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Original Research Article

Is There Evidence of an Association Between Acute Health Care Utilization and Function in Older Adults Over Time? A Population-Based Cohort Study

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Abstract

Background and Objectives: Acute health care use varies by age, with older adults the highest users of acute health care services. Using data from The Irish Longitudinal Study on Ageing (TILDA), the aim of this study was to investigate the association between acute health care utilization (emergency department [ED] visit with or without hospitalization) at baseline and subjective and objective measures of function measured at 4-year follow-up.

Research Design and Methods: This study represents a secondary analysis of a prospective cohort study, where data from Wave 1 (baseline) and Wave 3 of TILDA were analyzed in conjunction with a public and patient involvement group of older adults. Acute health care utilization was defined as an ED visit with or without hospitalization in the previous 12 months. Function was assessed objectively using the Timed Up and Go (TUG) test and a measure of grip strength, and subjectively using self-report limitations in activities of daily living (ADL) and instrumental ADL (IADL).

Results: A total of 1 516 participants met the study inclusion criteria. Mean age was 70.9 ± 4.6 years and 48% were male. At baseline, 1 280 participants reported no acute health care use. One hundred and eighteen indicated an ED visit but no hospitalization in the previous 12 months and 118 reported both an ED visit and hospitalization. Adjusting for all covariates, compared to those with no acute health care utilization, those with an ED visit with no hospital admission had poorer TUG performance at follow-up ($\beta = 0.67$, 95% confidence interval: 0.34, 1.29, $p = .039$).

Discussion and Implications: This paper supports previous research that acute health care events, specifically ED usage, are associated with reduced function for older adults as assessed by TUG at follow-up. No associations were observed for grip strength, ADL, or IADL. Further research is required in this area, exploring ED visits and the possible benefits of evaluating older adults at this stage.

Keywords: Activities of daily living, Emergency department, Functional assessment, Hospitalization, Timed Up and Go

Translational Significance: An increasing number of older adults are accessing acute care due to the changing demographics and the number of older adults living with comorbidities. Older adults are at risk of a decline in function following an emergency department (ED) visit and a hospital admission. An ED visit offers a window of opportunity to identify older adults at risk of a decline in function, using Timed Up and Go, and to appropriately target resources to better support them in their community. The association between acute care visits and subsequent function on health care use is an important international emerging challenge.

A growing aging population worldwide has led to increased focus on healthy aging, and prevention of age-related illnesses and decline in function (1,2). Many older adults are living into their 80s and 90s due to advances in the treatment of acute health events that were once considered life-threatening (3). While heterogeneity in aging exists (4), multimorbidity and a decline in physical function usually accompany the aging process (5,6). As the global

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population ages, there is an increased demand for all health care services, especially emergency departments (EDs) (7). International reports have highlighted increased use of ED services by older adults (8,9), defined as those aged 65 years and older (8,10,11). It is estimated that 65% of patients who are not hospitalized after their ED visit are discharged home (12). An ED presentation has been described as a "sentinel event" for older adults, as EDs are a high-risk environment for negative outcomes (13). The ED is becoming a more prominent source of emergency hospital admissions (8) and accordingly, the number of older adults requiring hospitalization is also increasing (14). Hospitalization also poses risks to older adults and international studies report that 80% of those who stay in hospital longer than 14 days are over 65 years of age (15).

There is evidence from longitudinal studies that up to 42% of older adults discharged from the ED experience a short-term self-reported decline in their functional status (16), and this decline can persist for up to 1 year (17). A decline in functional status is associated with an increased risk of further ED visits, hospitalization, increased care needs, institutionalization, mortality, and associated increased health care costs (17). Frequent ED use is associated with increased risk of adverse effects such as hospitalizations, a decline in functional status, complications related to treatment and procedures, and suboptimal follow-up (1,18). Furthermore, a decline in functional status can have longer-term consequences for older adults including decreased life satisfaction (19), lower quality of life (19), and an increase in family and carer stress (20).

Similarly, older adults who are hospitalized are vulnerable to adverse outcomes including cognitive decline, falls, readmission, mortality, and limitations in activities of daily living (ADL) (21). Limitations in ADL due to hospitalization precipitates a decline in function and mortality (21). Regardless of whether an older adult is admitted to hospital or discharged from the ED, there is a risk of experiencing a number of adverse outcomes (13,22). It is critical to identify individuals most vulnerable to a decline in function and subsequent dependency in order to encourage healthy aging and prioritize health care interventions (20).

