




Trends in Location of Death Among Older Adult Americans After Falls

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Abstract

Introduction: Fall-related mortality is increasing among older adults, yet trends and changes in the location of fall-attributed deaths are unknown; additionally, potential disparities are understudied. **Methods:** To assess trends/factors associated with place of death among older adult fall deaths in the US, a cross-sectional analysis of deaths using mortality data from 2003–2017 was performed. **Results:** Most deaths occurred in hospitals, however, the proportion decreased from 66.4% ($n = 9,095$) to 50.7% ($n = 15,817$). The proportion occurring in nursing facilities decreased from 15.9% ($n = 2175$) to 15.3% ($n = 4,778$), while deaths at home and in hospice facilities increased. Male, Black, Native American, and married decedents had increased odds of hospital death. **Conclusion:** As fall deaths increase among older adults, end-of-life needs of this population deserve increased attention. Research should explore needs and preferences of older adults who experience falls and their caregivers to reduce disparities in place of death and to ensure high quality of care is received.

Keywords

falls, geriatric trauma, older adult trauma, end-of-life care, hospice

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Introduction

Accidental injuries are the third leading cause of death in the United States (US) among adults aged 65 and older. Of these injury-related deaths, the majority are due to falls. (Control & Prevention, 2017; Murphy et al., 2017) From 2007 to 2016, the fall mortality rate among adults aged 65 and older increased by 31%. (Burns & Kakara, 2018) During the same period, the fall mortality rate among adults aged 75 and older increased by about 42%. (Hartholt et al., 2019) In 2016, nearly 30,000 US residents died as a result of a fall (Burns & Kakara, 2018) and it is estimated that by 2030, seven older adults will die from a fall each hour. (Control & Prevention, 2017)

Following trauma, including falls, older adults tend to experience worse outcomes than younger individuals. (Kuhne, Ruchholtz, Kaiser, Nast-Kolb, & Working Group on Multiple Trauma of the German Society of, 2005) Even after a ground-level fall, often considered a lower risk injury, adults aged 70 and older are more than 3 times as likely to die than younger adults. (Spaniolas et al., 2010) Falls are a leading cause of hip

fractures among older adults, and hip fractures are associated with an increased risk of death. (Dubljanin-Raspopovic et al., 2013; Rapp et al., 2008) Comorbidities, frailty, and impaired immune function may hinder older adults' recovery and negatively impact their quality of life after a traumatic injury, while a history of physical activity may reduce the risk of a severe fall injury. (Joseph et al., 2015, 2017; Marciniak et al., 2021) Up to

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half of frail or cognitively-impaired older adults hospitalized following trauma are discharged to nursing facilities due to their increased care needs, and roughly 20% will die within 1 year.(Joseph et al., 2015, 2017; Maxwell et al., 2016) Individuals with multiple chronic diseases have a greater fall risk than individuals with fewer than two chronic diseases (Kwon et al., 2018), and Black and Hispanic individuals experience higher rates of many chronic diseases than white people.(Ochieng et al., 2021) However, research finds that white people are more likely to experience falls than members of other racial groups.(Geng et al., 2017; Nicklett & Taylor, 2014) Furthermore, despite aggressive attempts to standardize trauma care across the nation, racial minorities and individuals of lower socioeconomic levels experience worse post-trauma outcomes, including mortality.(Ali et al., 2013; Haider et al., 2013; Haines, Rust, et al., 2018; Haines, Agarwal, & Jung, 2018; Haines, Jung, et al., 2018; Haines, Zens, et al., 2018; Moffet et al., 2018)

Despite the substantial suffering and high risk of death following a traumatic injury such as a fall, most older adult trauma patients are unlikely to have their palliative care needs met.(McGreevy et al., 2017; Mosenthal et al., 2008; Owens, 2012) Much as dementia is under-recognized as a terminal illness (Mitchell et al., 2009; Sachs et al., 2004), falls may not be viewed as terminal events, and older adults who have experienced a fall may be at risk of receiving suboptimal care at the end of life. Individuals belonging to minority racial and ethnic groups may be even less likely to receive palliative care, specialized medical care that prioritizes quality of life and symptom management at any stage of serious illness.(Haines, Jung, et al., 2018; Johnson, 2013) Palliative care and hospice, a type of palliative care for individuals with a limited life expectancy, have been associated with reductions in symptom distress and improved care quality.(Kavalieratos et al., 2016) Importantly, palliative care aims to help patients receive care in line with their health care and end of life goals and preferences, possibly increasing the likelihood of dying in one's preferred location.(Bell et al., 2010; Kavalieratos et al., 2016)

Societal efforts to deinstitutionalize death, including the increased use of palliative care and hospice, have likely contributed to the home becoming the most common location of death for individuals dying from natural causes in the United States.(Cross & Warraich, 2019) Research has not yet examined where individuals with fall-attributed deaths die and how location of fall-attributed deaths may have changed over time. Therefore, we sought to 1) Describe trends in location of death due to falls and 2) Examine disparities in place of death by demographic and social characteristics.

