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Self-Reported Physical Function as a Predictor of Hospitalization in the LIFE Study

Kathryn E. Callahan, MD, MS¹, Laura Lovato, MS², Michael E. Miller, PhD², Anthony P. Marsh, PhD³, Roger A. Fielding, PhD⁴, Thomas M. Gill, MD⁵, Erik J. Groessl, PhD⁶, Jack Guralnik, MD, PhD⁷, Abby C. King, PhD⁸, Stephen B. Kritchevsky, PhD¹, Mary M. McDermott, MD⁹, Todd Manini, PhD¹⁰, Anne B. Newman, MD, MPH¹¹, and W. Jack Rejeski, PhD³

¹Wake Forest School of Medicine, Department of Internal Medicine, Section on Gerontology and Geriatric Medicine; Sticht Center for Healthy Aging and Alzheimer's Prevention

²Wake Forest School of Medicine, Public Health Sciences

³Wake Forest University, Department of Health and Exercise Science

⁴Tufts University, Friedman School of Nutrition Science and Policy

⁵Yale School of Medicine

⁶University of California, San Diego, Health Services Research Center

Corresponding Author: Kathryn E. Callahan, MD, MS, Department of Internal Medicine, Section on Gerontology and Geriatric Medicine, Wake Forest School of Medicine, Medical Center Boulevard, Winston-Salem, NC 27157, T: 336-713-8583; F: 336-716-0427, kecallah@wakehealth.edu.

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Administrative, technical, or material support: All

⁷University of Maryland School of Medicine

⁸Stanford University School of Medicine, Departments of Health Research and Policy and of Medicine

⁹Northwestern University, Feinberg School of Medicine

¹⁰University of Florida, Institute on Aging

¹¹University of Pittsburgh, Graduate School of Public Health

Abstract

Background—Hospitalization reduces mobility for many older adults, which in turn is associated with an increased risk of hospitalization. Physical function screening may identify an at-risk population for intervention. The Mobility Assessment Tool – short form (MAT-sf) is a brief, animated, computer-based means of assessing mobility that predicts mobility disability. This study explored whether baseline MAT-sf scores are associated with number of hospitalizations and time to first hospitalization across a median follow-up of 2.7 years.

Design—Post-hoc analysis of prospectively-gathered data from the Lifestyle Interventions and Independence for Elders (LIFE) Study, a randomized clinical trial of lifestyle interventions to preserve mobility in older adults, conducted in eight U.S. academic medical centers.

Participants—Among 1635 sedentary community-dwelling older adults enrolled in LIFE, 1574 completed baseline physical function screening including the MAT-sf, with baseline scores ranging from 30.2 (low function) to 69.8 (high function) on a scale from 30-80.

Measurements—Number of hospitalizations and time to first hospitalization, adjusted for age, gender, race, living alone, clinical site, baseline comorbidities, # prescription medications, and cognition.

Results—Of the 1557 participants with data regarding hospitalization status, 726 (47%) experienced at least one hospitalization; the majority (78%) of these experienced 1-2 hospitalizations. For every 10-point difference in MAT-sf score, the rate of all hospitalizations was higher by 19% in those with lower scores (adjusted rate ratio 1.20, 95% CI: 1.08-1.32, $p < 0.001$). Lower baseline MAT-sf scores were also associated with an increased risk of first hospitalization (adjusted Hazard Ratio 1.20, 95% CI: 1.09 to 1.32, $p < 0.01$, per 10-point difference in MAT-sf).

Conclusion—Low MAT-sf scores identify older adults at increased risk for hospitalizations; further study is needed to test interventions to reduce hospitalizations in these patients.

Keywords

physical function; hospitalization; mobility

INTRODUCTION

Hospitalization results in reduced mobility for many older adults; over half of all chronic disability is associated with hospitalization, and one-third of adults over 75 years old leave the hospital with a new deficit in activities of daily living (ADLs)¹ or decline in objective

performance measures of function.² Most older adults who experience ADL loss are unlikely to recover independence in ADLs, even as their medical illnesses resolve: at one year, it has been reported that only 28% have fully regained function, and 41% of these have died.^{1,3,4}