The ability of a person to conduct the everyday tasks required to meet their fundamental needs and preserve their health is referred to as functional status (23). Functional status is commonly assessed using both subjective and objective performance measures. Subjective measures include self-reported limitations in ADL and instrumental ADL (IADL). Objective tests of functional status include the assessment of grip strength, gait speed, 30-second chair stand test, Timed Up and Go (TUG) test, and Assessment of Motor and Process Skills (24,25). The TUG is a widely used test of mobility and lower extremity function (24). Similarly, grip strength dynamometry is commonly used to estimate overall muscle strength in older adults (26). Poor scores or performance in both measures are associated with hospitalization and institutionalization (27).

Ireland has a unique mixed public–private system of health care, which is undergoing reforms to move toward a universal health care system aiming to shift care away from acute settings to the community (28,29). While there is evidence to link relationships of an ED presentation and a decline in functional status in clinical trials in Ireland (30), at a population level, there is a lack of evidence of the relationship between an acute health care utilization and subsequent function. Given the effect of a decline in functional status on quality of life and maintaining independence into older age, understanding the impact of an acute health care utilization on its trajectories has important implications for decisions on clinical practice and public health policies. Using data from The Irish Longitudinal Study on Ageing (TILDA), the aim of this study was to investigate if an association exists between acute health care utilization (ED visit with or without hospitalization) at baseline and objective measures of function (TUG and grip strength) and subjective measures (limitations in ADL and IADL) measured at 4-year follow-up.

Method

Study Design

This study represents secondary analysis of a prospective cohort study where data from Wave 1 and Wave 3 of TILDA were analyzed. The STrengthening the Reporting of OBservational studies in Epidemiology (31) guidelines were used to guide the conduct and reporting of this study (see Supplementary Material).

TILDA is a nationally representative prospective cohort study assessing the health, economic, and social circumstances of community-dwelling adults aged 50 and older in the Republic of Ireland (32,33). Details of the study sample have been described in detail elsewhere (32) and a summary of the study is available on https://tilda.tcd.ie/about/where-are-we-now/. Briefly, participants were randomly selected using the Irish Geodirectory, a comprehensive and current listing of all residential addresses in the Republic of Ireland. Residents aged 50 years and older at selected addresses, and their partner or spouse, regardless of age, were invited to participate. Ethical approval was obtained from the Faculty of Health Sciences Research Ethics Committee at Trinity College Dublin and all participants provided written informed consent (32,33).

Data Collection

Wave 1 of the study was conducted between October 2009 and February 2011 and 8 174 participants aged 50 years and older were recruited. Wave 3 took place between March 2014 and October 2015. At both Wave 1 and Wave 3, data collection included 3 components: a computer-assisted personal interview (CAPI) including detailed questions on all aspects of aging; a self-completion questionnaire that was posted back to the study center; and a full health evaluation performed by a research nurse in the participant's home or in a special health center (32).

For participation in the overall TILDA study, participants were deemed eligible if they had a Mini-Mental State Examination (MMSE) score ≥18 and no self-reported doctor-diagnosed cognitive impairment or Parkinson's disease (32). For the present study, participants were deemed eligible if they were older adults (aged 65 years or older) and completed the health assessment incorporating objective measures of function at Wave 1 (baseline) and were followed up in Wave 3 of the study. Only participants aged 65 years and older were included in the analysis as this group has been shown to be the heaviest users of the ED and most likely to need hospitalization (7,8,34).

Exposure of Interest: Acute Health Care Use (ED Visit and Hospitalization)

In the CAPI at Wave 1 of TILDA, participants were asked the following questions in relation to health care utilization:

> In the last 12 months, how many times did you visit a hospital Emergency Department (sometimes called A&E or Accident and Emergency) as a patient?
>
> In the last 12 months, on how many occasions were you admitted to hospital overnight?

Participants were classified into 3 groups as "No ED visit" if they did not attend the ED in the previous 12 months; "ED visit, no hospitalization" group if they presented to the ED but did not report a hospital admission in the previous 12 months; and "ED visit with hospitalization" group if they attended the ED and had a hospital admission in the previous 12 months.

Objective Measures of Physical Function

The TUG test

The TUG was assessed at both Wave 1 and 3. Participants were asked to rise from a chair, walk 3 m at their normal pace, turn around, return to the chair, and sit down (24). Mobility aids were allowed if needed, and no instructions were given about the participants' use of their arms. The time taken from the initial "Go" command to when the participant was sitting with his/her back resting against the back of the chair again was recorded in seconds using a stopwatch.

Grip strength

Grip strength was assessed at both Wave 1 and 3 and measured with a Baseline hydraulic hand dynamometer (Fabrication Enterprises Inc., White Plains, NY), which is composed of an analog reading scale and a gripping handle with a strain gauge (32). Grip strength was recorded as the mean maximal isometric grip strength of the dominant hand (kg) over 2 trials.

