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Claims-Based Frailty and Outcomes–Applying an Aging Measure to Older Adults with Parkinson's Disease

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Abstract

Background: Frailty is a geriatric syndrome with negative health impacts not captured by comorbidity and disability alone. The prevalence of frailty in Parkinson disease has been described, but data on frailty-associated outcomes are limited.

Objective: To describe the level of frailty and investigate the association between frailty and outcomes in a Medicare sample of persons diagnosed with Parkinson disease.

Methods: We used the claims-based frailty index to assess frailty in a cohort of Medicare beneficiaries with Parkinson disease in 2013. Frailty was categorized as non-frail/prefrail, mildly frail, moderately frail, and severely frail. Adjusted logistic regression models examined the relationship between frailty and mortality, hospitalization, emergency department visits, and fall-related injuries through 2014.

Results: Of 62,786 beneficiaries with Parkinson disease in 2013, 55.3% were frail. Frail individuals were more likely to be female, older, Black, metropolitan dwelling, without neurologist care, nursing facility residents, or multimorbid. The average daily levodopa equivalent

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dose initially increased, then decreased from the prefrail to the severely frail groups. Compared to non-frail/prefrail persons, severely frail persons had higher adjusted odds of one-year mortality (AOR=2.74, 95% CI: 1.98, 3.78), hospitalization (AOR=2.34, 95% CI: 1.74, 3.14), emergency department visits (AOR=2.97, 95% CI: 2.14, 4.13), and fall-related injury (AOR=1.43, 95% CI: 0.90, 2.26).

Conclusion: Frailty is common and differentially distributed among older adults with PD. Frailty in PD is associated with adverse health outcomes and death. Observational study analyses may benefit from adjustment for frailty; claims-based frailty surveillance may identify vulnerable PD patients in health system, registry, or administrative data.

Keywords

Parkinson Disease; Medicare; Frailty; Outcomes; Research Methods

INTRODUCTION

Frailty is a state of dwindling physiological reserve and subsequent physiologic vulnerability typically seen with older age.[1,2] Frailty impacts, on average, 17% of community-dwelling older adults (≥50 years of age); however, the estimated prevalence differs by setting, population characteristics, and approach to frailty measurement.[3] Treatment patterns may vary between frail and non-frail individuals.[4] Falls, impairment, disability, hospitalization, and mortality are all associated with frailty.[2,5-7] These findings persist even after accounting for comorbidities and disability.[2] Given its strong association with adverse health outcomes, failing to adjust for frailty in observational studies of older adults may lead to biased study estimates due to residual confounding.[4] Frailty may also function as an effect measure modifier.[4,8]

Previous studies of persons with Parkinson disease (PD) find a prevalence of frailty between 3.4% and 84%[9-23] and that PD pathology is associated with progression to frailty.[18] These are noteworthy findings; however, the current literature on frailty in PD is primarily based on data that are drawn from small[10-13,15-24] or academic center [14,15,17,19,21,23] samples. Prior work has demonstrated that academic center limited sampling may systematically exclude individuals with PD who are older, female, from minority race/ethnic groups, rural dwelling, or from lower socioeconomic strata.[25] Medical claims provide an opportunity to examine frailty and its associated outcomes in a more diverse PD patient sample.[26,27]

Several instruments have been developed to capture frailty using modalities such as patient questionnaires, clinical examination, or medical claims.[7,8,28] *Physical frailty phenotype* centered instruments characterize frailty based on physical symptoms that may overlap with presentations of PD itself, including unintentional weight loss, weakness, low energy, low physical activity, and slowness.[2,9,24] In contrast, *deficit- accumulation* based instruments assess frailty by summing diagnoses of individual chronic conditions and other ailments.[29] We used a validated deficit- accumulation based frailty instrument to 1) describe the distribution of frailty and 2) determine if frailty is associated with key health outcomes among older adult Medicare beneficiaries with PD.

METHODS

Standard Protocol Approvals and Patient Consents

The University of Pennsylvania Human Research Protections Office and the Centers for Medicare and Medicaid Services (CMS) approved this study with a waiver of individual level consent.