Further, older adults with functional deficits experience higher rates of hospitalization and recurrent readmissions,⁵ along with higher overall healthcare utilization and healthcare costs.^{6,7} Medicare recipients represented nearly half of all hospital spending in 2012.⁸ Predicting those who are at higher risk for hospital admission and readmission can inform deployment of care navigation services that have been demonstrated to reduce high cost, high-burden care pre- and post-hospitalization. Though many possible predictors have been identified,^{9–11} predictive models emphasize disease over function. Cognition and physical function are rarely assessed prior to hospitalization and thus have been under-represented;¹² this makes it difficult to know how important prior functional status is to decline during hospitalization. Whereas screening for deficits in physical function may identify an at-risk population for early intervention to prevent hospitalization and readmission,¹³ commonly used assessments of functional decline such as gait speed/accelerometry,^{6,7} inpatient walking activity,¹⁴ and grip strength¹⁵ can be challenging to implement in clinical practice.¹⁶ A brief, easily implemented mobility assessment tool that predicts hospital utilization would aid in identifying patients for whom additional services and resources could reduce hospitalizations and further functional loss.

The Mobility Assessment Tool – short form (MAT-sf) is a brief, self-report tool that asks an older adult to characterize their mobility in reference to an animated avatar performing mobility tasks of varying difficulty. MAT-sf scores predict mobility disability.^{17,18} The avatar performs real world tasks (walking on uneven paths, climbing stairs), and the full measure quantifies mobility limitation: MAT-sf scores are standardized around a mean of 50; standard deviation (SD) = 10.¹⁷ In practice, scores range from 30-80, with higher scores signifying better mobility. Completion of the MAT-sf takes about 3-5 minutes. The validity, reliability, and predictive value of the MAT-sf have been reported elsewhere, and it was found to be effective in predicting incident mobility disability in initially non-disabled older adults across a period of 24 months in the Lifestyle Interventions and Independence for Elders (LIFE) study.¹⁹

In the current investigation we explore whether physical function, as measured by baseline MAT-sf scores, is predictive of subsequent hospitalization and time to hospitalization in the LIFE study. We hypothesized that poorer physical function would be associated both with a larger number of hospitalization events and a shorter time to first hospitalization.

METHODS

Design and Participants

We conducted a post-hoc analysis of prospectively-gathered data from the Lifestyle Interventions and Independence for Elders (LIFE) Study, a randomized clinical trial of lifestyle interventions to preserve mobility in older adults that was conducted in eight U.S. academic medical centers.^{20–23} The LIFE protocol has been described elsewhere;²¹ the

study enrolled 1635 sedentary community-dwelling older adults, aged 70-89 years old, who scored a 9 or less on the Short Physical Performance Battery (SPPB) but were still able to walk 400 meters.²² Exclusion criteria reflected safety concerns, adherence, and ability to complete the trial: for example, potential participants were excluded due to severe chronic disease, concerning symptoms during a 400 meter walk, severe mental illness, substance use, and cognitive impairment that would limit participation. This analysis included the 1574 participants who completed the MAT-sf as part of comprehensive baseline physical function screening. Participants were randomized either to a health education arm or to a structured exercise program that consisted of two sessions of supervised training in aerobic activity, resistance, and flexibility exercises each week, along with 3-4 days of recommended walking at home.²³ The primary outcome was major mobility disability (MMD), or the loss of the ability to walk 400 meters within 15 minutes; results demonstrated that a structured exercise program reduced MMD in at-risk older adults.²⁰ The median overall follow-up was 2.6 years, with all hospitalizations recorded during this time period.

Baseline Assessments

At baseline, participants were surveyed about their demographics, medical and hospital histories, and recent healthcare utilization. Baseline examination included body weight, blood pressure, and heart rate, an electrocardiogram, the Quality of Wellbeing scale, and cognitive testing. Finally, measures of physical function included the MAT-sf, the Short Physical Performance Battery (SPPB)²⁴, and a 400m walk performed at a usual pace.

Predictor Variable

For this analysis, the predictor variable was participants' baseline score on the MAT-sf.

Outcome Variables

Inpatient hospitalizations were ascertained at 6-month intervals. Participants were asked at follow-up interviews about any hospitalizations since the last interview. As all hospitalizations were considered serious safety events, medical records were obtained and reviewed. Records were abstracted by adjudicators blinded to intervention assignment, who then identified additional hospitalizations, diagnosis codes, procedures, and length of stay. For this analysis, we examined participants' total number of hospitalizations and time to first hospitalization.