Subjective Measures of Physical Function

Limitations in ADL and IADL

Limitations in ADL and IADL scales were measured in both Wave 1 and Wave 3. For ADL, participants were asked if they had difficulty dressing, bathing, feeding, getting in and out of bed, toileting, and walking across a room (32). For IADLs, participants were asked whether they had difficulty preparing a hot meal, performing household chores, purchasing groceries, making telephone calls, taking medications, and managing finances (32). These questions were modified from standardized ADL and IADL scales (35). For both variables, a binary outcome was created at each wave in order to capture those participants who had any disability in ADL and IADL and those who had none.

Covariates

Based on prior research and stakeholder input, baseline demographic, social, and health variables known to be associated with ED utilization, a decline in function, and limitations in ADL and IADL in older adults were included as covariates in the statistical analysis (1,36–38). These covariates were age, sex, living arrangement, educational attainment (some primary/none, primary, some secondary, secondary, diploma/certificate, primary degree, and postgraduate/higher level), health behaviors including smoking status, physical activity level (measured using the short-form International Physical Activity Questionnaire) (39), self-reported physical health (measured using 5 response options "excellent, very good, good, fair, or poor") (32), global cognitive function (measured using the Montreal Cognitive Assessment tool (40)), number of doctor-diagnosed medical conditions ("number of chronic conditions"), and polypharmacy (defined as 5 or more medications that participants take regularly, not including supplement use).

Missing Data

Only participants with complete data for acute health care utilization at a Wave 1 were analyzed as demonstrated in Figure 1. See Supplementary Tables 1 and 2 for baseline characteristics of those participants who were excluded from the analysis due to not having a health center assessment and those lost to follow-up.

Public and Patient Involvement

This study was developed in conjunction with a public and patient involvement (PPI) panel of older adults. The PPI panel was formed to act as research partners for projects related to older adults (41). Following the conceptualization of the research question (M.C., R.G., and S.L.), 2 unstructured telephone meetings were conducted with 5 members of the PPI panel which focused on discussions as to what outcomes were important to track in those participants who had an acute health care utilization at Wave 1 (baseline). The initial meeting focused on an exploration of the TILDA data set, their own personal experiences of a visit to the ED, and their subsequent trajectory post discharge, with a focus on their ability to perform ADL and their return to physical activity. The second meeting focused on a discussion on the outcomes within the TILDA data set which related to health status and objective and subjective measures of functional status, including limitations in ADL, IADL, measures of walking speed, and grip strength. Furthermore, health and demographic differences that may influence functional status were discussed and evaluated, based on existing literature. A combination of previous published literature and stakeholder input served as the basis for the final covariate selection.

Statistical Analysis

Descriptive statistics of the sample at Wave 1 (baseline) were summarized and described as mean with standard deviation or count (n) and percentage (%) as appropriate. The Chi-squared test for categorical variables and analysis of variance for continuous variables were used to assess differences between health care utilization groups at baseline. Linear regression was used to investigate the relationship between ED use at baseline and grip strength and TUG performance at Wave 3. Logistic regression was used to investigate the relationship between ED use at baseline and whether a participant had a disability in ADL and IADL, or not, at Wave 3. For each outcome, 3 models were run. Model 1 was adjusted for age and sex, Model 2 adjusted for age, sex, and baseline function, and Model 3 adjusted for all covariates (age, sex, education, living arrangement, smoking status, self-rated physical health, polypharmacy, number of chronic