Methods

Data Source

Aggregated death certificates data obtained from the Centers for Disease Control and Prevention Wide-Ranging Online Data for Epidemiologic Research (CDC WONDER) from

January 1, 2003 to December 31, 2017 were used to perform a nationwide, retrospective cohort study of older adult patients with deaths primarily attributed to falls.(Control et al., 2019) CDC WONDER is a system developed by the CDC to promote data-driven decision making by health practitioners and researchers and provide detailed public health information to the public.

The primary outcome of interest for this analysis was the location of death. Location of death categories for patients dying of falls (International Statistical Classification of Diseases and Related Health Problems, 10th Revision codes ICD-10 W00-W19) included hospital, home, nursing facility, hospice facility, and other (outpatient medical facility, emergency department, and dead on arrival at the hospital). CDC WONDER lists all deaths since 1999 using ICD-10 codes; therefore, the conversion of ICD-9 codes was not required.

Demographic characteristics included age (65–74, 75–84 and 85 and above), sex, race (White, Black, Native American/Alaska Native, and Asian/Pacific Islander), ethnicity (Hispanic, Non-Hispanic), marital status (married, not married), education (high school or less and college or more), county urbanization, and year of death. Using standardized NCHS rural-urban classification, the following categories were created: large metropolitan (population \geq 1 million), medium/small metropolitan (50,000–999,999), and rural (<50,000).(Ingram & Franco, 2014)

Statistical Analysis

We used multivariable logistic regression to evaluate associations between decedent characteristics and place of death. Unique models were generated for each place of death versus all other locations and adjusted for age, sex, race, ethnicity, marital status, education level, and year of death. Observations with missing values for any measures were removed. We report odds ratio (OR) and 95% confidence intervals (CI). Two-tailed *p* values of <0.05 were considered statistically significant for all analyses. As this study used de-identified and publicly available data, an institutional review board was not required. All analyses were completed using Stata software (StataCorp. 2017. Stata Statistical Software: Release 15. College Station, TX: StataCorp LLC).

Results

Overall Trends

From January 1, 2003 to December 31, 2017, 330,142 deaths were attributed primarily to falls. (Table 1). The number of annual deaths from falls increased from 13,701 in 2003 to 31,190 in 2017. Throughout the study period, the majority of deaths occurred in hospitals (57.2%, *n* = 188,759) followed by nursing facilities (15.4%, *n* = 50,871), other locations (10.3%, *n* = 33,842), and hospice facilities (9.2%, *n* = 30,519). Only 7.9% (*n* = 26,151) of deaths occurred at home.

Table 1. Place of Death of Decedents from Falls (2003–2017).

	Total (%)	Hospital (%)	Home (%)	Nursing Facility (%)	Hospice Facility (%)	Other (%)
Characteristic	330,142	188,759 (57.2)	26,151 (7.9)	50,871 (15.4)	30,519 (9.2)	33,842 (10.3)
Age						
65–74	47,518 (14.3)	30,803 (16.3)	5116 (19.5)	2800 (5.5)	2755 (9.0)	6044 (17.9)
75–84	108,936 (33.0)	68,254 (36.2)	8211 (31.4)	12,260 (24.1)	8958 (29.3)	11,253 (33.3)
85 and older	173,688 (52.6)	89,702 (47.5)	12,824 (49.0)	35,811 (70.4)	18,806 (61.6)	16,545 (48.8)
Sex						
Male	152,209 (46.1)	93,960 (49.8)	11,784 (45.1)	18,029 (35.4)	12,964 (42.5)	15,472 (45.7)
Female	177,933 (53.9)	94,799 (50.2)	14,367 (54.9)	32,842 (64.6)	17,555 (57.5)	18,370 (54.3)
Race						
White	310,087 (93.9)	175,696 (93.1)	24,434 (93.4)	49,254 (96.8)	29,324 (96.1)	31,379 (92.7)
Black	11,419 (3.5)	7152 (3.8)	977 (3.7)	924 (1.8)	816 (2.7)	1550 (4.6)
Asian or Pacific Islander	7293 (2.2)	5065 (2.7)	602 (2.3)	530 (1.0)	300 (0.1)	796 (2.4)
Native American	1343 (0.4)	846 (0.4)	138 (0.5)	163 (0.3)	79 (0.3)	117 (0.4)
Ethnicity						
Non-Hispanic	316,119 (95.8)	180,276 (95.5)	24,661 (94.3)	49,590 (97.5)	29,137 (95.5)	32,455 (95.9)
Hispanic	13,379 (4.1)	8108 (4.3)	1439 (5.5)	1205 (2.4)	1326 (4.3)	1301 (3.8)
County Urbanization						
Large Metro	162,195 (49.1)	92,682 (49.1)	12,844 (49.1)	23,517 (46.2)	15,733 (51.6)	17,419 (51.5)
Medium/Small Metro	108,932 (33.0)	60,225 (31.9)	8526 (32.6)	16,801 (33.0)	12,239 (40.1)	11,141 (32.9)
Nonmetro	59,015 (17.9)	35,852 (19.0)	4781 (18.3)	10,553 (20.7)	2547 (8.3)	5282 (15.6)

