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Editor's choice

Research Article

Effects of Mobility and Multimorbidity on Inpatient and Postacute Health Care Utilization

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Abstract

Background: This study examines effects of mobility and multimorbidity on hospitalization and inpatient and postacute care (PAC) facility days among older men.
Methods: Prospective study of 1,701 men (mean age 79.3 years) participating in Osteoporotic Fractures in Men (MrOS) Study Year 7 (Y7) examination (2007–2008) linked with their Medicare claims. At Y7, mobility ascertained by usual gait speed and categorized as poor, intermediate, or good. Multimorbidity quantified by applying Elixhauser algorithm to inpatient and outpatient claims and categorized as none, mild–moderate, or high. Hospitalizations and PAC facility stays ascertained during 12 months following Y7.
Results: Reduced mobility and greater multimorbidity burden were independently associated with a higher risk of inpatient and PAC facility utilization, after accounting for each other and traditional indicators. Adjusted mean total facility days per year were 1.13 (95% confidence interval [CI] = 0.74–1.40) among men with good mobility increasing to 2.43 (95% CI = 1.17–3.84) among men with poor mobility, and 0.67 (95% CI = 0.38–0.91) among men without multimorbidity increasing to 2.70 (95% CI = 1.58–3.77) among men with high multimorbidity. Men with poor mobility and high multimorbidity had a ninefold increase in mean total facility days per year (5.50, 95% CI = 2.78–10.87) compared with men with good mobility without multimorbidity (0.59, 95% CI = 0.37–0.95).
Conclusions: Among older men, mobility limitations and multimorbidity were independent predictors of higher inpatient and PAC utilization after considering each other and conventional predictors. Marked combined effects of reduced mobility and multimorbidity burden may be important to consider in clinical decision-making and planning health care delivery strategies for the growing aged population.

Keywords: Gait speed, Multimorbidity, Hospitalization, Postacute care, Older men.

Multimorbidity (defined by the co-occurrence of at least two chronic medical conditions and measured by a simple count of conditions or a weighted index) is a risk factor for hospitalization and higher total direct health care costs (eg, Medicare expenditures) in older adults after adjustment for demographic characteristics and prior utilization (1,2). However, existing measures of prevalent multimorbidity explain only a modest proportion of the variation in total direct health care costs in the subsequent year (3). Thus, better characterization of older patients who are at risk for extensive and costly health care is needed.

Objective measures of mobility such as usual gait speed provide direct assessments of vitality, integrating documented and unknown disorders across multiple organ systems. Mobility limitations are associated with increased risks of adverse health outcomes including disability, falls, and mortality (4,5). Previous studies (6–10) have also found that reduced mobility is associated with an increased risk of hospitalization in older adults. However, it is unclear whether mobility predicts health care utilization independent of comprehensively assessed multimorbidity and the combined impact of poor mobility and high multimorbidity on utilization is unknown.

Community-dwelling older patients on hospital discharge may require extended care in a postacute care (PAC; skilled nursing or inpatient rehabilitation) facility to address functional limitations. PAC represents the fastest growing segment of health care expenditures among Medicare beneficiaries as hospital length of stay is decreasing (11,12). Thus, measures of PAC utilization are especially important to include in research studies examining potential determinants of health care utilization in aged populations.

We used a unique longitudinal data set of 1,701 men (mean age 79.3 years) participating in the Year 7 exam (2007–2008) of the Osteoporotic Fractures in Men (MrOS) Study who were linked to their Medicare claims data to determine effects of mobility and multimorbidity on risk of hospitalization and rates of inpatient and PAC care facility days in community-dwelling older men.

Methods

Study Population

We studied participants enrolled in MrOS, a prospective cohort study of ambulatory community-dwelling men. From 2000 to 2002, 5,994 men ≥65 years of age were recruited from six geographic areas of the United States (13,14). The Centers for Medicare and Medicare Services approved the linkage to MrOS participants and successful matches to Medicare were achieved for 5,876 (98%) of the men in the cohort.