Covariates

The models were adjusted to account for potential confounders associated with the risk of hospitalization. Specifically, we adjusted for demographics (age, gender, race)¹⁰ and social determinants of health (living alone, level of education),¹¹ along with study site,²⁵ all individual baseline comorbid conditions and total number of prescription medications,⁹ a surrogate measure of medical complexity and comorbidity. We included baseline cognitive function as measured by the Mini-Mental Status Examination.²⁶ We also conducted an additional exploratory analysis adding baseline SPPB scores.

Statistical Analyses

All analyses were performed in SAS version 9.4 (SAS Institute, Inc., Cary, NC). Baseline characteristics were summarized using means (SD) and proportions according to range of baseline MAT-SF scores (30-39; 40-49; 50-59; 60). Relationships between the baseline MAT-sf score category and baseline characteristics were assessed using either ANOVA (for continuous measures) or chi-square tests (for categorical measures).

The effect of the baseline MAT-sf score on time until the first post-randomization hospitalization was evaluated using Cox proportional hazards regression models. Event times were defined as the time from randomization until the date of hospital admission, and censoring times were defined as the time from randomization until the last assessment for hospitalization or death. A series of models was fitted, sequentially adding pre-specified covariates to investigate for any attenuation of the relationship between baseline MAT-sf and the rate of hospitalization. The base model, Model 1, contained terms for the intervention, baseline MAT-sf, and the intervention by MAT-sf interaction. Model 2 added terms for study site, sex, age, race, education, and an indicator of whether the person lived alone. Model 3 added an indicator of baseline cognitive impairment (MMSE < 80), the number of prescription medications, and individual indicators of a baseline history of high blood pressure, heart attack, heart failure, use of a pacemaker, stroke, diabetes, osteoarthritis, arthritis, liver disease, lung disease and psychiatric problems to Model 2. For each model, we initially estimated hazard ratios (and 95% CI) for the baseline MAT-sf predictor within intervention arms and tested for the interaction between the baseline MAT-sf score and the intervention term at the nominal 0.05 level; if non-significant, we provided an overall estimate (95% CI) for both intervention arms combined. To explore the relationship between baseline MAT-sf and the number of hospitalizations, a similar series of models was used; however, for this analysis, rate ratios (95% CI) were calculated using a negative binomial model, with log-transformed total follow-up time as an offset. Estimation of number of hospitalizations per 100 person years of follow-up was performed for 10 unit differences in baseline MAT-sf score, using Model 1. To explore the association of the MAT-sf with both outcomes, after controlling for baseline performance-based physical function using the SPPB, an additional analysis was carried out adding baseline SPPB into model 3 for analyses of both number of hospitalizations and time until initial hospitalization.

RESULTS

The LIFE study randomized 1635 older adults; of these, 1574 completed MAT-sf at baseline, and 1557 had some follow-up information on hospitalizations. As shown in Table 1, the average age of participants at baseline was 79 years. Approximately 67% were female, and 77% were white. Participants' baseline MAT-sf scores ranged from 30.2 (lower function) to 69.8 (higher function).²² MAT-sf scores varied with age, sex, marital/partnered status, and living alone. The only comorbidities associated with lower MAT-sf scores were congestive heart failure (CHF) and a history of fractures.

Hospitalizations

Of the 1557 participants who responded to all visit queries about hospitalizations, 726 (47%) experienced at least one hospitalization, with the majority (78%) of these experiencing 1-2 hospitalizations across a median follow-up of 2.7 years (min=0.12 years; max=3.6 years).

Table 1 also describes the number of hospitalizations per 100 person-years of follow-up for each category of MAT-sf score. Those with the lowest MAT-sf scores – 30-39 – experienced the highest numbers of hospitalizations (34.1 hospitalizations per 100 person-years), while those with the highest MAT-sf scores – 60+ - experienced the lowest numbers of hospitalizations (27.4 hospitalizations per 100 person-years; $p = 0.003$).

Table 2 describes the association between baseline mobility limitation as defined by MAT-sf and all hospitalization events. For every 10-point lower MAT-sf score, there was a 20% higher rate of all hospitalizations (Model 3; adjusted rate ratio 1.20; 95% CI: 1.08-1.32, $p<0.001$), persisting through inclusion of all covariates in the model. No difference in the association was noted by intervention group (p interaction = 0.50).

Worse mobility as defined by lower baseline MAT-sf scores was also associated with a 20% higher risk of first hospitalization (adjusted Hazard Ratio 1.20, 95% CI: 1.09 to 1.32, $p<0.001$, per 10 point difference in MAT-sf). Again, no differences in the association by intervention arm was noted (p interaction = 0.08). Depicted pictorially, the Figure demonstrates a Kaplan-Meier curve, plotting time to initial hospitalization by 10-unit difference in MAT-sf score.