Ethnicity not stated: 644; Other category includes outpatient medical facility or ER, dead on arrival, other and unknown.

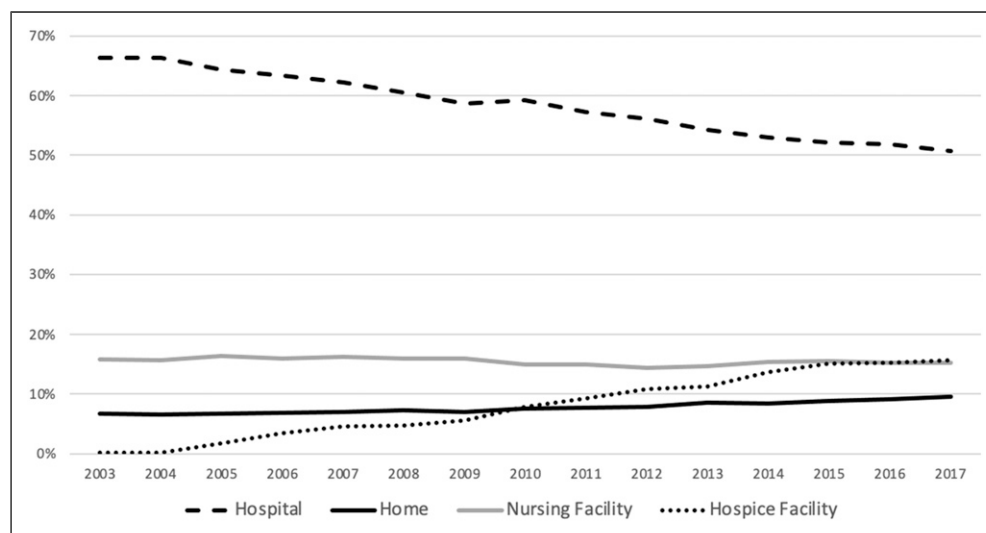


Figure 1. Trends in location of deaths due to falls, 2003–2017

Most decedents from fall-attributed deaths were white (93.9%, $n = 310,087$), female (53.9%, $n = 177,933$) and age 85 or older (52.6%, $n = 173,688$).

Differences by Age

Trends in place of death during the study were consistent across all age groups; however, there were notable differences in death location by age. Compared to decedents aged 65–74, a higher

proportion of decedents aged 85 and older died in nursing facilities (20.6% vs. 5.9%) or hospice facilities (10.8% vs. 5.8%). In comparison, a smaller proportion died at home (7.4% vs. 10.8%) or in the hospital (51.7% vs. 64.8%). (Figure 1).

Differences by Race and Ethnicity

Compared to the decedents of other races, a greater proportion of whites died in nursing facilities and hospice facilities, while