Data Source

Data were obtained from the 2011-2014 CMS Research Identifiable Files.[30] We extracted beneficiary demographics, Medicare enrollment information, and data on specific comorbid conditions from the Chronic Conditions Data Warehouse (CCW) and Master Beneficiary Summary File. All other diagnoses and procedures were extracted from the Carrier file. Prescription claims were identified in the Part D Drug Event file. As detailed below, data beginning in the year 2011 was used to establish Medicare eligibility, PD diagnosis, comorbidities, and treatment; frailty status was measured over the year 2013, and study outcomes were measured from January 1, 2014, through December 31, 2014.

Study Sample

To be included in the cohort study and ensure adequate reference periods, a beneficiary must have (1) qualified for Medicare benefits by being age 65 on or before January 1, 2011, (2) had complete Medicare coverage (Part A and B coverage, no health maintenance organization [HMO] coverage) through the end of 2014 or month of death in 2014, and (3) had Part D prescription coverage with no alternative insurance or prescription programs (e.g., dual eligibility or retiree drug subsidy) over the same period.

We further restricted our sample to individuals under active management for PD. We required beneficiaries to have at least one physician or advanced practice provider (APP) claim for PD (International Classification of Diseases, Ninth Revision, Clinical Modification [ICD-9-CM] code 332.0) in 2013. We excluded those individuals who also had physician or APP claims for atypical parkinsonian syndromes, including drug-induced parkinsonism (ICD-9-CM 332.1), atypical parkinsonism (ICD-9-CM 333.0, 094.82), dementia with Lewy bodies (ICD-9-CM 331.82), amyotrophic lateral sclerosis (ICD-9-CM 335.20, 335.21) or schizophrenia (per the CCW) at any time between 2011 and 2014.[31] We required at least one prescription fill for a U.S. Food and Drug Administration (FDA)-approved antiparkinson medication within six months of a qualifying 2013 PD diagnosis.[32]

Independent Variables

Our primary independent variable was frailty, which we measured using the claims-based frailty index (CFI).[33] The CFI was developed and validated for use in Medicare claims data and differentially weights categories of ICD diagnosis; Healthcare Common Procedure Coding System (HCPCS); and Current Procedural Terminology, 4th Edition (CPT-4) codes.[5,33,34] Additional details of the instrument's operationalization with ICD, HCPCS, and CPT-4 codes, as well as weighting procedures, are available from Kim et al. (2018).[33] CFI scores were estimated using Carrier file diagnosis and procedure data from January 1, 2013, through December 31, 2013, and each person in our sample was assigned to one

of five CFI frailty categories: "non-frail" (CFI score <0.10), "prefrail" (0.10-0.19), "mildly frail" (0.20-0.29), "moderately frail" (0.30-0.39), and "severely frail" (≥0.40).[35,36]

Outcomes

Our primary outcomes have been examined in prior frailty studies—mortality, hospitalization, emergency department (ED) visits, and fall-related injuries.[7] The annual number of acute hospitalizations and ED visits and date of death were extracted from the 2014 Master Beneficiary Summary File.[37] We identified 2014 fall-related injuries using claims containing e-codes (E880, E881, E882, E884, E885, and E888)[38] in the Carrier file. However, because we only had detailed claims information for beneficiaries in the years that they also received care for PD, we created an injury subset sample limited to individuals who also had a claim for PD in 2014. All outcomes were dichotomized.

Covariates

All covariates were based on 2013 data. Sociodemographic covariates included sex, race (White, Black, Other/Missing [Asian, Hispanic, North American Native, Other, Unknown]), age group, and geographical residence. Geographical residence (metropolitan, non-metropolitan) was determined by classifying beneficiary state and county codes according to USDA Rural-Urban Continuum Codes (RUCCs).[39] The 73 beneficiaries with missing RUCC information were assigned to the most common classification—metropolitan. Nursing facility residence was determined by the presence of a CPT-4 code between 993.01-993.13. or 993.18[40,41] Chronic condition burden was determined using the Combined Comorbidity Score (CCS).[42]

Individuals with their first physician or APP diagnosis of PD in 2013 were considered incident PD cases. Beneficiaries with at least one claim submitted by a physician with a neurology specialty code were deemed to have received neurologist care. Deep Brain Stimulation (DBS) surgery was determined by any CPT-4 codes for existing or new DBS procedures (618.55, 618.62, 618.63, 618.64, 618.65, 618.67, 618.68, 618.80, 618.85, 618.86, 618.88, 959.61, 959.62, 959.70, 969.72, 959.3, 959.78, 959.79) in 2011, 2012, or 2013. Dopaminergic medication prescription fills data were converted to daily Levodopa Equivalent Doses (LED) based on a previously published conversion formula.[43] The mean daily LED for each patient was calculated based on days of pill coverage for 2013.