All active surviving men were invited to participate in a Year 7 (Y7) visit (2007–2008). A total of 3,910 men completed an examination of whom 3,840 had a measurement of gait speed and complete covariate data (Figure 1). Of these, 1,701 men who were enrolled in the Medicare Fee-For-Service (FFS) program (Parts A and B [and not Part C, Medicare Advantage]) continuously from 1 year prior to 1 year after the Y7 exam (or until death within the latter) comprised the analytical cohort for this study. Characteristics of these participants did not differ from those of the 2,139 participants attending Y7 examination not enrolled in an FFS plan, with the exception that men in the analytical cohort were less likely to be nonwhite and more likely to have a college education (Supplementary Table 1). While the difference in cognitive function reached statistical significance, it was small in absolute magnitude.

Mobility

Mobility at Y7 was ascertained from the average usual gait speed in two trials over a 6-m course. Trials were completed starting from a still position and consecutively without a rest between attempts. Mobility was categorized as poor (gait speed < 0.8 m/s), intermediate (gait speed 0.8 to <1.0 m/s), or good (gait speed ≥ 1.0 m/s) based on the findings of previous literature examining the association of gait speed with adverse health outcomes in older adults (4,5) and the distribution of gait speed in the study population.

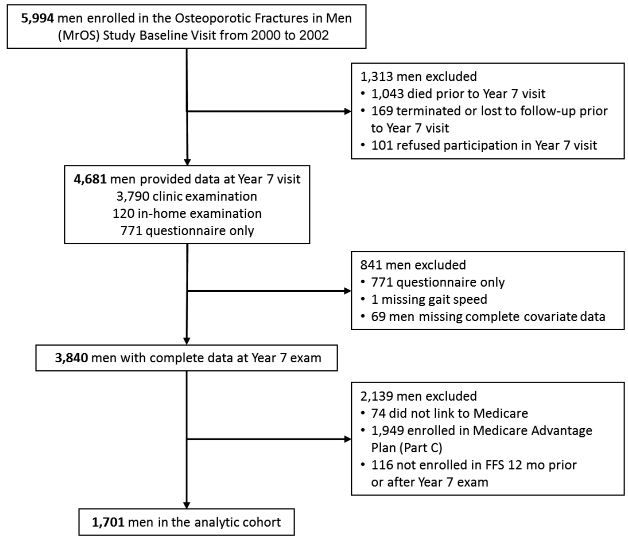

Figure 1. Participant flow.

Multimorbidity

Participant multimorbidity burden was ascertained with the Elixhauser method (15–17) that took into account the presence or absence of 31 specific medical conditions using ICD9 codes in Medicare inpatient and outpatient claims data for the 12 months prior to the date of the Y7 MrOS examination. To examine the effect of the variation in number of medical conditions on study outcomes, multimorbidity was categorized as none (0–1 conditions), mild–moderate (2–4 conditions), or high (≥5 conditions) based on clinical relevance of cut points and the skewed distribution of this predictor in the study population.

Outcome Measures

Data on hospital stays and inpatient facility days for the 12-month period following the date of the Y7 exam were obtained from the Medicare Provider Analysis and Review (MedPAR) file. Among men hospitalized, PAC facility days during this same time period were calculated using a modified version of the Wei algorithm (18); dates for stays in skilled nursing or inpatient rehabilitation or nursing facility were identified using dates in the MedPAR file and the Minimum Data Set (version 2.0).

Other Measurements

Each participant completed a questionnaire and was asked at the Y7 examination about marital status, health status, and smoking. Depressive symptoms were evaluated using the Geriatric Depression Scale (19). Physical activity was assessed using the Physical Activity Scale for the Elderly (20). Cognitive function was assessed using the Modified Mini-Mental State Examination (21). Body weight and height were measured; body mass index in kilogram per square meter was calculated. Participants were queried about race/ethnicity and education at the time of initial MrOS enrollment. Data on hospitalizations in the 12-month period preceding the Y7 examination were obtained using MedPAR file.

Statistical Analysis

Characteristics of the 1,701 men who were enrolled in Medicare FFS (analytical cohort) were compared across the three categories of mobility and the three categories of multimorbidity using chi-square tests (categorical variables) and analysis of variance (continuous variables).