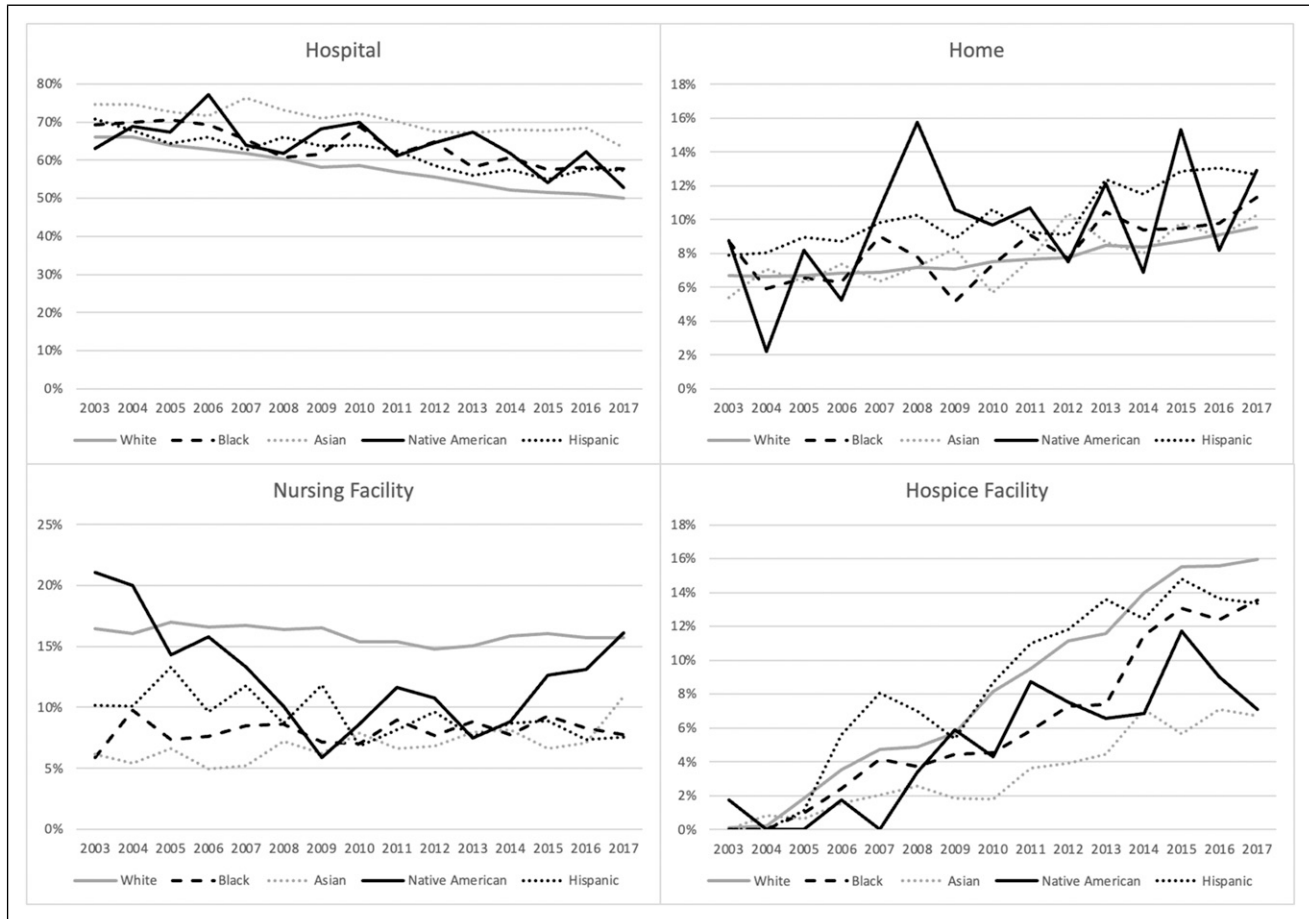


Figure 2. Location of death by race and ethnicity, 2003–2017

a smaller proportion died in hospitals (Figure 2). From 2003 to 2017, proportional hospital deaths decreased among all races, though a greater decline was observed among white (24.2%) compared to Black decedents (16.5%) or those individuals belonging to other racial groups (15.3%). The most considerable increase in home deaths occurred among decedents belonging to other racial groups (78.7%), followed by whites (42.1%). Home deaths increased 29.7% among Black decedents. While nursing facility deaths among whites decreased by 4.4% from 2003 to 2017, the proportion of nursing facility deaths increased among Black decedents (31.9%) and those belonging to other racial groups (33.3%).

Compared to non-Hispanics, a greater proportion of Hispanic decedents died in the hospital or at home, while a small portion died in nursing facilities or hospice facilities. Although trends were similar among Hispanics and non-Hispanics, between-group differences widened overtime for all places of death.

Geographic Differences

Declines in in-hospital deaths occurred at all levels of urbanization. In 2017, the greatest proportion of hospital deaths

occurred in rural areas (55.3%) and the least in medium/small metropolitan areas (47.8%, Figure 3). The proportion of deaths occurring at home remained similar across all levels of urbanization, reaching 9.6% in 2017. While the proportion of deaths in nursing facilities decreased over time in metropolitan areas, the proportion occurring in rural areas increased. In 2017, the most considerable proportion of nursing facility deaths occurred in rural areas (18.8%) and the smallest in large metropolitan areas (14.0%). Rural hospice facility deaths consistently lagged behind urban areas. In 2017, only 8.3% of rural deaths occurred in hospice facilities compared to 18.8% in medium/small metropolitan areas and 16.0% in large metropolitan areas.

