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Research Article

# Comparing Estimates of Fall-Related Mortality Incidence Among Older Adults in the United States

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## Abstract

**Background:** Falls are the leading cause of injury-related mortality among older adults in the United States, but incidence and risk factors for fall-related mortality remain poorly understood. This study compared fall-related mortality incidence rate estimates from a nationally representative cohort with those from a national vital record database and identified correlates of fall-related mortality.
**Methods:** Cause-of-death data from the National Death Index (NDI; 1999–2011) were linked with eight waves from the Health and Retirement Study (HRS), a representative cohort of U.S. older adults ($N$ = 20,639). Weighted fall-related mortality incidence rates were calculated and compared with estimates from the Centers for Disease Control and Prevention (CDC) vital record data. Fall-related deaths were identified using International Classification of Diseases (Version 10) codes. Person-time at risk was calculated from HRS entry until death or censoring. Cox proportional hazards models were used to identify individual-level factors associated with fall-related deaths.
**Results:** The overall incidence rate of fall-related mortality was greater in HRS–NDI data (51.6 deaths per 100,000; 95% confidence interval: 42.04, 63.37) compared with CDC data (42.00 deaths per 100,000; 95% confidence interval: 41.80, 42.19). Estimated differences between the two data sources were greater for men and adults aged 85 years and older. Greater age, male gender, and self-reported fall history were identified as independent risk factors for fall-related mortality.
**Conclusion:** Incidence rates based on aggregate vital records may substantially underestimate the occurrence of and risk for fall-related mortality differentially in men, minorities, and relatively younger adults. Cohort-based estimates of individual fall-related mortality risk are important supplements to vital record estimates.

**Keywords:** Falls, Mortality, Epidemiology, Risk factors

Falls are a prevalent and growing public health concern in the United States, affecting nearly a third of older adults each year (1). Falls frequently lead to injuries, disability, and substantial health care costs totaling over $50 billion annually (1–3). Moreover, falls are the leading cause of injury-related mortality among older adults; the annual rate of fall-related deaths in the United States has increased each year from 2000 to 2016 (1,4). Despite increasing research on falls and fall prevention, much less is known about rates of fall-related mortality or the individual-level factors associated with fall-related deaths. Understanding fall-related mortality occurrence is important given that risks of fall-related death may be distinct from risk factors related to falls or fall-related injuries. Preventing death from falls may require more comprehensive and targeted prevention strategies.

Much of the current population-based evidence regarding fall-related mortality comes from the Centers for Disease Control and Prevention's (CDC) Wide-ranging ON-line Data for Epidemiologic Research (WONDER) system, a publicly available resource that provides aggregate national mortality statistics from the National Center for Health Statistics (5). This resource has been used extensively to highlight the public health impact of fall-related mortality in the United States. For instance, previous studies have revealed the high percentage of unintentional injury deaths attributable to falls, as well as increasing rates of fall-related death, especially among older white men and American Indians (6–10). Likewise, researchers have identified higher fall-mortality rates in regions with potentially less access to health care services (11). Similar vital record studies have demonstrated growing international rates of fall-related mortality (10,12–14).

Although CDC vital record and similar databases have provided important insights, they may offer an incomplete understanding of fall-related mortality due to inherent limitations. First, because aggregate cross-sectional rates do not account for loss (or gain) of individuals from a population over time, they may bias mortality rates or conflate individual risk with population-level trends. As such, increasing fall-related mortality rates in aggregate data may reflect improvements in reporting rather than longitudinal increases in incidence or individual risk (6,7). Consequently, estimates of relative risk (RR) based on incidence rates from aggregate data may also be distorted, leading to incorrect conclusions about the groups or individuals at greatest risk of fall death. Second, fall-related mortality rates from WONDER and other vital record databases are typically reported within a limited set of sociodemographic groups (eg, age, race, gender, region). The role of other key factors such as mobility, functional limitations, wealth, and fall history cannot be readily assessed at the individual level using vital record data. Few studies have investigated risk factors for fall-related mortality at the individual level; however, as fall-related mortality is a function of fall risk, fall severity, and resilience to fall-related injury, it is important to understand risk factors for fall-related mortality independent of fall risk alone. The present study addresses this gap in the literature.

Given the limitations of previous work and data sources on fall-related mortality, the aims of the present study are threefold: (a) to estimate U.S. national incidence rate of fall-related mortality using nationally representative longitudinal cohort data; (b) to compare these estimates with fall-related mortality records from WONDER; and (c) to estimate individual-level characteristics related to greater fall-related mortality.