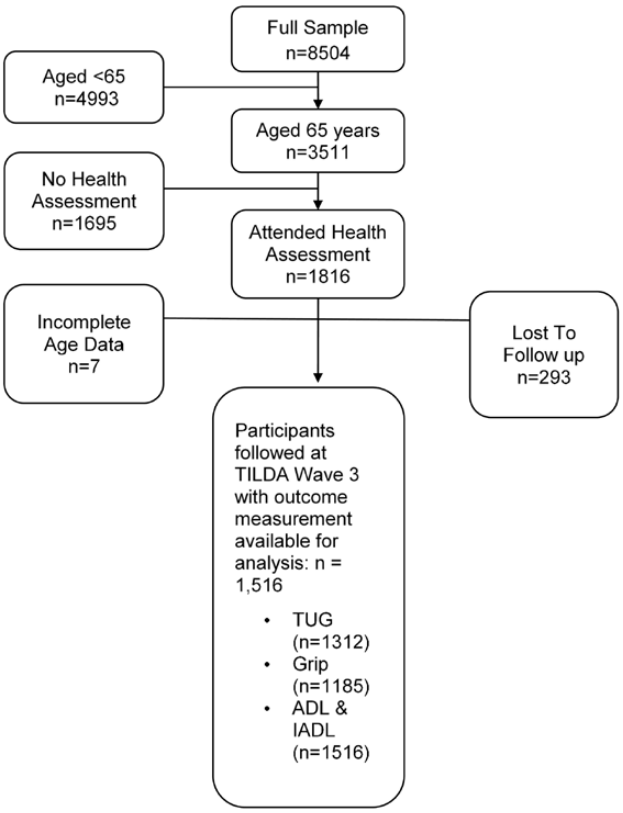

Figure 1. Flow diagram of study participants from TILDA cohort. *Notes*: ADL = activities of daily living; IADL = instrumental activities of daily living; TILDA = The Irish Longitudinal Study on Ageing; TUG = Timed Up and Go test.

conditions, physical activity level, cognition as well as the baseline outcome variables). Multicollinearity was assessed for each model using the variance inflation factor command and analyses were performed using Stata version 15.1 (StataCorp LP, College Station, TX). Significance was set at $p < .05$ for all analyses.

Results

Characteristics of the Baseline Study Population

A total of 1 516 participants met the study inclusion criteria. Figure 1 presents a data flow chart of study participants. Supplementary Table 1 illustrates baseline descriptive characteristics of excluded participants. Those not included in the present analysis were older, living alone, current smokers, and had lower physical activity levels but similar levels of ED visits and hospitalizations within the last 12 months. Of the 1 516 participants included in the study, the mean age of the included sample was 70.9 years (SD = 4.6) and 48% were male. At baseline (Wave 1), 236 participants experienced an ED visit and 1 280 participants had no ED visit and no hospitalization events. Of those 236 who experienced an ED visit, 118 indicated an ED visit but no hospitalization in the previous 12 months and 118 indicated they experienced both an ED visit and hospitalization in the previous 12 months. Baseline characteristics of the included sample are presented in Table 1. The groups were significantly different at baseline with regard to the number of chronic diseases, self-rated physical health, polypharmacy, and level of physical activity, whereby those in the "ED visit with hospitalization" group had poorest health and activity levels. Baseline grip strength or TUG did not differ among groups. While the overall prevalence of limitations in ADL and IADL at baseline was low, compared to those in the "No ED visit" group, individuals that reported an ED visit with or without hospitalization at baseline were more likely to report limitations in both ADL and IADL.

Outcomes

Objective measures of physical function

Findings from multiple linear regression analysis investigating the relationship between baseline acute health care utilization and Wave 3 TUG score are illustrated in Table 2. In Model 1 (adjusted for age and sex), compared to "No ED visit" group, both "ED visit, no hospitalization" (beta coefficient [β] = 1.03, 95% confidence interval [CI]: 0.30, 1.78, p = .006) and "ED visit with hospitalization" (β = 0.99, 95% CI: 0.27, 1.71, p = .007) groups were associated with poorer TUG performance. When adjusted for baseline TUG (Model 2), this relationship persisted for "ED visit, no hospitalization" group (β = 0.90, 95% CI: 0.28, 1.52, p = .005) but no evidence of a difference with "ED visit with hospitalization" group (β = 0.25, 95% CI: −0.36, 0.86, p = .423). In Model 3 adjusting for all covariates, compared to those with no acute health care utilization ("No ED visit" group), those with an ED visit with no hospital admission had poorer TUG performance at 4-year follow-up (β = 0.67, 95% CI: 0.34, 1.29, p = .039). Those in the "ED visit, no hospitalization" group took 0.67 seconds longer to complete the TUG in comparison to the "No ED visit" group.

Findings for grip strength are presented in Table 3. In Model 1 (adjusted for age and sex), those in the "ED visit with hospitalization" group had statistically significant reduced grip strength compared to the "No ED visit" group (β = −1.53, 95% CI: −2.78, −0.28, p = .016). Being in the "ED visit with hospitalization" group was associated with a 1.53-kg lower grip strength compared to "No ED visit" group. This relationship did not persist after adjustment for baseline grip (Model 2, β = −0.47, 95% CI: −1.45, 0.50, p = .340) or additional covariates (Model 3, β = −0.28, 95% CI: −1.27, 0.71, p = .577). There was no evidence of a difference in grip strength between those in the "ED visit, no hospitalization" group and those in the "No ED visit" group.