In 2017, a higher proportion of decedents in the Northeast died in hospitals (58.9%, Figure 4) compared to other census regions. The Northeast also had the smallest percentage of deaths at home (8.0%) and in hospice facilities (10.0%) relative to other regions in 2017. Throughout the study, the greatest proportion of home deaths occurred in the West (12.6% in 2017) compared to other regions. In 2017, the greatest proportion of nursing facility deaths occurred in the Midwest (21.4%). The greatest proportion of hospice facility

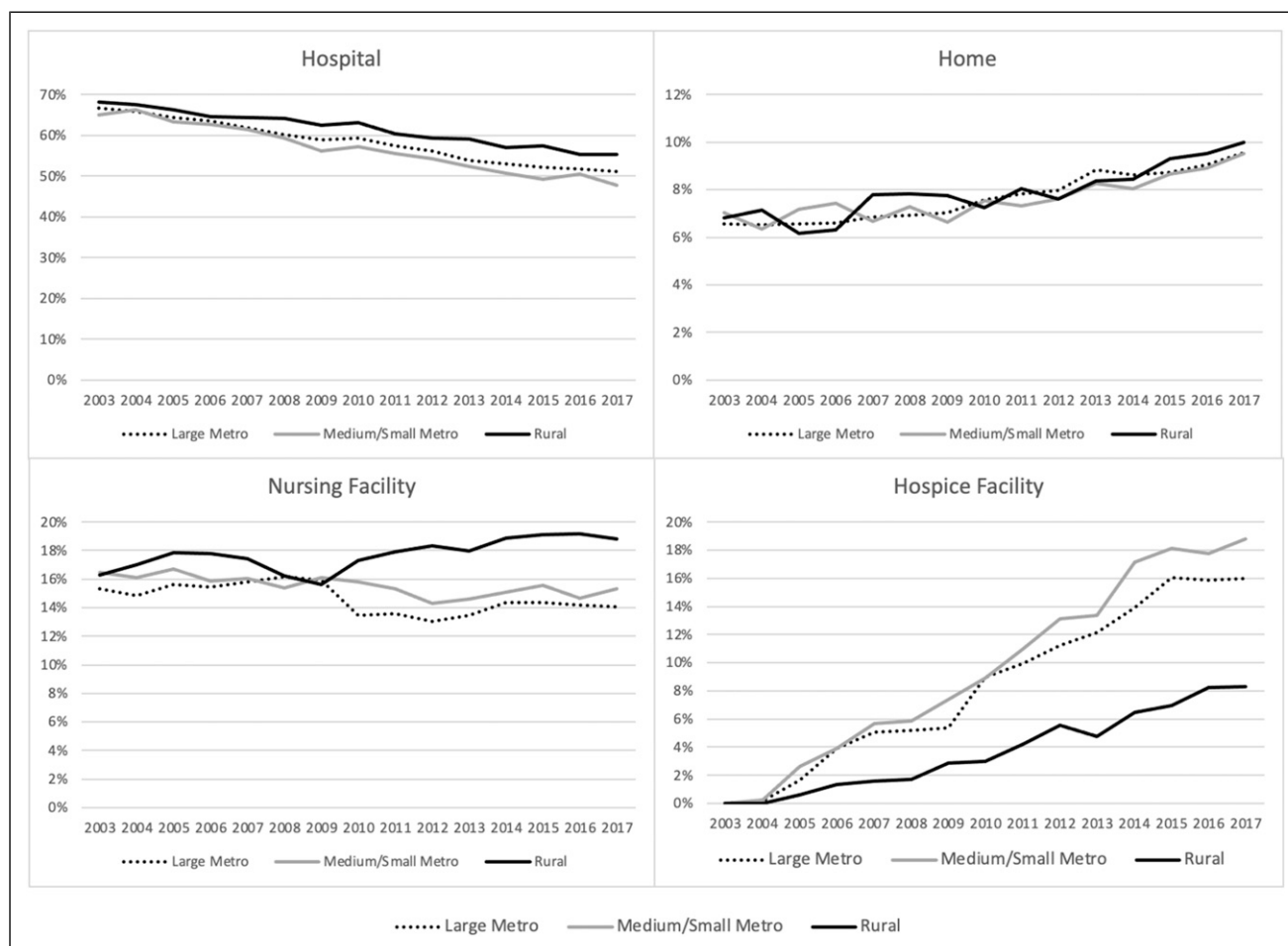


Figure 3. Location of death by rural-urban status, 2003–2017

deaths occurred in the South (23.2% in 2017) compared to other regions.

Logistic Regression Results

Of fall-attributed deaths from 2003 to 2017, 306,307 met the criteria for inclusion in our regression analysis. Age, sex, race, ethnicity, marital status, and education level were significantly associated with place of death. (Table 2).

After adjusting for covariates, odds of both home and hospital death declined with age, while odds of dying within a nursing facility and hospice facility increased with age. Patients ≥85 had the highest odds of dying at a nursing facility (OR = 3.44 [CI = 3.31–3.57]) or hospice facility (OR = 1.87 [CI = 1.79–1.95]) relative to decedents age 65 to 74. Relative to females, male decedents had greater odds of hospital death (OR = 1.23 [CI = 1.21–1.25]) and decreased odds of dying in a nursing facility (OR = .761 [CI = .741–.781]) or hospice

facility (OR = .900 [CI = .873–.927]). There was no significant sex difference for death at home.