When the SPPB score at baseline was added to Model 3 for the number of hospitalizations, the RR for the baseline MAT-sf score was reduced from 1.20 to 1.14 (95% CI 1.03 to 1.27; $p=0.01$); for time until the initial hospitalization, and the HR was reduced to 1.20 to 1.16 (95% CI 1.04 to 1.29; $p=0.005$).

DISCUSSION

Hospitalization is a common and often life-altering event for older adults, particularly in relation to functional outcomes; unnecessary hospitalizations also contribute to annual costs of nearly \$18 billion.²⁷ In this large cohort of older adults recruited for the LIFE study, baseline physical function as measured by the MAT-sf, a brief self-report assessment of physical function, demonstrated an inverse relationship with hospitalizations. Specifically, poorer baseline function predicted an increased overall rate of hospitalization along with an increased risk of first hospital admission. This relationship was preserved even when controlling for covariates often related to hospitalizations in older adults, such as medical comorbidities, demographics, and social determinants of health.

Poor physical function and mobility have long been markers for morbidity and mortality, and more recently, health care utilization.^{6,7,28,29} Our results in the LIFE population suggest that baseline physical function, separate from morbidity risk, has an independent relationship with hospitalizations. This association may mean that poor mobility can serve as a marker for the vulnerability that leads to more hospitalizations and, subsequently, worse

function and dependency. We further found that with each 10-unit decrease in baseline function as measured by MAT-sf, there was an increase in hospitalizations, which corresponds to the noted stepwise relationship between MAT-sf and major mobility disability in prior studies.¹⁹ We included the SPPB in one model as an objective standard measurement of physical function, which is described at the end of the results section. Of note, this study selected for more vulnerable individuals as those with an SPPB greater than 9 were excluded. Including the baseline SPPB in the model modestly attenuated the relationship between MAT-sf and hospitalization, and vice versa. However, MAT-sf retains a significant influence even in the presence of the SPPB. Moreover, an advantage of the MAT-sf in a clinical context is its brevity and relative ease of use.

Other studies have explored the relationship between physical function and health care utilization; most notably through comprehensive mobility assessment,⁵ objective speed/strength,^{14,15} lower extremity strength as assessed with the SPPB,³⁰ or self-report of difficulty with a ¼ mile walk.⁷ Our results support the concept that baseline physical function as assessed by the MAT-sf may be predictive of subsequent hospital utilization, and thus health care costs. LIFE included records of hospitalizations, which allowed accurate determination of these relationships. Moreover, we believe that the MAT-sf is well suited for use in clinical practice. First, it removes the ambiguity often inherent in questionnaire items such as the ability to climb stairs by illustrating clearly defined tasks in which we manipulate difficulty by varying the number of steps, the presence or absence of handrails, and the speed of movement.³¹ Second, the instrument is easily administered on an iPad or PC that be completed while patients are waiting for their appointment, and the instrument can be download at no cost to health care providers (see <http://college.wfu.edu/hes/matsf/> for guidance and/or contact the senior author). The MAT-sf has been found to outperform self-reported disability in predicting 400-m walk performance,¹⁸ predicts major mobility disability in at-risk older adults,³² and has been used in a clinical setting to successfully predict post-operative complications and time to discharge following elective, non-cardiac surgery.³³

It is important, though, to consider limitations as well. This study examines events in participants recruited into a clinical trial, with the subsequent biases towards higher education and socioeconomic status that attend such trials. Also, those with dementia, depression, or recent serious illness were excluded from the LIFE study; the relationship between physical function and hospitalization may differ in a sicker population. However, these patients did not lack for medical complexity; as described by Marsh et al., the most common diagnoses for hospitalizations were cardiac disorders (213 hospitalizations); gastrointestinal disorders (81); surgical or medical procedures (76); and infections (73).³⁴

In addition, the presence of the intervention status complicates our findings. Marsh et al. noted more hospitalizations in the physical activity intervention arm than in the health education arm.³⁴ In our results, there is a slight difference in the strength of association between baseline physical function and hospitalizations in the PA group; however, the interaction did not reach statistical significance (Table 2). The impact of physical activity interventions for vulnerable older adults on hospitalization and health care utilization may be an area for further exploration.