Statistical Analysis

All analysis was conducted in SAS v9.4 (Cary, NC). Descriptive analyses were conducted on sociodemographic and clinical characteristics. Differences in beneficiary characteristics by frailty status were assessed with Chi-squared tests and Kruskal-Wallis tests. The association between 2013 frailty and 2014 outcomes was assessed with both crude and adjusted logistic regression models. Models were first adjusted for sociodemographic characteristics (age category, sex, race, and residence). Second, models were adjusted for all covariates described above. Due to sparse numbers, the non-frail and prefrail groups were collapsed for regression analyses.

RESULTS

Study Sample Characteristics

A total of 6,887,060 beneficiaries met Medicare eligibility criteria. Of those, 88,216 (1.3%) met the study criteria for actively treated PD in 2013. After excluding individuals also diagnosed with atypical parkinsonism and other alternative neurodegenerative disease diagnoses, the final sample included 62,786 Medicare beneficiaries with PD (55,568 met inclusion criteria for the injury subset analysis). Table 1 displays beneficiary characteristics for the full and injury subset analysis. Overall, 20.7% (n=13,005) were incident PD cases. In general, individuals in the final study sample were predominantly male, 75-84 years of age, White, metropolitan-residing, and under neurologist care. DBS was uncommon (3.2%, n=1,986), and 13.2% (n=8,307) of the sample resided in a nursing facility at some point in 2013. The median CCS was 1.0 (interquartile range [IQR]=3.00).

Frailty

CFI analysis revealed that only 0.1% (n=67) of beneficiaries in our PD sample were non-frail, 44.6% (n=28,011) were prefrail, 46.2% were mildly frail (n=29,009), 8.8% were moderately frail (n=5,495), and 0.3% (n=204) were severely frail (Table 1 & Table 2). Frailty was more common in females, older age groups, Blacks, metropolitan dwellers, incident cases, those without neurologist care, those receiving nursing facility care, and those with more comorbidities (Table 2). The median average annual daily LED was 410 mg/day (IQR=354); 97.0% of beneficiaries (n=60,866) had an average annual LED greater than 0, suggesting treatment with a dopaminergic PD medication. Median annual average LED increased initially, in the non-frail (400 mg/day [IQR=450]) and prefrail groups (439 mg/day [IQR=390]), but declined thereafter (mildly frail=400 [IQR=337], moderately frail=334 [IQR=354], severely frail=304 [IQR=296]). A total of 32 individuals, mostly in the prefrail or mildly frail group had extreme mean daily LED values greater than or equal to 3,000 mg/day (annual mean range=3,000-7,092). Excluding these individuals made no changes in the median values.

Outcomes

Table 3 presents the results of crude and adjusted logistic regression models. In total, 10.3% (n=6,471) of beneficiaries died, 27.2% (n=17,068) were hospitalized at least once, and 45.1% (n=28,288) had at least one ED visit in 2014. The odds of mortality increased with increasing frailty in both crude and adjusted models. After adjustment for sex, age category, race, residence, PD status (incident vs. prevalent), neurologist care, nursing facility residence, DBS, CCS, and mean daily LED, the odds of dying in 2014 was 1.74 times higher (95% CI: 1.62, 1.88) in the mildly frail group compared to the non-frail/prefrail group. For the moderately frail and the severely frail group, the odds were 2.38 times (95% CI: 2.13, 2.66) and 2.74 times (95% CI: 1.98, 3.78) higher than the non-frail/prefrail group, respectively.