Subjective measures of physical function

Table 4 shows the logistic regression analyses investigating the relationship between acute health care utilization at baseline and limitations in ADL and IADL at follow-up. In Model 1, compared to those in the "No ED visit" group, there was an increased odds of a limitation in ADL for those in the "ED visit, no hospitalization" group (odds ratio [OR]: 2.00, 95% CI: 1.07, 3.74, p = .029). This association was no longer significant in Model 2 (OR: 1.52, 95% CI: 0.79, 2.94, p = .204) or Model 3 (OR: 1.36, 95% CI: 0.66, 2.83, p = .404) and there was no evidence of a difference between "No ED visit" and "ED visit with hospitalization" groups in any of the models. With regard to the development of a limitation in IADL there was no evidence of a difference between the "No ED visit" group and "No ED visit, no hospitalization" group or "ED visit with hospitalization" group in any of the models (Table 4).

Table 1. Demographic and Health Covariates of the Sample at Baseline

Characteristic	Total Sample (n = 1 516)	No ED Visit (n = 1 280)	ED Visit, No Hospitalization (n = 118)	ED Visit With Hospitalization (n = 118)	p Value
Age (years), mean (*SD*)	70.9 (4.6)	70.6 (4.6)	71.3 (4.9)	71.1 (4.9)	.366*
Gender, *n* (%)					
Male	727 (47.9)	615 (48.1)	48 (40.6)	64 (54.3)	.112**
Education, *n* (%)					
Some primary (not complete)	40 (2.6)	33 (2.5)	3 (2.5)	4 (3.3)	.747***
Primary (or equivalent)	427 (28.1)	356 (27.8)	35 (29.6)	36 (30.5)	
Intermediate cert	319 (21.0)	272 (21.2)	27 (22.8)	20 (15.9)	
Leaving certificate	233 (15.3)	199 (15.5)	11 (9.3)	23 (19.4)	
Diploma/certificate	248 (16.3)	212 (16.5)	22 (18.6)	14 (11.8)	
Primary degree	158 (10.4)	133 (10.4)	13 (11.0)	12 (10.1)	
Postgraduate	90 (5.9)	74 (5.7)	7 (5.9)	9 (7.6)	
Living arrangement, *n* (%)					
Alone	370 (24.4)	304 (23.8)	37 (31.3)	29 (24.5)	.362***
Living with spouse	885 (58.3)	758 (59.2)	59 (50.0)	68 (57.6)	
Living with other	261 (17.2)	218 (17.0)	22 (18.6)	21 (17.8)	
Smoker, *n* (%)					
Never	718 (47.3)	622 (48.5)	49 (41.5)	47 (39.8)	.216***
Past	660 (43.5)	541 (42.2)	59 (50.0)	60 (50.8)	
Current	138 (9.1)	117 (9.1)	10 (8.47)	11 (9.3)	
Self-rated health, *n* (%)					
Excellent	251 (16.5)	231 (18.0)	11 (9.3)	9 (7.6)	<.001**
Very good	454 (29.9)	399 (31.1)	32 (27.1)	23 (19.4)	
Good	508 (33.5)	426 (33.2)	42 (35.5)	40 (33.9)	
Fair	251 (16.5)	189 (14.7)	27 (22.8)	35 (29.6)	
Poor	52 (3.4)	35 (2.7)	6 (5.0)	11 (9.3)	
IPAQ, *n* (%)					
Low	432 (28.6)	367 (28.7)	27 (23.0)	38 (32.2)	.044***
Moderate	587 (38.8)	481 (37.6)	51 (43.5)	55 (46.6)	
High	491 (32.5)	427 (33.4)	39 (33.3)	25 (21.1)	
MOCA, mean (*SD*)	24.6 (3.3)	24.6 (3.4)	24.3 (3.0)	24.4 (3.8)	.227***
Polypharmacy, *n* (%)	390 (25.9)	304 (23.9)	43 (37.1)	43 (36.7)	.034***
Number of chronic conditions, mean (*SD*)	3.0 (1.3)	2.9 (1.2)	3.3 (1.4)	3.3 (1.5)	.006***
Grip strength (kg), mean (*SD*)	24.2 (8.9)	24.5 (8.9)	22.4 (8.8)	23.5 (8.4)	.717***
Female		18.1 (4.9)	17.1 (5.3)	17.0 (4.7)	
Male		31.2 (7.3)	28.9 (7.43)	28.8 (7.0)	
TUG time (seconds), mean (*SD*)	9.4 (2.2)	9.4 (2.2)	9.6 (1.9)	10.1 (2.3)	.118***
Limitations in ADL, *n* (%)	143 (9.4)	98 (7.7)	22 (18.6)	23 (19.5)	.000***
Limitations in IADL, *n* (%)	80 (5.3)	60 (4.7)	8 (6.8)	12 (10.2)	.029***

Notes: ADL = activities of daily living; ED = emergency department; IADL = instrumental activities of daily living; IPAQ = International Physical Activity Questionnaire; MOCA = Montreal Cognitive Assessment tool; SD = standard deviation; TUG = Timed Up and Go test.
**p* Value from 1-way analysis of variance.
***p* Value from Chi-squared test for independence (continuity correction).
****p* Value from Chi-squared test.