This study offers insight for several potential new directions in research. First, further studies could assess the impact of exercise interventions on subsequent hospitalizations and health care utilization, including length of stay, discharge destination, or subsequent hospital-related mobility disability. These data would also support an investigation to use a tool such as the MAT-sf to identify vulnerable older adults at risk for mobility challenges early, to link them with resources to improve function and/or additional services such as care coordination, which has been demonstrated to reduce high-cost, high-burden utilization that may only worsen function. Finally, the MAT-sf is a brief and easy-to-use test that has been clinically implemented in small pilot studies.³³ Broader implementation may prove its utility as a quick and clinically relevant tool to identify older adults at risk for mobility disability and excess hospitalizations, guiding medical and community interventions. Future study is needed to explore best interventions for preventing hospitalizations in this vulnerable population.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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References

1. Covinsky KE, Palmer RM, Fortinsky RH, et al. Loss of independence in activities of daily living in older adults hospitalized with medical illnesses: increased vulnerability with age. *J Am Geriatr Soc.* 2003; 51:451–8. [PubMed: 12657063]
2. Ehlenbach WJ, Larson EB, Curtis JR, Hough CL. Physical Function and Disability After Acute Care and Critical Illness Hospitalizations in a Prospective Cohort of Older Adults. *J Am Geriatr Soc.* 2015; 63:2061–9. [PubMed: 26415711]
3. Sager MA, Franke T, Inouye SK, et al. Functional outcomes of acute medical illness and hospitalization in older persons. *Arch Intern Med.* 1996; 156:645–52. [PubMed: 8629876]

4. Boyd CM, Landefeld CS, Counsell SR, et al. Recovery of activities of daily living in older adults after hospitalization for acute medical illness. *J Am Geriatr Soc*. 2008; 56:2171–9. [PubMed: 19093915]
5. Falvey JR, Burke RE, Malone D, Ridgeway KJ, McManus BM, Stevens-Lapsley JE. Role of Physical Therapists in Reducing Hospital Readmissions: Optimizing Outcomes for Older Adults During Care Transitions From Hospital to Community. *Physical therapy*. 2016; 96:1125–34. [PubMed: 26939601]
6. Studenski S, Perera S, Patel K, et al. Gait speed and survival in older adults. *JAMA*. 2011; 305:50–8. [PubMed: 21205966]
7. Hardy SE, Kang Y, Studenski SA, Degenholtz HB. Ability to walk 1/4 mile predicts subsequent disability, mortality, and health care costs. *J Gen Intern Med*. 2011; 26:130–5. [PubMed: 20972641]
8. Centers for Medicare and Medicaid Services. 2014;2014.
9. Kansagara D, Englander H, Salanitro A, et al. Risk prediction models for hospital readmission: a systematic review. *JAMA*. 2011; 306:1688–98. [PubMed: 22009101]
10. Shulan M, Gao K, Moore CD. Predicting 30-day all-cause hospital readmissions. *Health Care ManagSci*. 2013; 16:167–75.
11. Arbaje AI, Wolff JL, Yu Q, Powe NR, Anderson GF, Boulton C. Postdischarge environmental and socioeconomic factors and the likelihood of early hospital readmission among community-dwelling Medicare beneficiaries. *Gerontologist*. 2008; 48:495–504. [PubMed: 18728299]
12. Callahan CM, Arling G, Tu W, et al. Transitions in care for older adults with and without dementia. *J Am Geriatr Soc*. 2012; 60:813–20. [PubMed: 22587849]
13. Depalma G, Xu H, Covinsky KE, et al. Hospital readmission among older adults who return home with unmet need for ADL disability. *Gerontologist*. 2013; 53:454–61. [PubMed: 22859438]
14. Fisher SR, Graham JE, Ottenbacher KJ, Deer R, Ostir GV. Inpatient Walking Activity to Predict Readmission in Older Adults. *Archives of physical medicine and rehabilitation*. 2016; 97:S226–31. [PubMed: 27264549]
15. Simmonds SJ, Syddall HE, Westbury LD, Dodds RM, Cooper C, Aihie Sayer A. Grip strength among community-dwelling older people predicts hospital admission during the following decade. *Age Ageing*. 2015; 44:954–9. [PubMed: 26504117]
16. Studenski S, Perera S, Wallace D, et al. Physical performance measures in the clinical setting. *J Am Geriatr Soc*. 2003; 51:314–22. [PubMed: 12588574]
17. Rejeski WJ, Ip EH, Marsh AP, Barnard RT. Development and validation of a video-animated tool for assessing mobility. *J Gerontol A Biol Sci Med Sci*. 2010; 65:664–71. [PubMed: 20403946]
18. Rejeski WJ, Marsh AP, Anton S, et al. The MAT-sf: clinical relevance and validity. *J Gerontol A Biol Sci Med Sci*. 2013; 68:1567–74. [PubMed: 23685766]
19. Rejeski WJ, Rushing J, Guralnik JM, et al. The MAT-sf: identifying risk for major mobility disability. *J Gerontol A Biol Sci Med Sci*. 2015; 70:641–6. [PubMed: 25680917]
20. Pahor M, Guralnik JM, Ambrosius WT, et al. Effect of structured physical activity on prevention of major mobility disability in older adults: the LIFE study randomized clinical trial. *Jama*. 2014; 311:2387–96. [PubMed: 24866862]
21. Fielding RA, Rejeski WJ, Blair S, et al. The Lifestyle Interventions and Independence for Elders Study: design and methods. *J Gerontol A Biol Sci Med Sci*. 2011; 66:1226–37. [PubMed: 21825283]
22. Marsh AP, Lovato LC, Glynn NW, et al. Lifestyle interventions and independence for elders study: recruitment and baseline characteristics. *J Gerontol A Biol Sci Med Sci*. 2013; 68:1549–58. [PubMed: 23716501]
23. Rejeski WJ, Axtell R, Fielding R, et al. Promoting physical activity for elders with compromised function: the lifestyle interventions and independence for elders (LIFE) study physical activity intervention. *Clinical interventions in aging*. 2013; 8:1119–31. [PubMed: 24049442]
24. Guralnik JM, Simonsick EM, Ferrucci L, et al. A short physical performance battery assessing lower extremity function: association with self-reported disability and prediction of mortality and nursing home admission. *Journal of gerontology*. 1994; 49:M85–94. [PubMed: 8126356]
25. Fisher ES, Wennberg JE, Stukel TA, Sharp SM. Hospital readmission rates for cohorts of Medicare beneficiaries in Boston and New Haven. *N Engl J Med*. 1994; 331:989–95. [PubMed: 8084356]