The crude and adjusted odds of both hospitalization and ED visit increased with more severe CFI frailty (p-value for linear trend <0.0001). After adjustment, those with severe frailty had

2.34 times greater odds of hospitalization (95% CI: 1.74, 3.14) and 2.97 times greater odds of an ED visit (95% CI: 2.14, 4.13) as compared to the non-frail/prefrail group.

In the injury subset sample, 13.5% (n=7,510) experienced an injurious fall in 2014. Compared to the non-frail/prefrail group, the fully adjusted odds of injury was 1.62 (95% CI: 1.53, 1.72) in the mildly frail and 2.09 (1.87, 2.33) in the moderately frail groups; the magnitude of increase was less and not significant in the severely frail group (OR = 1.43, 95% CI: 0.90, 2.26).

DISCUSSION

In our study of a large, national sample of older Medicare beneficiaries with PD using a previously validated CFI, we found that frailty is common, suggesting an overwhelming state of vulnerability among these individuals. Frail persons with PD were older, had more comorbidities, and had worse health outcomes than non-frail persons with PD. Finally, we found that frailty measures a phenotypic state that is beyond what is captured by PD treatment intensity alone. These findings have important implications for the care of individuals with PD and the design and analysis of observational studies of PD.

Our current findings using a CFI demonstrate that frailty is identifiable in 55.3% of Medicare beneficiaries with PD. This estimate is higher than estimates typically found in general older adult samples drawn from either community settings[3,44] or Medicare beneficiary data.[5] PD itself contributes to the frailty phenotype, as expected, based on studies which find that compared to controls, frailty is more common in PD.[14-16,21] Previous studies of persons with PD report a wide range of frailty estimates[9-23] with the highest estimate (84%) stemming from an inpatient sample.[14] Our high prevalence could reflect an older sample with more severe, treated disease. However, studies with similar prevalence estimates among those with PD have been conducted in an older, community-dwelling sample (50% frail)[9,20] and a younger, tertiary care center sample (52%).[23] Estimates of frailty may also differ based on the instrument used and its corresponding thresholds.[34] Consequently, direct comparisons of our data with prior estimates are challenging because prior studies primarily have used phenotype-centered instruments,[9] rather than the CFI we utilized in our study. One prior study found an 81% agreement between a deficits-based and phenotype-based frailty instrument in frailty classification of individuals with neurodegenerative diseases.[24]

In our study, frailty among beneficiaries with PD was more prevalent among those that are describable as female, Black, and older. These associations are consistent with the general, older adult population;[2,3,16,44] however, there is limited evidence of demographic patterns in PD frailty.[10,15,17,21-23] In the general older adult population, frailty has also been associated with socioeconomic status and education level;[2,16] however, we did not have individual-level data on these factors in this dataset.

After accounting for sociodemographic and clinical characteristics (including comorbidity burden), frailty was positively associated with one-year mortality, hospitalization, and ED visits among persons with PD. These findings provide evidence for the predictive validity

of frailty in PD. General population studies have found similar relationships between frailty and these outcomes.[5,7,33] Prior data on the longitudinal relationships between frailty and outcomes in PD are limited to a single hospital-based PD study, which found that frailty is associated with inpatient mortality, but not 30-day post-discharge mortality, institutionalization, a longer length of stay, or 30-day readmission.[14]

In our assessment of fall-related injuries in PD, the odds of an injury initially increased with frailty but then declined in the severely frail group. This pattern may be the result of increased mortality in the severely frail group. Alternatively, the frailest PD patients likely become less likely to fall as compared to those who are moderately frail, because they no longer attempt independent ambulation (even with assistance or assist device) and are receiving full external support and supervision for transfers or ambulation.

Several studies have found that compared to non-frail, frail individuals with PD had higher Unified Parkinson Disease Rating Scale (UPDRS) scores,[15,17,19,21,22] Hoehn and Yahr Scores,[10,17,21,23] and dopaminergic medication dosages.[11,12,17,21,23] By directly examining the relationship between dopaminergic medication dose and frailty levels, we found that the association between frailty severity and PD medication dosage is not consistently linear, with potential clinical and research implications. Our finding is consistent with the clinical observation that PD medication efficacy and tolerance decline in advanced PD stages as patients develop cognitive impairment and increasingly convert to a dopaminergic drug-resistant postural instability and gait disorder phenotype.[45] The research implications of our findings are that LED measurements may not fully account for the clinical picture that drives common outcomes like death, injurious falls, and acute care use in persons with PD.

