0.68</td>
</tr>
<tr>
<td>Sex</td>
<td>2.72</td>
<td>1.10</td>
<td>6.93†</td>
<td>8.49§</td>
<td>0.04</td>
</tr>
<tr>
<td>Ethnicity</td>
<td>3.89‡</td>
<td>1.79</td>
<td>2.56</td>
<td>3.65‡</td>
<td>3.69‡</td>
</tr>
<tr>
<td>Education, y</td>
<td>1.41</td>
<td>0.79</td>
<td>11.76‡</td>
<td>10.68§</td>
<td>3.67</td>
</tr>
<tr>
<td>Arthritis (present vs absent)</td>
<td>13.80†</td>
<td>14.40†</td>
<td>21.20†</td>
<td>14.40†</td>
<td>2.00</td>
</tr>
<tr>
<td>CES-D score</td>
<td>76.60‡</td>
<td>15.73‡</td>
<td>24.76†</td>
<td>2.10</td>
<td>21.29†</td>
</tr>
<tr>
<td>Parkinsonian sign score</td>
<td>75.06‡</td>
<td>57.18‡</td>
<td>47.37†</td>
<td>36.65‡</td>
<td>18.93‡</td>
</tr>
</tbody>
</table>

*Data are given as F values. Other covariates (not shown) in each model were medical illnesses that were each coded as present vs absent (diabetes mellitus, myocardial infarction, congestive heart failure, chronic obstructive pulmonary disease, peripheral vascular disease, and seizures).
†P<.001.
‡P<.05.
§P<.005.
self-reported measures of function and the performance-based test scores (r range, 0.24-0.32; P<.001 for all) (Table 2). The axial function subscore (r=0.14-0.28) and the rigidity subscore (r=0.16-0.25) correlated to a greater extent with the functional and performance-based test scores than did the tremor subscore (r=0.001-0.07) (Table 2). An increase in the parkinsonian sign score was associated with greater functional difficulty in each of the self-reported scales and with slower performance on the timed gait test and timed chair stand (Table 3).

We examined the association between functional and performance-based scores and the parkinsonian sign score after adjusting for other covariates in analysis of covariance models (Table 4). In most models, the parkinsonian sign score and age were most strongly associated with the functional and performance-based test scores. Finally, in a single general linear model in which we adjusted for the covariates previously listed, the parkinsonian sign score was independently associated with the following dependent variables: the Blessed Functional Activities Scale score (F=6.53, P<.001), the Schwab and England Activities of Daily Living Scale score (F=2.33, P=.01), the Active Life Expectancy Scale score (F=3.39, P<.001), the timed gait test score (F=3.00, P<.001), and the chair stand test score (F=2.10, P=.02).

Although they are characterized by slowness, stiffness, and gait disorder, to our knowledge the functional correlates of MPS have not been studied. In the present study, these signs were present in nearly 1 of 4 of the community-dwelling elderly persons. The most prevalent of these signs were problems with axial function and rigidity. We used several self-reported measures of function and 2 performance-based tests to assess the functional correlates of these signs in nearly 2000 community-dwelling elderly persons. Parkinsonian signs were correlated with greater functional difficulty, including self-reported and performance-based measures of function. This correlation was independent of the effects of age and other potential confounding variables that we measured (eg, depressive symptoms and medical comorbidity). Axial dysfunction and rigidity, rather than tremor, were associated with functional difficulty.

The functional impact of parkinsonian signs in patients with PD is well established. While it is a reasonable hypothesis that MPS might be associated with some functional impairment, to our knowledge this had not been examined previously. The degree of functional impairment that we observed in participants without dementia who had MPS was mild on average, but it increased according to the severity of the MPS. The mean Schwab and England Activities of Daily Living Scale score in a participant with an MPS score of 1-2 was approximately 87, which indicates an individual who is completely independent but is aware of difficulty and reports that daily chores take twice as long to perform. Their mean Blessed Functional Activities Scale score was approximately 1 to 1.5, indicating either some difficulty on 2 or 3 daily tasks or a lot of difficulty on at least 1 daily task. In participants whose MPS score was 7 or higher, the mean Schwab and England Activities of Daily Living Scale score was 76, indicating individuals who are beginning to lose independence and who take between 2 and 4 times longer to perform their chores. Their mean Blessed Functional Activities Scale score was approximately 2, indicating either some difficulty on 4 daily tasks or a lot of difficulty on 2 daily tasks. As a comparison, the mean Schwab and England Activities of Daily Living and Blessed Functional Activities Scale scores that we found in the patients with PD who were excluded were 71.0 and 4.5, respectively.

Axial function and rigidity, rather than tremor, were associated with functional difficulty. There is some overlap between the types of tasks that compose the UPDRS axial function score and tests of function. This overlap, however, is not complete. Speech and facial expression are components of the UPDRS axial function score but not measured in functional tests, and many of the self-reported measures of function (eg, comb or brush hair) are not incorporated into the UPDRS axial function score.

A limitation of these analyses is that they were cross-sectional. Therefore, we were able to examine the functional correlates rather than the consequences of MPS. A prospective study, which is planned, will examine the functional consequences of these signs. In addition, our modified UPDRS did not include the assessment of appendicular bradykinesia so that it is possible that we may have underestimated the correlates of MPS. None of the participants with MPS had PD. While it is possible that some of these participants could develop incident PD during follow-up, given the low reported incidence of PD in this age group (0.5-2.5 per 1000 persons per year), the number is expected to be small (ie, ≤2.5 PD cases per 1000 persons followed up per year).9 Despite these limitations, the study had several strengths, including the use of a community-based sample, the size of the sample (approximately 2000 elderly participants), the use of multiple standardized functional scales, the use of scales that assessed self-reported function and performance-based tests of function, and the adjustment for dementia, depressive symptoms, and other potential confounders.

Accepted for Publication: April 27, 2004. 
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Funding Support: This study was supported by federal grants AG07232, R01 NS56630, R01 NS42859, and R01 NS59422 from the National Institutes of Health, Bethesda, Md.
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