26. Callahan KE, Lovato JF, Miller ME, Easterling D, Snitz B, Williamson JD. Associations Between Mild Cognitive Impairment and Hospitalization and Readmission. *J Am Geriatr Soc.* 2015; 63:1880–5. [PubMed: 26313420]
27. Jencks SF, Williams MV, Coleman EA. Rehospitalizations among patients in the Medicare fee-for-service program. *N Engl J Med.* 2009; 360:1418–28. [PubMed: 19339721]
28. Newman AB, Simonsick EM, Naydeck BL, et al. Association of long-distance corridor walk performance with mortality, cardiovascular disease, mobility limitation, and disability. *Jama.* 2006; 295:2018–26. [PubMed: 16670410]
29. Fried LP, Kronmal RA, Newman AB, et al. Risk factors for 5-year mortality in older adults: the Cardiovascular Health Study. *JAMA.* 1998; 279:585–92. [PubMed: 9486752]
30. Penninx BW, Ferrucci L, Leveille SG, Rantanen T, Pahor M, Guralnik JM. Lower extremity performance in nondisabled older persons as a predictor of subsequent hospitalization. *J Gerontol A Biol Sci Med Sci.* 2000; 55:M691–7. [PubMed: 11078100]
31. Marsh AP, Ip EH, Barnard RT, Wong YL, Rejeski WJ. Using video animation to assess mobility in older adults. *J Gerontol A Biol Sci Med Sci.* 2011; 66:217–27. [PubMed: 21127192]
32. Rejeski WJ, Rushing J, Guralnik JM, et al. The MAT-sf: identifying risk for major mobility disability. *J Gerontol A Biol Sci Med Sci.* 2015; 70:641–6. [PubMed: 25680917]
33. Kim S, Marsh AP, Rustowicz L, et al. Self-reported Mobility in Older Patients Predicts Early Postoperative Outcomes after Elective Noncardiac Surgery. *Anesthesiology.* 2016; 124:815–25. [PubMed: 26978144]
34. Marsh AP, Applegate WB, Guralnik JM, et al. Hospitalizations During a Physical Activity Intervention in Older Adults at Risk of Mobility Disability: Analyses from the Lifestyle Interventions and Independence for Elders Randomized Clinical Trial. *J Am Geriatr Soc.* 2016; 64:933–43. [PubMed: 27225353]

Impact Statement

We certify that this work is confirmatory of recent novel clinical research. Specifically, this work confirms the following research that demonstrates physical function as a predictor of hospitalizations and healthcare cost.