Discussion

This study investigated the association between acute health care utilization (ED visit with or without hospitalization) at baseline and objective (TUG and grip strength) and subjective measures (limitations in ADL and IADL) of function measured at 4-year follow-up in a cohort of community-dwelling older adults in Ireland. Our results indicate that after adjustment for all covariates, those who had an ED visit with no hospitalization in Wave 1 had significantly poorer performance in TUG at 4-year follow-up in contrast to those who had no acute health care utilization event and those that underwent hospitalization. Those in the "ED visit, no hospitalization" group

Table 2. Association of Acute Health Care Utilization Event With TUG Performance

	Model 1 (n = 1 312)				Model 2 (n = 1 310)				Model 3 (n = 1 274)			
	Coef	[95% CI]	p Value	R^2	Coef	[95% CI]	p Value	R^2	Coef	[95% CI]	p Value	R^2
Acute healthcare utilization event				0.113				0.373				0.415
No ED visit	Ref.				Ref.				Ref.			
ED visit, no hospitalization	1.03	[0.30, 1.78]	.006		0.90	[0.28, 1.52]	.005		0.67	[0.34, 1.29]	.039	
ED visit with hospitalization	0.99	[0.27, 1.71]	.007		0.25	[−0.36, 0.86]	.423		−0.16	[−0.78, 0.46]	.616	
Age	0.26	[0.21, 0.30]	<.001		0.11	[0.08, 0.15]	<.001		0.08	[0.04, 0.13]	<.001	
Sex	0.61	[0.21, 1.00]	.003		0.44	[0.11, 0.77]	.010		−0.18	[−0.71, 0.34]	.493	
Wave 1 TUG time (baseline)					1.00	[0.91, 1.08]	<.001		0.88	[0.78, 0.97]	<.001	

Notes: Coef = coefficient; CI = confidence interval; ED = emergency department; TUG = Timed Up and Go test. R^2: R-squared; Model 1: adjusted for age and sex; Model 2: Model 1 adjusted for baseline TUG; Model 3: Model 2 adjusted for all covariates (age, sex, baseline TUG, education, living arrangement, smoking status, grip strength, self-rated physical health, level of physical activity, cognitive function, polypharmacy, number of chronic conditions, grip strength, activities of daily living, instrumental activities of daily living).

Table 3. Association of Acute Health Care Utilization Event With Grip Strength

	Model 1 (n = 1 185)				Model 2 (n = 1 174)				Model 3 (n = 1 154)			
	Coef	[95% CI]	p Value	R^2	Coef	[95% CI]	p Value	R^2	Coef	[95% CI]	p Value	R^2
Acute healthcare utilization event				0.532				0.722				0.732
No ED visit	Ref.				Ref.				Ref.			
ED visit, no hospitalization	−0.94	[−2.26, 0.38]	.162		−0.29	[−1.29, 0.73]	.581		−0.43	[−1.46, 0.61]	.417	
ED visit with hospitalization	−1.53	[−2.78, −0.28]	.016		−0.47	[−1.45, 0.50]	.340		−0.28	[−1.27, 0.71]	.577	
Age	−0.42	[−0.49, −0.34]	<.001		−0.14	[−0.20, −0.08]	<.001		−0.12	[−0.19, −0.05]	<.001	
Sex	−12.35	[−13.04, −11.67]	<.001		−3.34	[−4.16, −2.53]	<.001		−3.37	[−4.23, −2.51]	<.001	
Wave 1 grip strength (baseline)					0.69	[0.64, 0.73]	<.001		0.68	[0.63, 0.73]	<.001	

Notes: Coef = coefficient; CI = confidence interval; ED = emergency department. R^2: R-squared; Model 1: adjusted for age and sex; Model 2: Model 1 adjusted for baseline grip (kg); Model 3: Model 2 adjusted for all covariates (age, sex, baseline grip, education, living arrangement, smoking status, grip strength, self-rated physical health, level of physical activity, cognitive function, polypharmacy, number of chronic conditions, Timed Up and Go, activities of daily living, instrumental activities of daily living). Model 3: Model 2 adjusted for all covariates.

took 0.67 (95% CI: 0.34, 1.29) seconds longer to complete the TUG in comparison to the "No ED visit" group.