## Methods

### Study Design and Data

This retrospective cohort study used data from two sources: (a) the Health and Retirement Study (HRS) core survey linked with the National Death Index (NDI) and (b) CDC's WONDER system. At the time of this study, linked HRS and NDI data (HRS–NDI) were available as restricted data, with all analyses conducted in a secure virtual data enclave. Permission to use linked HRS–NDI database was obtained through a restricted data access agreement with the University of Michigan. Data from WONDER are publicly available.

The HRS is an ongoing longitudinal study of adults aged 51 and older in the United States begun in 1992. In 1998, the study implemented a steady-state design, recruiting additional birth cohorts to make the sample representative of the U.S. population over age 50, with subsequent cohorts enrolled every 6 years. HRS core survey respondents are interviewed every 2 years and report on a wide range of sociodemographic, health, and financial variables (15). For respondents who are unwilling or unable to complete an interview, HRS employs proxy respondents, usually a spouse or other relative. All respondents are interviewed in their homes at baseline; however, HRS does follow respondents if they transition to nursing homes or other institutions. The HRS uses a complex, multistage area sampling design that involves oversampling of minority households. Analytic weights that adjust for the complex design as well as nonresponse are provided, allowing estimates generalizable to adults over age 50 in the United States (16). A detailed description of the study design and content is available from previous work (17). The HRS is sponsored by the National Institute on Aging (grant number NIA U01AG009740) and is conducted by the University of Michigan. HRS data were linked at the individual level with NDI records by the National Center for Health Statistics (NCHS) using methods described previously (18). The NDI is a centralized database established by NCHS containing death record information compiled from state vital statistics offices (19). The HRS–NDI linked data include date of death and underlying cause of death classified by International Classification of Diseases, Version 10 (ICD-10) codes.

The WONDER database is an interactive online resource that provides fatal injury, violent death, and injury cost data (5). As with NDI, cause-of-death data from WONDER are derived from the NCHS National Vital Statistics System and categorized by ICD-10 codes.

### Analytic Sample

This study used longitudinal data for respondents interviewed in eight waves of the HRS (1998–2012). We began in 1998 because that was the first year the sample was fully representative of the population over age 50, and we end in 2012 because that is the last year for which the HRS–NDI linkage was available. We excluded respondents from analysis if they were 64 years or younger at the time of all interviews ($n$ = 8,293) or were interviewed by proxy ($n$ = 2,065). Of 30,997 total respondents who participated in HRS during the study period, 20,639 met our eligibility criteria and were included in analysis.

### Measures

#### Outcome Measures

Fall-related mortality was determined separately for HRS–NDI and WONDER databases using underlying ICD-10 cause-of-death codes. Fall-related death was defined in both data sources as any ICD-10 code for unintentional fall (W00–W19) listed as the underlying cause of death. In separate analyses, we considered only deaths that occurred specifically due to unintentional falls "on the same level," for example, falls from bed, falls from a wheelchair, falls from slipping (ICD-10: W00–W10, W18, and W19), excluding falls "to a different level," such as falls from scaffolding, trees, or cliffs. Person-time at risk for fall-related death was calculated as the time from the first interview date after January 1, 1999, the first date for which ICD-10 cause-of-death codes were available, through December 31, 2011, the last date at which they were available. Respondents who were known to be alive as of December 31, 2011 or who were lost to follow-up were considered censored at the time of their most recent HRS interview. For descriptive analyses, we measured the frequency of all-cause mortality, falls, and injurious falls. We defined falls as any self-reported fall in the previous 2 years and injurious falls as any fall resulting in the need for medical treatment.

#### Covariates

Potential demographic covariates included age (65–74, 75–84, ≥85 years), race (white, black, other), gender (male/female), education (years), and income below federal poverty threshold (yes/no). Three dichotomous functional limitation variables were considered—instrumental activities of daily living (IADL) limitation, ADL limitation, and mobility limitation. For each variable, limitation was defined as self-reported difficulty in at least one of five IADLs (using a telephone, taking medication, handling money, shopping, preparing meals), one of five ADLs (bathing, eating, dressing, walking across a room, and getting in or out of bed), or one of five mobility tasks (walking one block, several blocks, or across the room, and climbing one flight or several flights of stairs), respectively. Fall history was categorized by the number of self-reported falls in the 2 years preceding baseline interview (no fall, one fall, or two or more falls). Physical activity was categorized by weekly participation in vigorous activity (yes/no).

### Analysis

We calculated weighted frequencies of self-reported falls, fall-related injury, mortality, and fall-related mortality in the HRS–NDI sample by demographic and health-related respondent characteristics.