Notable disparities in places of death for individuals who had falls were observed by race. Compared to whites, black decedents had significantly greater odds of hospital death (OR = 1.24 [CI = 1.18–1.31]) and lower odds of nursing facility (OR = .528 [CI = .491–.567]) and hospice facility death (OR = .817 [CI = .754–.885]). Native American decedents had increased odds of dying at home (OR = 1.23 [CI = 1.03–1.46]), in a hospital (OR = 1.25 [CI = 1.12–1.40]) and lower odds of dying in nursing facilities (OR = .797 [CI = .637–.996]) and hospice (OR = .641 [CI = .538–.764]). Individuals of Asian descent had higher odds of dying in hospitals (OR = 1.71 [CI = 1.62–1.80]) and lower odds of dying in nursing facilities (OR = .449 [CI = .395–.510]) or hospice (OR = .386 [CI = .346–.431]). Decedents of Hispanic ethnicity had significantly greater odds of home (OR = 1.37 [CI = 1.30–1.44]) or hospital

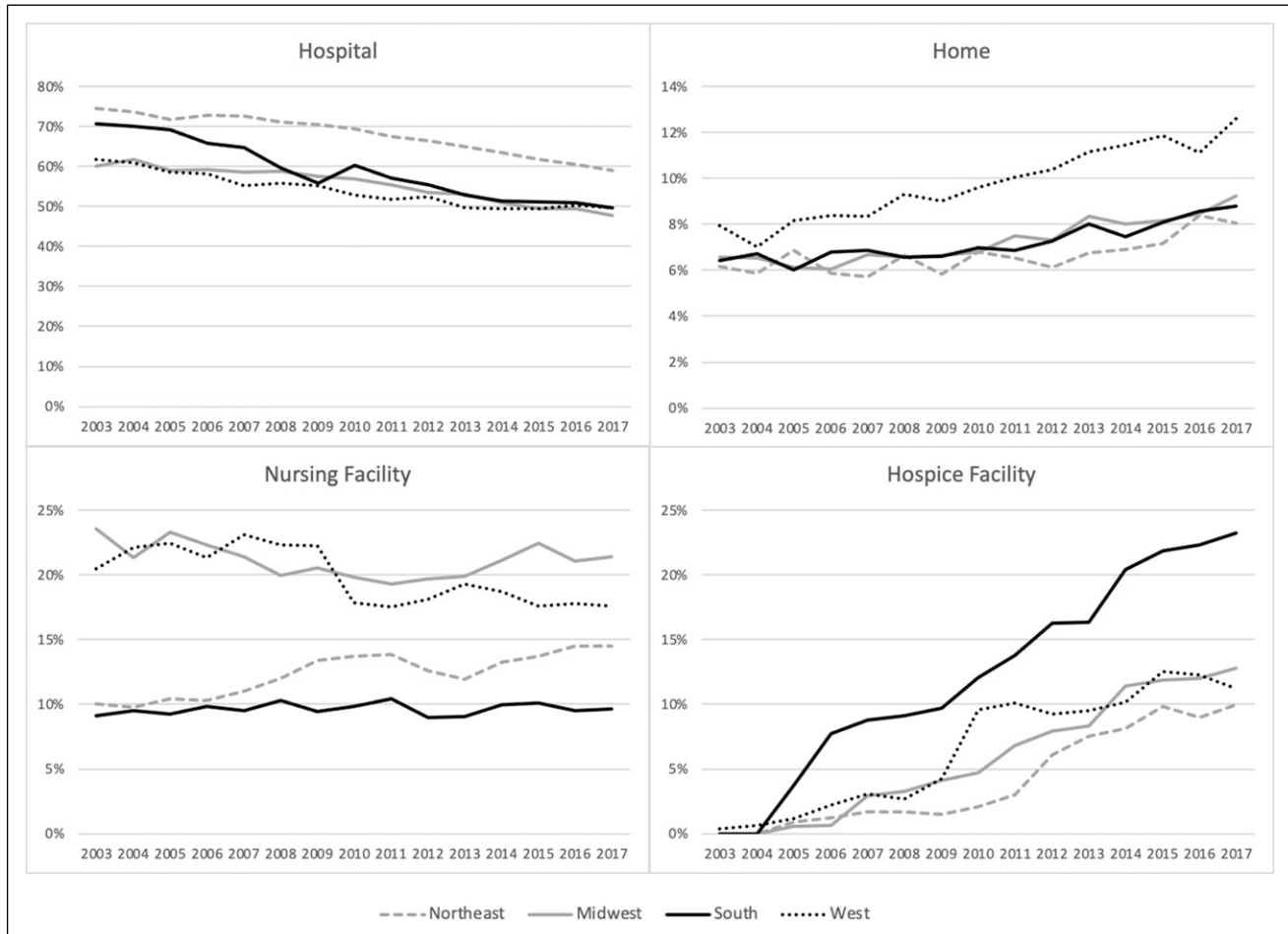


Figure 4. Location of death by census region, 2003–2017

death (OR = 1.11 [CI = 1.06–1.17]) but significantly lower odds of dying in a nursing facility (OR = .570 [CI = .523–.621]). Ethnicity did not significantly affect death within hospice facilities.