As more PD research involves "big data" from health systems, claims datasets and disease registries, researchers need additional tools to reduce misclassification bias, particularly as an individual or cohort progresses beyond the mild/moderate disease phase. Given the need for additional safety studies of many medications for non-motor symptoms in PD,[46] accounting for frailty may also be crucial to obtain unbiased effect estimates in pharmacoepidemiology studies by reducing residual confounding. Frailty may be an important confounder in PD studies more broadly.[47] Finally, frailty may allow for matching persons with PD to controls in other studies, including biomarker and outcomes studies. Assessing frailty among persons with PD in a clinical setting may inform prognostic counseling and decision-making, such as palliative care referral or the need for deprescribing.[14,48] Additionally, screening for frailty could result in referrals for physical therapy, exercise, and nutritional consultations to mitigate frailty.[49]

Our study has several strengths, including its use of a previously validated frailty instrument and a study design intended to provide inclusive, Medicare beneficiary-representative data on PD. This type of analysis could be applied to other large datasets including health system data and disease registries. Concerning limitations, claims data do not contain disease-specific measures or patient-reported outcomes, such as cognitive testing, PD motor symptom severity scores, or quality of life. Even with the deficit-based frailty approach, there is an overlap between frailty items and PD, thus we were unable to disentangle frailty from PD-related motor and non-motor symptoms.[48] The lack of traditional PD severity

measures in our data further limited our ability to assess the independent contribution of frailty on outcomes. However, frailty, irrespective of etiology, still has important health implications.[24] LED doses may have been over- or under-estimated due to unavailable inpatient prescription data, early or late refills, titrations, and weaning.

As with all claims, registry, or observational studies, miscoding or under/over coding may affect our data and subsequent observations in a random or non-random manner. We were also unable to capture claims not in the Carrier file, such as those from durable medical equipment suppliers. Approaches to address these limitations include future studies that attempt to validate the CFI against clinically assessed frailty in PD and clinical measures of PD symptoms and severity, using data from a large, phenotyped cohort linked to claims data. Future studies may also seek to develop a claims-based index to assess PD severity, anchored to the UPDRS and other standard clinical research measures.

CONCLUSIONS

Frailty among individuals with PD can be measured in claims data. Accounting for frailty may reduce bias and improve PD observational study data analyses' methodological quality, particularly studies that use "big data" or assess drug safety and effectiveness. Given the high prevalence of frailty in PD, and its impact on outcomes, frailty assessments may have future implications for PD research and care.

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Table 1.

Descriptive sociodemographic and clinical characteristics of eligible Medicare beneficiaries with active management of Parkinson disease (PD) in 2013 (n=62,786)

Characteristic	Full Sample (n=62,786)	Injuries Subset Analysis* (n=55,568)
Sex, n (Col %)		
Male	33,178 (52.8)	29,862 (53.7)
Female	29,608 (47.2)	25,706 (46.3)
Age Category, n (Col %)		
65-74 years	18,022 (28.7)	16,573 (29.8)
75-84 years	30,190 (48.1)	26,931 (48.5)
≥85 Years	14,574 (23.2)	12,064 (21.7)
Race, n (%)		
White	60,108 (95.7)	53,221 (95.8)
Black	1,046 (1.7)	894 (1.6)
Other/Missing	1,632 (2.6)	1,453 (2.6)
Residence, n (Col %)		
Metropolitan	48,522 (77.3)	43,428 (78.2)
Non-Metropolitan	14,264 (22.7)	12,140 (21.9)
PD Status		
Incident	13,005 (20.7)	9,678 (17.4)
Prevalent	49,781 (79.3)	45,890 (82.6)
Neurologist Care, n (Col %)		
Yes	51,529 (82.1)	47,007 (84.6)
No	11,257 (17.9)	8,561 (15.4)
Nursing Facility Residence, n (Col %)		
Yes	8,307 (13.2)	6,622 (11.9)
No	54,479 (86.8)	48,946 (88.1)
DBS, n (Col %)		
Yes	1,986 (3.2)	1,900 (3.4)
No	60,800 (96.8)	53,668 (96.6)
Combined Comorbidity Score, Median (IQR)	1.0 (3.00)	1.0 (3.00)
Mean Daily LED (mg), Median (IQR)	410 (354)	431 (381)
Frailty Status, n (Col %)		
Non-Frail	67 (0.1)	64 (0.1)
Prefrail	28,011 (44.6)	26,024 (46.8)
Mildly Frail	29,009 (46.2)	25,185 (45.3)
Moderately Frail	5,495 (8.8)	4,156 (7.5)
Severely Frail	204 (0.3)	139 (0.3)