To estimate the predictors of mean annualized number of inpatient and PAC facility days, we used a two-part model for both statistical and heuristic reasons. The distribution of inpatient and PAC facility days had excess zeros. Thus, an appropriate model needed to accommodate this feature. We also hypothesized that predictors of hospital admission versus discharge from hospital or PAC facility to community would differ, suggesting that a two-part model would be appropriate. Therefore, we used a two-part logistic-Poisson Hurdle model (22) to determine the independent effects of mobility on both components with and without adjustment for multimorbidity (and vice versa). The two-part Hurdle model generated mean inpatient and PAC facility days per year by separately estimating the odds of being hospitalized (yes/no) using a logit function, and then among those who were hospitalized, estimating counts of inpatient and PAC facility days using a log link model (ie, GLM regression with a log link and a working Poisson variance function). These models were used in the second part in order to obtain parameter estimates in terms of rate ratios (RRs) of facility days per year. Robust stand errors were used to avoid having to specify a parametric distribution such as Poisson (23). The effects of reduced mobility and greater multimorbidity on the outcome of inpatient and PAC facility days were displayed by estimating mean days per year according to each of nine distinct combined phenotypes of mobility and multimorbidity using the two-part Hurdle model. Bootstrapped 95% confidence intervals (CI) were used in these models to avoid having to make model specification assumptions (24).

Initial models were adjusted for age and site. Multivariable models were further adjusted for traditional prognostic indicators (ie, marital status, health status, hospitalization in past year, depressive symptoms, physical activity) that were independently associated with hospitalization after accounting for age, site, mobility, and multimorbidity. We also included cognitive function in the multivariable model because of evidence from other studies suggesting that cognition is associated with risk of hospitalization even after accounting for mobility and multimorbidity (7,25). Analyses were performed to determine if there was evidence of an interaction on the ratio scale between mobility (categorical variable, three levels) and multimorbidity (categorical variable, three levels) for prediction of total facility days. In a secondary analysis evaluating for the presence of an interaction, mobility and multimorbidity were each expressed as continuous variables.

Results

Among the 1,701 men in the cohort, mean (*SD*) age was 79.3 (5.3) years (range 71–98 years) at the Y7 examination (Tables 1 and 2) and 315 (18.5%) had been hospitalized at least once in the past year. Mean (*SD*) gait speed was 1.1 (0.2) m/s. Poor mobility was present in 189 men (11.1%), intermediate mobility was present in 297 men (17.5%), and good mobility was present in 1,215 men (71.4%). High multimorbidity was present in 345 men (20.3%), mild-to-moderate multimorbidity was present in 726 men (42.7%), and 630 men (37.0%) had no evidence of multimorbidity. Reductions in mobility and a higher burden of medical conditions clustered together in the cohort. At the same time, heterogeneity in combined phenotypes of mobility and multimorbidity was present. The prevalence of each of the 31 medical conditions ascertained using inpatient and outpatient claims during the year prior to Y7 exam date is provided in Supplementary Table 2.

Table 1. Characteristics of 1,701 Men at Year 7 Examination Overall and by Category of Mobility[a]