Relative to non-married decedents, married individuals had increased odds of dying in the hospital (OR = 1.31 [CI = 1.29–1.33]) and decreased odds of dying at home (OR = .713 [CI = .666–.763]), in a nursing facility (OR = .716 [CI = .694–.739]), or in a hospice facility (OR = .961 [CI = .942–.980]). Decedents with at least some college education had greater odds of dying at home (OR = 1.14 [CI = 1.12–1.16]) or in a hospice facility (OR = 1.11 [CI = 1.09–1.14]) and lower odds of dying in the hospital (OR = .928 [CI = .914–.942]) or in nursing facilities (OR = .969 [CI = .953–.986]).

Since 2004, patients' odds of dying within the hospital have gradually declined annually to 2017, while patients' odds of dying at home have slowly increased. The most significant increase in the location of mortality over the years was in hospice facilities. The odds of dying in a hospice

facility increased from 9.4 times to 91.8 times from 2005 to 2017.

Discussion

Our analysis of national mortality data demonstrates that although the majority of fall-attributed deaths continue to occur in the hospital, the proportions of older adults dying in hospice facilities and at home have increased substantially. Additionally, we found disparities in place of death by age, sex, race, ethnicity, marital status, and level of education. These analyses highlight the numerous factors impacting the location of death for older adults who die of falls and offers insight into areas where interventions may be targeted to decrease these disparities.

The proportion of deaths occurring in hospice facilities after falls increased substantially from 2003 to 2017, suggesting that more trauma patients' palliative needs are being met through greater hospice use. However, the general

Table 2. Multivariable Logistic Regression: Decedent Characteristics and Place of Death, 2003–2017

(N = 306,307)	Hospital versus all Other Places	Home versus all Other Places	Nursing Facility versus all Other Places	Hospice Facility all Other Places
Age	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
65–74	1 [Ref]	1 [Ref]	1 [Ref]	1 [Ref]
75–84	.924***(.888–.962)	.678***(.651–.706)	1.88***(.179–1.98)	1.54***(.147–1.62)
85 and above	.655***(.627–.685)	.615***(.584–.649)	3.44***(.331–3.57)	1.87***(.179–1.95)
Sex				
Female	1 [Ref]	1 [Ref]	1 [Ref]	1 [Ref]
Male	1.23***(.121–1.25)	1.00 (.987–1.02)	.761***(.741–.781)	.900***(.873–.927)
Race				
White	1 [Ref]	1 [Ref]	1 [Ref]	1 [Ref]
Black	1.24***(.118–1.31)	1.03 (.956–1.10)	.528***(.491–.567)	.817***(.754–.885)
Native American	1.25***(.112–1.40)	1.23* (.103–1.46)	.797* (.637–.996)	.641***(.538–.764)
Asian	1.71***(.162–1.80)	1.06 (.984–1.13)	.449***(.395–.510)	.386***(.346–.431)
Ethnicity				
Non-Hispanic	1 [Ref]	1 [Ref]	1 [Ref]	1 [Ref]
Hispanic	1.11***(.106–1.17)	1.37***(.130–1.44)	.570***(.523–.621)	1.09 (.966–1.24)
Marital Status				
Not Married	1 [Ref]	1 [Ref]	1 [Ref]	1 [Ref]
Married	1.31***(.129–1.33)	.713***(.666–.763)	.716***(.694–.739)	.961***(.942–.980)
Education				
High school or less	1 [Ref]	1 [Ref]	1 [Ref]	1 [Ref]
Some college or more	.928***(.914–.943)	1.14***(.112–1.16)	.969***(.953–.986)	1.11***(.109–1.14)

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ Note: In addition to adjusting for all variables in the table, models adjusted for year of death.

inpatient level of hospice typically provided in facilities is limited by Medicare to patients experiencing a temporary symptom burden unable to be managed in other settings.(C. f. M. M. Services, 2018) It is possible that many patients dying in hospice facilities from fall-attributed deaths were transferred to these facilities when death was imminent.(Lah et al., 2018) Changes to the overly restrictive Medicare inpatient hospice regulations might enable more individuals to access inpatient hospice when care cannot be adequately provided in other settings.