The TUG time of the older adults in this study is similar to that of a cross-sectional study of 176 community-dwelling older adults living in Cork, Ireland (42), with the average TUG time of 9.5 seconds (*SD* 2.38 seconds) for their sample. Baseline (Wave 1) TUG performance for the participants in the "ED visit, no hospitalization" group was 9.55 seconds (1.94 seconds) and 10.14 seconds (2.25 seconds) in the "ED visit with hospitalization" group. This is considered a clinically significant difference in TUG performance (43).

Our findings are in line with international evidence that older adults who have an ED visit are at risk of adverse outcomes including functional decline, morbidity, and mortality (8,13,17). Given the projected increases in population aging in the coming decades, these findings emphasize the difficulties facing health care systems caused by the rising demand for acute medical care among older adults, particularly for ED services (7–9,44). The TUG test is a simple, well-established measure of lower extremity function and mobility (24). Slow gait speed (24), reduced balance, and functional indices are all associated with low TUG scores in older adults (45). The TUG is a composite dynamic test that has a neuromuscular component as it requires turning and walking and executive function (46); thus, while simple to administer it is considered complex to complete (46). The TUG test is predictive of decline in an individual's global health and limitations in ADL (45). International studies report that 80% of those who stay in hospital longer than 14 days are over 65 years of age (15). Within those 14 days older adults are assessed and undergo rehabilitation which often continues post discharge. In this study, evidence of a decline in TUG was seen only in those with an ED visit *without* hospitalization, and not those with ED visit *with* hospitalization. It is plausible

Table 4. Association of Acute Health Care Utilization Event With Limitations in ADL and IADL

	Model 1 (n = 1 516)			Model 2 (n = 1 516)			Model 3 (n = 1 456)		
	OR	[95% CI]	p Value	OR	[95% CI]	p Value	OR	[95% CI]	p Value
ADL									
Acute health care utilization event									
No ED visit	Ref.			Ref.			Ref.		
ED visit, no hospitalization	2.00	[1.07, 3.74]	.029	1.52	[0.79, 2.94]	.204	1.36	[0.66, 2.83]	.404
ED visit with hospitalization	1.66	[0.86, 3.23]	.134	1.22	[0.61, 2.46]	.572	0.78	[0.35, 1.74]	.551
Age	1.02	[0.98, 1.07]	.279	1.00	[0.96, 1.05]	.873	0.94	[0.88, 0.99]	.035
Sex	0.95	[0.63, 1.43]	.800	1.01	[0.66, 1.54]	.958	0.48	[0.24, 0.96]	.039
Wave 1 disability in ADL (baseline)				6.01	[3.74, 9.67]	<.001	2.96	[1.63, 5.37]	<.001
IADL									
Acute health care utilization event									
No ED visit	Ref.			Ref.			Ref.		
ED visit, no hospitalization	1.62	[0.85, 3.09]	.144	1.56	[0.78, 3.10]	.210	1.19	[0.55, 2.56]	.666
ED visit with hospitalization	1.70	[0.89, 3.24]	.109	1.38	[0.69, 2.76]	.365	0.85	[0.38, 1.87]	.679
Age	1.10	[1.05, 1.14]	<.001	1.08	[1.03, 1.13]	<.001	1.00	[0.95, 1.05]	.983
Sex	1.20	[0.80, 1.80]	.380	0.96	[0.62, 1.48]	.854	0.40	[0.19, 0.81]	.011
Wave 1 disability in IADL (baseline)				11.16	[6.58, 18.8]	<.001	3.20	[1.54, 6.62]	.002

Notes: ADL = activities of daily living; CI = confidence interval; IADL = instrumental activities of daily living; OR = odds ratio. Model 1: adjusted for age and sex; Model 2: Model 1 adjusted for baseline ADL/IADL; Model 3: Model 2 adjusted for all covariates (age, sex, baseline ADL/IADL, education, living arrangement, smoking status, grip strength, self-rated physical health, level of physical activity, cognitive function, polypharmacy, number of chronic conditions, grip strength, Timed Up and Go, ADL/IADL).

to assume that older adults in this study who experienced an ED visit and a hospitalization had their rehabilitation needs met in terms of improving function and ability to carry out ADL and IADL. The results of this study indicate that subtle changes in the TUG may have important clinical implications when screening those who are at risk of adverse outcomes. A systematic review of 68 studies investigating the psychometric properties of the TUG test reported that few studies report responsiveness to change in older adults and the studies were of a low quality (47). Clinicians can utilize this data to identify subpar performance, decide whether an intervention is necessary, and track changes after an intervention (48). There is evidence from other cohort studies that the risk of a decline in function and risk of hospitalizations are associated with slower TUG performance in older adults (45).