DBS=Deep Brain Stimulation, LED=Levodopa Equivalent Dose

* Subset sample analysis was restricted to individuals with any PD claim in 2014

Table 2.

Distribution of sociodemographic characteristics, clinical characteristics, and 2014 outcomes by 2013 frailty status among eligible Medicare beneficiaries with active management of Parkinson disease (PD) (n=62,786)

Characteristic	Non-Frail* (n=67)	Prefrail* (n=28,011)	Mildly Frail (n=29,009)	Moderately Frail† (n=5,495)	Severely Frail† (n=204)	p-value (Chi-Squared test)
Sex, n (Col %)						**<0.0001**
Male	16,444 (58.6)		14,328 (49.4)	2,333 (42.5)	73 (35.8)	
Female	11,634 (41.4)		14,681 (50.6)	3,162 (57.5)	131 (64.2)	
Age Category, n (Col %)						**<0.0001**
65-74 years	10,798 (38.5)		6,467 (22.3)	729 (13.3)	28 (13.7)	
75-84 years	13,321 (47.4)		14,288 (49.3)	2,489 (45.3)	92 (45.1)	
≥85 Years	3,959 (14.1)		8,254 (28.5)	2,277 (41.4)	84 (41.2)	
Race, n (Col %)						**0.0095**
White	26,827 (95.5)		27,817 (95.9)	5,464 (95.9)		
Black	445 (1.6)		496 (1.7)	105 (1.8)		
Other/Missing	806 (2.9)		696 (2.4)	130 (2.3)		
Residence, n (Col %)						**<0.0001**
Metropolitan	51 (76.1)	20,997 (75.0)	22,702 (78.3)	4,600 (83.7)	172 (84.3)	
Non-Metropolitan	16 (23.9)	7,014 (25.0)	6,307 (21.7)	895 (16.3)	32 (15.7)	
PD Status, n (Col %)						**<0.0001**
Incident	11 (16.4)	4,664 (16.7)	6,565 (22.6)	1,682 (30.6)	83 (40.7)	
Prevalent	56 (83.6)	23,347 (83.4)	22,444 (77.4)	3,813 (69.4)	121 (59.3)	
Neurologist Care, n (Col %)						**<0.0001**
Yes	24,041 (85.6)		23,167 (79.9)	4,161 (75.7)	160 (78.4)	
No	4,037 (14.4)		5,842 (20.1)	1,334 (24.3)	44 (21.6)	
Nursing Facility Residence, n (Col %)						**<0.0001**
Yes	448 (1.6)		4,349 (15.0)	3,325 (60.5)	185 (90.7)	
No	27,630 (98.4)		24,660 (85.0)	2,170 (39.5)	19 (9.3)	
DBS, n (Col %)						**0.0077**

Characteristic	Non-Frail* (n=67)	Prefrail* (n=28,011)	Mildly Frail (n=29,009)	Moderately Frail† (n=5,495)	Severely Frail† (n=204)	p-value (Chi-Squared test)
Yes	877 (3.1)		968 (3.3)	141 (2.5)		
No	27,201 (96.9)		28,041 (96.7)	5,558 (97.5)		
Combined Comorbidity Score, Median (IQR)	0 (0.00)	0 (1.00)	2.0 (3.00)	5.0 (4.00)	8.0 (3.00)	**<0.0001** §
Mean Daily LED, Median (IQR)	400 (450)	439 (390)	400 (337)	334 (354)	304 (296)	**<0.0001** §
Death, n (Col %)	1,276 (4.5)		3,593 (12.4)	1,518 (27.6)	84 (41.2)	**<0.0001**
Hospitalization, n (Col %)	5,081 (18.1)		9,395 (32.4)	2,475 (45.0)	117 (57.4)	**<0.0001**
Emergency Department Visit, n (Col %)	13 (19.4)	9,440 (33.7)	15,176 (52.3)	3,506 (63.8)	153 (75.0)	**<0.0001**
Injury, n (Col %) ‡	2,461 (9.4)		4,108 (16.3)	917 (22.1)	24 (17.3)	**<0.0001**