Unlike deaths from cardiovascular or chronic lung diseases, where the oldest decedents die more often in nursing facilities, this analysis finds that the majority of older adults with fall-attributed deaths die in hospitals.(Cross et al., 2020; Cross, Kaufman, Mentz, et al., 2019) While hospital deaths should not be assumed to inherently be of poor quality the continuously high rate of hospital death indicates that many older adults who die from falls may have many unmet end-of-life care needs.

Whereas the diagnosis of a serious illness frequently prompts end-of-life care discussions among families and caregivers, traumatic injuries occur suddenly, and care decisions often must be made relatively quickly with caregivers. Documentation of care preferences in the form of advance

directives may not have happened. Additionally, patients who have experienced trauma are often treated in emergency departments and intensive care units, where aggressive care aimed at curing and preventing death remains the norm.(Mosenthal et al., 2008) Palliative care should be part of the standard continuum of care offered by all geriatric serving clinicians, including trauma trained clinicians.(TQIP, 2018) Further training may be appropriate to provide clinically and culturally appropriate palliative care to individuals with unexpected acute injuries.(Aslakson et al., 2014)

Unlike in studies of chronic diseases where marriage increases the likelihood of a patient dying at home, we find that this is not the case among older adults who die from falls.(Cross, Kaufman, Mentz, et al., 2019) If a traumatic event is not viewed as life-limiting and clinicians are focused on a cure, spouses of patients may encourage continued hospitalization. Despite the widespread reported preference for dying at home, the decreased functional status and increased care needs that older adults often face after traumatic injury may make returning to and remaining at home unsafe and infeasible for many, including those who have the support and care of a spouse.(Hamidi et al., 2018; Peetz et al., 2016) Increased home services and supports may allow older adults to remain at home if so desired.

Similar to research conducted on other disease groups, we found racial and socioeconomic disparities in the location of death.(Chino et al., 2019; Chino et al., 2018; Cross, Ely, et al., 2020; Cross, Kaufman, Mentz, et al., 2019; Sarah H Cross, Kaufman, Taylor Jr., Kamal, & Warraich, 2020; Cross, Kaufman, & Warraich, 2019; Cross & Warraich, 2019) Decedents who had not attained college education were more likely to die in the hospital and less likely at home or in hospice facilities than decedents who had at least some college education. White decedents were less likely to die in the hospital and more likely to die in a hospice facility than decedents belonging to minority racial groups. This analysis also found that white decedents were more likely to die in nursing facilities than decedents who are not white. Greater nursing facility use among White individuals has been previously documented and may be due to differing cultural preferences, financial resources, and disparities in access to quality nursing facilities.(Haines, Jung, et al., 2018) Some prior research indicates that Black individuals may prefer life-sustaining care at the end-of-life; underuse of hospice by racial minorities is well-documented.(O'Brien et al., 1995; Suri et al., 1999) Additionally, the racial disparities in hospice facility death that we observed mirror findings from previous research on hospice use among trauma patients.(Haines, Zens, et al., 2018) Disparities in referral to palliative care for hospitalized Black patients also exist, possibly perpetuated by stereotypes and clinician biases regarding racial preferences.(Johnson, 2013)

Our analysis also found notable geographic differences in place of death. While hospice facility deaths increased in all areas, the proportion of hospice facility deaths was the smallest in rural areas and may reflect disparities in access to these facilities, which have substantial overhead costs and are not cost-effective without a sizable patient base.(Cross et al., 2020) The limited rural hospice workforce is likely also be a barrier to rural hospice access.(Lynch, 2013) Increasing the supply of rural hospice staff through efforts such as loan repayment programs should be considered. Policies reducing the financial vulnerability of rural inpatient hospice facilities through critical access designation may be effective in reducing disparities in access.(C. f. M. a. M. Services, 2019) While the proportion of nursing facility deaths fell slightly in metropolitan areas, in rural areas, the proportion of deaths occurring in nursing facilities increased - perhaps reflecting the need for institutional care in the absence of available hospice facilities.

Limitations

Although national mortality data provides the most comprehensive information on deaths in the United States, there are limitations to note. First, errors in death certificates have been documented, with deaths from injuries likely to be underreported.(Betz et al., 2008; McGivern et al., 2017) Additionally, the use of hospice at home or in nursing

facilities could not be determined from this dataset. We also lacked information on the location of the decedents' falls and the amount of time that elapsed between the fatal fall and death. Furthermore, our data source did not include information regarding any clinical care received or transitions of care that may have occurred prior to death. Importantly, we were unable to determine patient preferences for place of death.

Conclusion

To our knowledge, this is the first comprehensive description of trends in the location of death among older adults after traumatic falls. As fall-related mortality rises, the end-of-life needs of this population will deserve increased attention. Efforts to integrate palliative care into trauma care settings must continue. Further research is needed to understand and reduce disparities in place of death among older adult trauma patients.

Declaration of Conflicting Interests

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