Our results indicate that there was no evidence of a relationship between baseline health care use and grip strength measured at follow-up. Current methods of measuring grip strength vary widely, making comparisons across studies difficult (49). Our finding is in line with the complete TILDA population of over 50s, where the majority of older adults' grip strength stayed the same between Waves 1 and 3 (33). Using Wave 3 data minimized the methodological differences utilized in Wave 2 of TILDA to assess objective measures of physical function.

Descriptive statistics in this study indicate that those participants that had an acute health care event at Wave 1 (baseline) had more limitations in ADL and IADL. However, there was no evidence of a relationship between acute health care utilization and limitations in ADL or IADL at follow-up after adjustment for covariates.

The overall prevalence of a limitation in ADL is low in this cohort of older adults. Just 7% reported a limitations in ADL at Wave 3 in comparison to the 28% in English Longitudinal Study of Ageing (ELSA) (50), and 18% in U.S. Health and Retirement Study (HRS) (51). Similarly, the prevalence of a limitation in IADL is also less than ELSA (28%) (50) and HRS (17%) (51). The differences may relate to methodological issues while there is measurement equivalence between HRS and SHARE on limitations in ADL and IADL, measurement equivalence is not present with ELSA. While all 3 studies use the same questions to assess limitations in ADL and IADL, measurement equivalence was not observed across 3 international studies of aging (52). The CAPI questionnaire may fail to capture the fact that limitations in ADL and IADL are on a spectrum from slight to severe, not just absent or present (53), and can reverse over time.

The ability to target and address risk factors early on in order to prevent further decline makes early diagnosis of a decline in function in older adults crucial. The ED is the source of emergency hospital admission for older adults and thus an ED visit for an older adult offers an opportunity to identify those with a decline in function and plan appropriate intervention in the acute or community setting. In support of this, an umbrella review concluded that targeted comprehensive geriatric assessment (CGA) offers a higher possibility of independent living, better long-term cognitive outcomes, fewer people receiving institutional care, and lower mortality, with the benefit seen in an inpatient setting (54). CGA offers a "window of opportunity" for the assessment on an older adult who is at risk of adverse outcomes and the implementation of interventions to reduce such adverse outcomes.

This study is not without limitations. The TILDA sampling excludes people living with dementia or people living in nursing homes at baseline and thus may not be representative of the whole population over 65 years (32,33). Furthermore, those who participated in a baseline health center assessment were generally healthier with fewer chronic conditions (33). There is a risk of measurement error due to recall bias with

regard to health care utilization and our research question did not explicitly ask if an ED visit resulted in a hospitalization; thus, there may be a measurement/classification error due to the assumptions we have made. However, self-reported measures have been noted as the most accurate for notable events such as ED visits and unscheduled hospital admissions (55–57). TILDA methodology includes face-to-face CAPI and a robust survey design which may increase accuracy of recall.

In addition, there may be unmeasured confounders that could explain the relationships between variables (ie, factors relating to ED/hospital visits). In addition, given the methodology of TILDA, there are no measures of function prior to the baseline reported health care utilization; therefore, it is possible that increased health care utilization preceded the functional decline captured in our analysis (58). Results should therefore be interpreted with caution. Assessing function following baseline health care utilization as we have done lessens this possibility but cannot eliminate it.

As previously described, small sample sizes may have limited the statistical power to explore certain relationships, particularly for limitations in ADL and IADL. This may have been compounded by preexisting differences in limitations in ADL and IADL between the groups at baseline. Finally, it should be noted that Models 2 and 3 are adjusted for baseline function (59), thus there is a possibility this introduced bias, therefore our results need to be interpreted with caution (60).

The strengths of this study include the use of a population-based, nationally representative cohort, with rich detail on demographic, social, and health characteristics of participants. Consultation with a PPI panel of older adults on the choice of covariates is a further strength and while the value of PPI in research related to older adults is recognized, this type of research partnership between academics and PPI in statistical modeling is relatively novel (61). This research partnership can enhance understanding, increase relevance, foster learning, and advance impact (61). An additional strength of this study is that it was completed in Ireland, where the health system is predominantly tax-funded with an increasing private health insurance sector that coexists with the public system (62,63).

The results of this study provide evidence of a relationship between acute health care utilization and reduced function, as assessed by TUG, at a 4-year follow-up. There was no evidence of associations for grip strength, ADL, or IADL. This paper supports previous research that acute health care events, specifically ED usage, is associated with function for older adults. An assessment in an acute care setting affords an opportunity to clinicians to assess function in terms of simple performance measures and ADL. Early detection of a decline in function is important for the health of older adults to promote healthy aging and for society given the aging of the population worldwide. However, further research is required in this area, exploring ED visits and the possible benefits of evaluating older adults at this stage.

Supplementary Material

Supplementary data are available at *Innovation in Aging* online.

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Conflict of Interest

None declared.

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