DBS=Deep Brain Stimulation, LED=Levodopa Equivalent Dose

*To avoid violating Center for Medicare and Medicaid Services cell suppression policy (no cells ≤10), these groups were combined for some characteristics

†To avoid violating Center for Medicare and Medicaid Services cell suppression policy (no cells ≤10), these groups were combined for some characteristics

‡Out of subset sample restricted to individuals with any PD claim in 2014 (n=55,568)

§Kruskal-Wallis Test

Table 3.

Associations 2013 categorical frailty and 2014 outcomes among eligible Medicare beneficiaries with active management of Parkinson disease (PD) (n=62,786)

2014 Outcome	2013 Frailty Category	Crude 2014 Incidence per 1,000 beneficiaries	Model 1*	Model 2*	Model 3*
			OR (95%CI)	AOR (95%CI)	AOR (95%CI)
Death					
	Non-Frail/Prefrail	45	1.00 (REF)	1.00 (REF)	1.00 (REF)
	Mildly Frail	124	**2.97 (2.78, 3.17)**	**2.47 (2.31, 2.64)**	**1.74 (1.62, 1.88)**
	Moderately Frail	276	**8.02 (7.39, 8.70)**	**6.06 (5.56, 6.59)**	**2.38 (2.13, 2.66)**
	Severely Frail	412	**14.70 (11.06, 19.54)**	**11.94 (8.89, 16.05)**	**2.74 (1.98, 3.78)**
Hospitalization					
	Non-Frail/Prefrail	181	1.00	1.00	1.00
	Mildly Frail	324	**2.17 (2.09, 2.25)**	**2.05 (1.97, 2.13)**	**1.69 (1.62, 1.77)**
	Moderately Frail	450	**3.71 (3.49, 3.94)**	**3.37 (3.17, 3.59)**	**2.03 (1.88, 2.20)**
	Severely Frail	574	**6.09 (4.60, 8.05)**	**5.58 (4.21, 7.38)**	**2.34 (1.74, 3.14)**
Emergency Department Visit					
	Non-Frail/Prefrail	337	1.00	1.00	1.00
	Mildly Frail	523	**2.16 (2.09, 2.24)**	**2.02 (1.95, 2.09)**	**1.78 (1.71, 1.84)**
	Moderately Frail	638	**3.47 (3.27, 3.69)**	**3.09 (2.91, 3.29)**	**2.26 (2.09, 2.44)**
	Severely Frail	750	**5.90 (4.29, 8.11)**	**5.25 (3.82, 7.23)**	**2.97 (2.14, 4.13)**
Injury †					
	Non-Frail/Prefrail	94	1.00	1.00	1.00
	Mildly Frail	163	**1.87 (1.77, 1.97)**	**1.68 (1.59, 1.77)**	**1.62 (1.53, 1.72)**
	Moderately Frail	221	**2.72 (2.50, 2.96)**	**2.25 (2.06, 2.46)**	**2.09 (1.87, 2.33)**
	Severely Frail	173	**2.00 (1.29, 3.12)**	1.64 (1.05, 2.56)	1.43 (0.90, 2.26)

Model 1: Unadjusted

Model 2: Adjusted for sex, age category, race, and residence

Model 3: Adjusted for sex, age category, race, residence, PD status, neurologist care, nursing facility residence, deep brain stimulation, Combined Comorbidity Score, and mean daily levodopa equivalent dosage

[*] P-value for linear trend for all analyses was <0.0001

[†] Out of subset sample restricted to individuals with any PD claim in 2014 (n=55,568)