Hardy SE, Kang Y, Studenski SA, Degenholtz HB. Ability to walk 1/4 mile predicts subsequent disability, mortality, and health care costs. *J Gen Intern Med* 2011;26:130-5.

Fisher SR, Graham JE, Ottenbacher KJ, Deer R, Ostir GV. Inpatient Walking Activity to Predict Readmission in Older Adults. *Archives of physical medicine and rehabilitation* 2016;97:S226-31.

Simmonds SJ, Syddall HE, Westbury LD, Dodds RM, Cooper C, Aihie Sayer A. Grip strength among community-dwelling older people predicts hospital admission during the following decade. *Age Ageing* 2015;44:954-9.

This work demonstrates that, even controlling for comorbid conditions and other sociodemographic factors linked to hospitalization, physical function holds a significant association with hospitalization events for older adults. However, our work is novel in that it describes a novel tool, the Mobility Assessment Tool (short form) - MAT-sf), which is clinically relevant, patient-driven, and brief.

Figure.
Kaplan Meier curve: lower baseline function as measured by MAT-sf is associated with higher proportion of hospitalization events across 36 months follow-up.

Baseline Demographics/Medical Conditions and Follow-Up Hospitalizations by MAT-sf scores: the LIFE Trial

Table 1

	Overall (N=1574)	Baseline MAT-sf Scores ⁽¹⁾				P-value
		MAT-sf 30-39 (N=56)	MAT-sf 40-49 (N=530)	MAT-sf 50-59 (N=605)	MAT-sf 60+ (N=383)	
Assigned to PA Intervention	790 (50.2%)	31 (3.9%)	256 (32.4%)	301 (28.1%)	202 (25.6%)	0.49
Age (years)	78.9 (5.2)	79.5 (5.6)	79.6 (5.3)	78.6 (5.2)	78.3 ± 5.1	<0.001
Female	1055 (67.0%)	48 (4.5%)	418 (39.6%)	404 (38.3%)	185 (17.5%)	<0.001
Non-White Race	363 (23.1%)	14 (3.9%)	108 (29.8%)	158 (43.5%)	83 (22.9%)	0.12
Lives Alone	778 (49.6%)	34 (4.4%)	281 (36.1%)	297 (38.2%)	166 (21.3%)	0.01
Income Level						<0.001
Less than \$50000	934 (67.0%)	38 (4.1%)	323 (34.6%)	364 (39.0%)	209 (22.4%)	
\$50,000 or greater	459 (33.0%)	11 (2.4%)	131 (28.5%)	171 (37.3%)	146 (31.8%)	
Education						0.22
High School or Less	505 (32.1%)	17 (30.4%)	187 (35.3%)	200 (33.1%)	101 (26.4%)	
College	661 (42.0%)	25 (44.6%)	223 (42.1%)	242 (40.0%)	171 (44.6%)	
Post Graduate	401 (25.5%)	14 (25.0%)	117 (22.1%)	161 (26.6%)	109 (28.5%)	
Unknown	7 (0.4%)	0 (0.0%)	3 (0.6%)	2 (0.3%)	2 (0.5%)	
MMSE Score	91.7 (5.3)	91.6 (5.1)	91.4 (5.3)	91.8 (5.2)	92.1 (5.4)	0.06
Number of Prescription Medications						0.10
0-4	595 (37.8%)	16 (2.7%)	184 (30.9%)	239 (40.2%)	156 (26.2%)	
5+	977 (62.2%)	40 (4.1%)	345 (35.3%)	365 (37.4%)	227 (23.2%)	
QWB General Health Rating	74.2 (15.1)	67.7 (15.7)	70.5 (15.5)	75.4 (14.1)	78.1 (14.6)	<0.001
Hypertension	1103 (70.7%)	43 (3.9%)	379 (34.4%)	427 (38.7%)	254 (23.0%)	0.19
MI/Heart Attack	123 (7.9%)	5 (4.1%)	38 (30.9%)	52 (42.3%)	28 (22.8%)	0.79
Heart Failure or CHF	68 (4.4%)	7 (10.3%)	25 (36.8%)	20 (29.4%)	16 (23.5%)	0.01
Stroke	108 (6.9%)	4 (3.7%)	39 (36.1%)	39 (36.1%)	26 (24.1%)	0.94
Diabetes or Diabetes Medication or Insulin	400 (25.5%)	18 (4.5%)	141 (35.3%)	156 (39.0%)	85 (21.3%)	0.26
Broken/Fractured Hip or Bones	495 (31.5%)	23 (4.6%)	189 (38.2%)	180 (36.4%)	103 (20.8%)	0.01
Arthritis or Rheumatism	302 (19.3%)	12 (4.0%)	118 (39.1%)	110 (36.4%)	62 (20.5%)	0.10