Characteristic	Overall (n = 1,701)	Good Mobility (n = 1,215)	Intermediate Mobility (n = 297)	Poor Mobility (n = 189)	p Value
Age (y), mean (*SD*)	79.3 (5.3)	78.2 (4.7)	81.3 (5.3)	83.6 (5.7)	<.001
Nonwhite, *n* (%)	142 (8.4)	92 (7.6)	36 (12.1)	14 (7.4)	.32
Education					<.001
High-school diploma or less, *n* (%)	293 (17.2)	168 (13.8)	72 (24.2)	53 (28.0)	
Some college, *n* (%)	367 (21.6)	248 (20.4)	70 (23.6)	49 (25.9)	
College diploma or above, *n* (%)	1,041 (61.2)	799 (65.8)	155 (52.2)	87 (46.0)	
Not married, *n* (%)	367 (21.6)	213 (17.5)	86 (29.0)	68 (36.0)	<.001
Health status, fair/poor/very poor, *n* (%)	232 (13.6)	103 (8.5)	63 (21.2)	66 (34.9)	<.001
Hospitalization in year prior to Year 7 exam, *n* (%)	315 (18.5)	176 (14.5)	66 (22.2)	73 (38.6)	<.001
Ever smoker, *n* (%)	1,008 (59.3)	711 (58.5)	185 (62.3)	112 (59.3)	.51
Body mass index (kg/m^2), mean (*SD*)	27.1 (3.8)	26.9 (3.4)	27.5 (4.0)	27.9 (5.3)	.002
Multimorbidity[b], *n* (%)					<.001
None (0–1 conditions)	630 (37.0)	503 (41.4)	93 (31.3)	34 (18.0)	
Mild–moderate (2–4 conditions)	726 (42.7)	534 (44.0)	120 (40.4)	72 (38.1)	
High (≥5 conditions)	345 (20.3)	178 (14.6)	84 (28.3)	83 (43.9)	
GDS score, mean (*SD*)	1.9 (2.2)	1.4 (1.6)	2.4 (2.4)	3.9 (3.1)	<.001
PASE score, mean (*SD*)	128.1 (67.1)	139.3 (64.7)	117.2 (62.5)	73.0 (59.3)	<.001
3MS score (0–100), mean (*SD*)	92.4 (6.7)	93.6 (5.7)	90.5 (7.5)	87.5 (8.6)	<.001
Incident hospitalization, *n* (%)	314 (18.5)	169 (13.9)	72 (24.2)	73 (38.6)	<.001
Incident stays in SNF or IRF, *n* (%)	67 (3.9)	29 (2.4)	12 (4.0)	26 (13.8)	<.001
Died within 12 mo, *n* (%)	51 (3.0)	18 (1.5)	6 (2.0)	27 (14.3)	<.001

Note: 3MS = Modified Mini-Mental State Examination; GDS = Geriatric Depression Scale; IRF = inpatient rehabilitation facility; PASE = Physical Activity Scale for the Elderly; SNF = skilled nursing facility.

[a]Mobility ascertained by usual gait speed and categorized as good (≥1.0 m/s), intermediate (0.8 to <1.0 m/s), and poor (<0.8 m/s). [b]Multimorbidity quantified using diagnoses in inpatient and outpatient claims data and categorized as none (0–1 conditions), mild–moderate (2–4 conditions), and high (≥5 conditions).

Table 2. Characteristics of 1,701 Men at Year 7 Examination Overall and by Category of Multimorbidity[a]

Characteristic	Overall (*n* = 1,701)	No Multimorbidity (*n* = 630)	Mild–Moderate Multimorbidity (*n* = 726)	High Multimorbidity (*n* = 345)	*p* Value
Age (y), mean (*SD*)	79.3 (5.3)	78.3 (4.9)	79.3 (5.1)	81.3 (5.8)	<.001
Nonwhite, *n* (%)	142 (8.4)	52 (8.3)	62 (8.5)	28 (8.1)	.95
Education					.016
High-school diploma or less, *n* (%)	293 (17.2)	97 (15.4)	121 (16.7)	75 (21.7)	
Some college, *n* (%)	367 (21.6)	131 (20.8)	165 (22.7)	71 (20.6)	
College diploma or above, *n* (%)	1,041 (61.2)	402 (63.8)	440 (60.6)	199 (57.7)	
Not married, *n* (%)	367 (21.6)	129 (20.5)	141 (19.4)	97 (28.1)	.008
Health status, fair/poor/very poor, *n* (%)	232 (13.6)	48 (7.6)	104 (14.3)	80 (23.2)	<.001
Hospitalization in year prior to Year 7 exam, *n* (%)	315 (18.5)	26 (4.1)	120 (16.5)	169 (49.0)	<.001
Ever smoker, *n* (%)	1,008 (59.3)	333 (52.9)	459 (63.2)	216 (62.6)	.002
Body mass index (kg/m^2), mean (*SD*)	27.1 (3.8)	27.0 (3.4)	27.2 (3.8)	27.4 (4.3)	.23
Mobility category[b], *n* (%)					<.001
Good	1,215 (71.4)	503 (79.8)	534 (73.6)	178 (51.6)	
Intermediate	297 (17.5)	93 (14.8)	120 (16.5)	84 (24.4)	
Poor	189 (11.1)	34 (5.4)	72 (9.9)	83 (24.1)	
GDS score, mean (*SD*)	1.9 (2.2)	1.4 (1.7)	1.8 (2.2)	2.7 (2.6)	<.001
PASE score, mean (*SD*)	128.1 (67.1)	141.6 (69.0)	128.1 (63.5)	103.6 (64.3)	<.001
3MS score (0–100), mean (*SD*)	92.4 (6.7)	93.3 (6.4)	92.5 (6.2)	90.3 (7.8)	<.001
Incident hospitalization, *n* (%)	314 (18.5)	62 (9.8)	130 (17.9)	122 (35.4)	<.001
Incident stays in SNF or IRF, *n* (%)	67 (3.9)	9 (1.4)	26 (3.6)	32 (9.3)	<.001
Died within 12 mo, *n* (%)	51 (3.0)	9 (1.4)	17 (2.3)	25 (7.3)	<.001