	Baseline MAT-sf Scores ⁽¹⁾				P-value
	Overall (N=1574)	MAT-sf 30-39 (N=56)	MAT-sf 40-49 (N=530)	MAT-sf 50-59 (N=605)	MAT-sf 60+ (N=383)
Chronic Lung Disease	244 (15.6%)	11 (4.5%)	89 (36.5%)	89 (36.5%)	55 (22.5%)
Emotional, Nervous, Psychiatric Problems	282 (18.1%)	12 (4.3%)	95 (33.7%)	108 (38.3%)	67 (23.8%)
400 meter Walk Time (seconds)	508.5 (113.2)	650.7 (105.4)	560.8 (118.1)	492.5 (95.7)	440.7 (75.2)
SPPB Score (range 0-12)	7.4 (1.6)	5.9 (2.0)	6.9 (1.7)	7.5 (1.5)	8.1 (1.2)
Hospitalizations per 100 person years (PY); # hospitalizations; PY of follow-up	34.1; 1458; 4271	41.7; 61; 146.4	38.9 539; 1384.1	33.2; 529; 1593.1	27.4; 266; 969.9
					0.003 ⁽²⁾

⁽¹⁾ Mean (sd) or N (%) unless otherwise noted

⁽²⁾ Obtained from unadjusted negative binomial model

Association between baseline mobility function scores (MAT-sf) and hospitalization events.

Table 2

Model:	Negative Binomial Model Results for Number of Hospitalization Events			
	Physical Activity Group Rate Ratio ⁽¹⁾ (95% CI)	Health Education Group Rate Ratio ⁽²⁾ (95% CI)	P-value for MAT-sf by Intervention Interaction	Combined Intervention Groups Rate Ratio ⁽³⁾ (95% CI)
1: Base Model	1.20 (1.05, 1.37)	1.27 (1.10, 1.15)	0.57	1.23 (1.12, 1.36)
2: Base Model plus clinical site, gender, age in years, white/non-white race, education, living alone	1.20 (1.05, 1.38)	1.29 (1.12, 1.49)	0.45	1.24 (1.13, 1.38)
3: Above, plus baseline cognitive impairment (mmse < 80), chronic conditions and Rx meds (0-4 vs >4)	1.16 (1.01, 1.33)	1.24 (1.07, 1.43)	0.50	1.20 (1.08, 1.32)

Model:	Cox Proportional Hazard Regression Results for Time Until Initial Hospitalization ⁽⁴⁾			
	Physical Activity Group Hazard Ratio ⁽²⁾ (95% CI)	Health Education Group Hazard Ratio ⁽²⁾ (95% CI)	P-value for MAT-sf by Intervention Interaction	Combined Intervention Groups Rate Ratio ⁽³⁾ (95% CI)
1: Base Model	1.16 (1.02, 1.31)	1.38 (1.20, 1.58)	0.06	1.25 (1.14, 1.37)
2: Base Model plus clinical site, gender, age in years, white/non-white race, education, living alone	1.15 (1.00, 1.30)	1.35 (1.17, 1.55)	0.09	1.23 (1.12, 1.36)
3: Above, plus baseline cognitive impairment (mmse < 80), chronic conditions and Rx meds (0-4 vs >4)	1.11 (0.97, 1.27)	1.31 (1.14, 1.50)	0.08	1.20 (1.09, 1.32)

⁽¹⁾ Rate Ratio expressed for a 10 MAT-sf unit difference between participants

⁽²⁾ Hazard Ratio expressed for a 10 MAT-sf unit difference between participants

⁽³⁾ Obtained from model dropping interaction term

⁽⁴⁾ Note that for Cox models, gender and clinical site were included as stratifying factors for the baseline hazard