Note: 3MS = Modified Mini-Mental State Examination; GDS = Geriatric Depression Scale; IRF = inpatient rehabilitation facility; PASE = Physical Activity Scale for the Elderly; SNF = skilled nursing facility.

[a]Multimorbidity quantified using diagnoses inpatient and outpatient claims data and categorized as none (0–1 conditions), mild–moderate (2–4 conditions), and high (≥5 conditions). [b]Mobility ascertained by usual gait speed and categorized as good (≥1.0 m/s), intermediate (0.8 to <1.0 m/s), and poor (<0.8 m/s).

After adjustment for age and site, estimation of the combined impact of reduced mobility and greater multimorbidity on the outcome of mean inpatient and PAC facility days per year indicated that men with poor mobility and high multimorbidity had 16-fold higher inpatient and PAC facility days per year (8.98, 95% CI = 4.77–16.91) compared with men with good mobility without multimorbidity (0.54, 95% CI = 0.34–0.85). After further accounting for traditional prognostic indicators including marital status, health status, depressive symptoms, activity level, cognitive function, and prior hospitalization, the increase in inpatient and PAC facility days per year was ninefold higher among men with poor mobility and high multimorbidity (5.50, 95% CI = 2.78–10.87) compared with men with good mobility without multimorbidity (0.59, 95% CI = 0.37–0.95; Figure 2). Although mobility and multimorbidity both independently contributed to cumulative inpatient and PAC facility days, there was no evidence that effect modification was present when each predictor was expressed as a three-level ordinal variable (*p* value for interaction term .66 in age- and site-adjusted model and .62 in multivariable model). However, when each predictor was expressed as a continuous variable, the *p* value for the interaction term was .06 in the age- and site-adjusted model and .07 in the multivariable model.

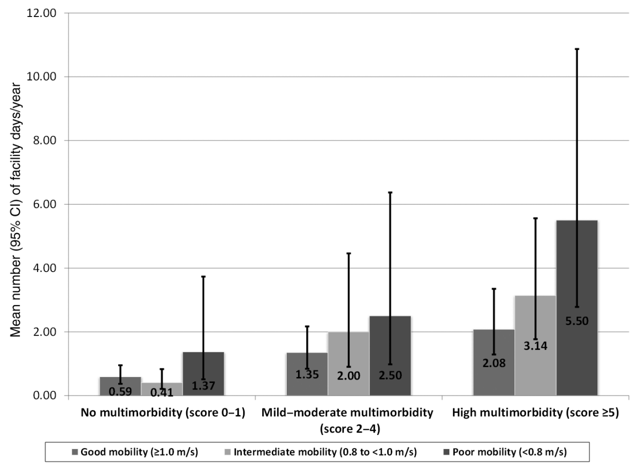

Figure 2. Mean inpatient and PAC facility days per year[a] according to combined phenotype of mobility and multimorbidity. [a]Adjusted for age, site, marital status, health status, depressive symptoms, hospitalization in past year, physical activity, and cognitive function; *p* value for interaction between mobility and multimorbidity in multivariable model was .62 in model expressing each predictor as a three-level ordinal variable and .07 in model expressing each predictor as a continuous variable. CI = confidence interval; PAC = postacute care.

Among men with poor mobility, 38.6% were hospitalized in the subsequent year with a mean duration of stay in inpatient or PAC facility of 20.9 days among those hospitalized. Among men with intermediate mobility, 24.2% were hospitalized in the subsequent year with a mean duration of facility stay of 12.2 days among those hospitalized. Among men with good mobility, 13.9% were hospitalized in the subsequent year with a mean duration of facility stay of 8.4 days among those hospitalized. In a model adjusted for age, site, and multimorbidity, men with poor mobility compared with those with good mobility had a 2.4-fold higher odds of hospitalization (odds ratio: 2.45, 95% CI = 1.68–3.58) and among those hospitalized, had a 1.9-fold greater rate of inpatient and PAC facility days (RR = 1.90, 95% CI = 1.16–3.01; Table 3). Among all participants, mean inpatient and PAC facility days per year was 1.09 (95% CI = 0.75–1.37) among men with good mobility, 1.81 (95% CI = 1.03–2.61) among men with intermediate mobility and 4.20 (95% CI = 2.26–6.27) among men with poor mobility. After further consideration of other traditional prognostic indicators, men with poor versus good mobility had a 1.6-fold higher risk of hospitalization (odds ratio = 1.61, 95% CI = 1.05–2.47). However, the association of reduced mobility with increased RRs of inpatient and PAC facility days among men hospitalized was no longer significant (RR [poor vs good mobility] = 1.46, 95% CI = 0.79–2.44). The graded pattern of reduced mobility with higher mean inpatient and PAC facility days per year among all men was attenuated (1.13 [95% CI = 0.74–1.40] among men with good mobility, 1.39 [95% CI = 0.74–2.00] among men with intermediate mobility, and 2.43 [95% CI = 1.17–3.84] among men with poor mobility), and the test for trend in the full model had a p value of .19.

After consideration of mobility and other conventional predictors, men with high multimorbidity compared with those without multimorbidity had nearly 2.9-fold higher odds of hospitalization (odds ratio = 2.86, 95% CI = 1.92–4.26) and among those hospitalized, had a 1.7-fold greater rate of inpatient and PAC facility days (RR = 1.71, 95% CI = 1.02–2.77; Table 4). Among all men, adjusted mean inpatient and PAC facility days per year was 0.67 (95% CI = 0.38–0.91) among men without multimorbidity, 1.53 (95% CI = 0.97–1.89) among men with mild-to-moderate multimorbidity, and 2.70 (95% CI = 1.58–3.77) among men with high multimorbidity.

Discussion

In this study of community-dwelling men, both mobility and multimorbidity were independent risk factors for higher inpatient and PAC utilization, and there was some evidence that their combined contribution was greater than their individual effects alone. Mean adjusted annualized inpatient and PAC facility days were twofold higher among

Table 3. Association of Mobility with Incident Health Care Utilization

Mobility Category[a]	Odds Ratio (95% CI) of Hospitalization	Rate Ratio (95% CI) of Inpatient and PAC Facility Days Among Those Hospitalized	Mean Rate of Inpatient and PAC Facility Days (95% CI; d/y)
Base model[b]			
Good (≥1.0 m/s)	1.00 (referent)	1.00 (referent)	1.21 (0.86–1.52)
Intermediate (0.8 to <1.0 m/s)	1.73 (1.25–2.39)	1.20 (0.72–1.89)	2.27 (1.34–3.25)
Poor (<0.8 m/s)	3.10 (2.14–4.48)	2.03 (1.20–3.30)	5.86 (3.27–9.04)
Base model[b] + multimorbidity			
Good (≥1.0 m/s)	1.00 (referent)	1.00 (referent)	1.09 (0.75–1.37)
Intermediate (0.8 to <1.0 m/s)	1.56 (1.12–2.18)	1.15 (0.68–1.84)	1.81 (1.03–2.61)
Poor (<0.8 m/s)	2.45 (1.68–3.58)	1.90 (1.16–3.01)	4.20 (2.26–6.27)
Multivariable model[c]			
Good (≥1.0 m/s)	1.00 (referent)	1.00 (referent)	1.13 (0.74–1.40)
Intermediate (0.8 to <1.0 m/s)	1.31 (0.93–1.86)	0.98 (0.58–1.60)	1.39 (0.74–2.00)
Poor (<0.8 m/s)	1.61 (1.05–2.47)	1.46 (0.79–2.44)	2.43 (1.17–3.84)

Note: CI = confidence interval; PAC = postacute care.

[a]Among the cohort, there were 1,215 men with good mobility (≥1.0 m/s), 297 men with intermediate mobility (0.8 to <1.0 m/s), and 189 men with poor mobility (<0.8 m/s). [b]Adjusted for age and site. [c]Adjusted for age, site, health status, marital status, multimorbidity, depressive symptoms, physical activity, hospitalization in the last year, and cognitive function.

Table 4. Association of Multimorbidity With Incident Health Care Utilization

Multimorbidity[a]	Odds Ratio (95% CI) of Hospitalization	Rate Ratio (95% CI) of Inpatient and PAC Facility Days Among Those Hospitalized	Mean Rate of Inpatient and PAC Facility Days (95% CI; d/y)
Base model[b]			
None (0–1 conditions)	1.00 (referent)	1.00 (referent)	0.66 (0.39–0.91)
Mild–moderate (2–4 conditions)	1.89 (1.36–2.62)	1.55 (0.98–2.39)	1.76 (1.15–2.27)
High (≥5 conditions)	4.41 (3.09–6.30)	1.96 (1.25–3.06)	4.23 (2.83–5.64)
Base model[b] + mobility			
None (0–1 conditions)	1.00 (referent)	1.00 (referent)	0.64 (0.38–0.89)
Mild–moderate (2–4 conditions)	1.85 (1.33–2.58)	1.55 (0.96–2.39)	1.70 (1.09–2.19)
High (≥5 conditions)	3.89 (2.70–5.59)	1.76 (1.13–2.76)	3.40 (2.28–4.51)
Multivariable model[c]			
None (0–1 conditions)	1.00 (referent)	1.00 (referent)	0.67 (0.38–0.91)
Mild–moderate (2–4 conditions)	1.62 (1.16–2.27)	1.51 (0.92–2.34)	1.53 (0.97–1.89)
High (≥5 conditions)	2.86 (1.92–4.26)	1.71 (1.02–2.77)	2.70 (1.58–3.77)

Note: CI = confidence interval; PAC = postacute care.

[a]Among the cohort, there were 630 men with no multimorbidity (0–1 conditions), 726 men with mild–moderate multimorbidity (2–4 conditions), and 345 men with high multimorbidity (≥5 conditions). [b]Adjusted for age and site. [c]Adjusted for age, site, health status, marital status, mobility, depressive symptoms, physical activity, hospitalization in the last year, and cognitive function.

men with poor mobility versus men with good mobility, fourfold higher among men with high multimorbidity versus men without multimorbidity, and ninefold higher among men with poor mobility and high multimorbidity compared with men with good mobility without multimorbidity.

Not surprisingly, we found that the burden of multimorbidity increased with poorer mobility in this cohort of men in the eighth to tenth decades of life and vice versa. At the same time, heterogeneity in combined phenotypes was present suggesting that reduced mobility is not synonymous with a high burden of medical conditions. These results lend credence to the view (26) that slow gait speed (dismobility) is a distinct diagnosis in older patients. Of note, multimorbidity defined simply by the co-occurrence of at least two chronic medical conditions was present in nearly two thirds of the cohort. This finding indicates that the traditional dichotomous definition of multimorbidity may be inadequate in characterizing risk attributable to the burden of medical conditions in studies of adults late in life.

The association of reduced mobility with higher utilization appeared to be primarily driven by a greater risk of hospitalization, whereas the relationship of multimorbidity burden with higher utilization was due to both a greater risk of hospitalization and an increase in the rate of inpatient and PAC facility days once hospitalized. At the same time, we found some evidence of effect modification between mobility and multimorbidity for the prediction of total number of inpatient and PAC facility days among all participants suggesting that the combined effect of these predictors on this outcome was greater than the sum of their individual effects alone. Previous longitudinal studies (6–10) in community-dwelling adults have reported associations of reduced mobility (ascertained by gait speed alone or by more extensive tests of lower extremity performance) and a higher risk of subsequent hospitalization. Although most of these analyses adjusted for a measure of medical disease burden, they relied on self-report of a limited number of conditions to quantify multimorbidity. In addition, these investigations did not account for prior utilization, quantify the combined effects of reduced mobility and greater multimorbidity on risk of hospitalization, or examine measures of PAC utilization. Similarly, numerous prospective studies (1–3,27,28) utilizing administrative claims data have ascertained multimorbidity using counts of diagnoses with or without a weighting system and consistently reported graded associations of increasing burden of medical conditions among community-dwelling older adults with higher risks of hospitalization and greater total direct health care costs. These investigations have adjusted analyses for demographic characteristics and prior hospitalization. However, they have not accounted for individual subject characteristics such as mobility, cognition, and physical activity level that may confound these associations.

Mobility limitation as manifested by a gait speed < 0.8 m/s over a 6-m walking course was a risk factor for higher utilization even after considering patient characteristics more frequently ascertained in clinical practice such as burden of medical conditions and history of recent hospitalization. This result adds to a growing body of evidence (4,5,26) suggesting that gait speed may be a feasible screening tool to use in the outpatient setting to more accurately characterize community-dwelling older adults who are at higher risk for adverse health outcomes, including more extensive and costly care. In addition to prognostic information, identification of slow gait speed may also be useful in clinical decision making prompting evaluation of treatable medical conditions (29), counseling about participation in a regular exercise program that has been demonstrated to reduce further decline in older adults with impaired mobility (30), and referral to physical therapy for a comprehensive evaluation of gait disturbance, rehabilitation, and recommendations about use of mobility aids. Slow gait speed previously documented in the outpatient clinic might also be useful to improve identification of individuals who may warrant a stay in a PAC facility after an acute hospital stay (31). Finally, our results also have implications for the design of future clinical trials aimed at preventing or treating dismobility that should evaluate the benefit of any intervention in reducing health care utilization, as well as its effects in reducing risk of mobility disability.

A number of biological mechanisms may, in part, explain the association of poor mobility with inpatient and PAC utilization even after consideration of multimorbidity (5,6,8). A measure of gait speed integrates documented and unrecognized disturbances in several organ systems as walking speed performance is dependent on the functions of the musculoskeletal system, central and peripheral nervous systems, and cardiopulmonary systems. Thus, gait speed reflects a complex interrelationship among several systems and reductions in gait speed may be present prior to an individual system impairment being recognized as a clinical disease diagnosis. Decreasing mobility may also lead to reductions in physical activity, worsening disability, and deconditioning that have direct effects on health care utilization. Finally, slow gait speed may be a marker of frailty and higher falls risk that may lead to greater health care utilization.

This study has a number of strengths such as the well-characterized cohort of older community-dwelling men, linkage to utilization data including care in inpatient and PAC facilities, and consideration of several confounding factors. However, this study has limitations. The cohort comprised fairly well-functioning men, and results may not be generalizable to women or more disabled populations. Data on number of hospitalizations and total facility days were limited to MrOS participants enrolled in FFS plans, but characteristics of MrOS participants enrolled in FFS plans including mobility were generally similar to those among MrOS participants enrolled in other health care plans who were excluded from this study. In addition, evidence (32) suggests that health care expenditures and mortality incidence in the recent decade were similar between Medicare FFS enrollees and enrollees in Medicare Advantage plans. Power was limited to quantify joint effects of combinations of mobility and multimorbidity phenotypes. We relied on one measure of multimorbidity that was a summary count of up to a maximum of 31 medical conditions recorded in administrative claims data. Although this approach may be overly simplistic, the heterogeneity of persons with multimorbidity defies neat classification, and a recent study (33) reported that a simple count of conditions was preferable to classification based on specific patterns of clusters of conditions for prediction of subsequent hospitalization. Our study did not evaluate whether objectively measured mobility adds to the prediction of health care utilization outcomes above and beyond self-reported function. Neither gait speed measurement nor functional status assessment is routinely performed in the primary care clinic and both require staff time in a setting faced with limited resources and high demands. Finally, residual confounding remains a potential explanation for our results.

In conclusion, mobility limitation and multimorbidity were each strong independent predictors of higher inpatient and postacute health care utilization among this cohort of older community-dwelling men after considering each other and conventional indicators including prior hospitalization. Our findings suggest that the combined effects of reduced mobility and multimorbidity burden may inform clinical decision-making and health care delivery planning for the growing population of aged adults.

Supplementary Material

Supplementary data is available at *The Journals of Gerontology, Series A: Biological Sciences and Medical Sciences* online.

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Conflict of Interest

None reported.

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