Using the WONDER system, we queried the annual incidence rate of unintentional fall-related deaths for adults aged 65 years and older by age, race, and gender categories. As defined in WONDER, incidence rate is the ratio of the annual frequency of fall-related deaths to the total population (deaths/100,000 people per year). Population denominators are derived from U.S. census estimated population on July 1 of each year (5). Implicit in this "incidence rate" calculation is that all individuals in a population at midyear are considered at risk for the entire year. Next, to address Study Aim 1, we calculated the incidence rate of fall-related mortality in HRS–NDI as the frequency of fall-related deaths per unit of total person-time at risk (deaths/100,000 person-years). This calculation accounts for partial individual years at risk, for instance, among individuals who died from nonfall causes or who emigrated from the United States between interview periods. To address Study Aim 2, we compared fall-related mortality incidence rates from WONDER (based on aggregate data) to incidence rates from HRS–NDI (based on person-time).

To address Study Aim 3, we used Cox proportional hazards models to estimate the association between selected demographic and health-related covariates and hazard of fall-related mortality in an exploratory analysis. Potential factors associated with fall-related mortality were identified based on prior literature. We then empirically assessed bivariate strength of association between each identified factor and fall-related mortality. Factors associated with 10% or greater relative hazard of fall-related mortality were included for adjustment in final analytic models. In separate models, we evaluated hazard of *any* unintentional fall-related mortality and mortality resulting from a fall on the same level.

All analyses were performed using Stata statistical software (Version 14.1; StataCorp LP, College Station, TX). All HRS–NDI estimates used HRS respondent-level weights, and the SVY command was used for correct variance estimation.

## Results

Table 1 reports weighted descriptive statistics of the study sample by four outcomes: falls, fall injury, mortality, and fall-related mortality.

**Table 1.** Weighted Characteristics of HRS–NDI Analytic Sample (*N* = 20,639) by Fall and Mortality Outcomes (1999–2011)

| Baseline Characteristics | Total<br>100% | Fall<br>65.3% | Fall-Related Injury<br>32.4% | Mortality<br>34.2% | Fall-Related Mortality<br>0.6% |
|---|---|---|---|---|---|
| Age | | | | | |
| 65–74 | 42.9% | 32.9% | 24.3% | 24.6% | 14.5% |
| 75–84 | 34.1% | 37.5% | 38.8% | 37.0% | 31.7% |
| ≥85 | 23.0% | 29.6% | 37.0% | 38.4% | 53.7% |
| Gender | | | | | |
| Male | 46.6% | 42.2% | 33.5% | 46.1% | 47.8% |
| Female | 53.4% | 57.8% | 66.5% | 53.9% | 52.2% |
| Race | | | | | |
| White | 86.4% | 88.1% | 89.7% | 87.9% | 93.3% |
| Black | 9.7% | 8.4% | 7.1% | 9.4% | 4.1% |
| Other | 3.9% | 3.5% | 3.3% | 2.7% | 2.7% |
| Poverty | | | | | |
| Above threshold | 91.4% | 91.1% | 90.2% | 88.1% | 94.6% |
| Below threshold | 8.6% | 8.9% | 9.9% | 11.9% | 5.4% |
| ADL limitation | | | | | |
| 0 | 89.3% | 87.3% | 85.9% | 83.3% | 90.4% |
| ≥1 | 10.7% | 12.7% | 14.1% | 16.7% | 9.6% |
| IADL limitation | | | | | |
| 0 | 84.4% | 82.9% | 82.4% | 86.7% | 90.9% |
| ≥1 | 15.6% | 17.1% | 17.6% | 13.4% | 9.1% |
| Mobility limitations | | | | | |
| 0 | 56.3% | 51.8% | 48.6% | 43.8% | 57.9% |
| ≥1 | 43.7% | 48.3% | 51.4% | 56.2% | 42.0% |
| Vigorous activity | | | | | |
| More than one time per week | 36.1% | 34.5% | 32.9% | 29.2% | 33.0% |
| Less than once per week | 63.9% | 65.5% | 67.1% | 70.8% | 67.0% |
| Baseline number of falls | | | | | |
| 0 | 71.4% | 55.8% | 53.2% | 66.1% | 65.5% |
| 1–2 | 20.0% | 30.9% | 33.4% | 22.7% | 23.0% |
| ≥3 | 8.6% | 13.3% | 13.4% | 11.3% | 11.6% |

*Notes*: ADL = activities of daily living; HRS = Health and Retirement Study; IADL = instrumental activities of daily living; NDI = National Death Index.

Over the 12-year study period, 65.3% of individuals reported falling at least once after baseline, whereas 32.4% reported experiencing an injury due to a fall. Approximately 34% of the weighted sample died during follow-up; 0.6% (unweighted $n$ = 91) died from a fall-related cause. Compared with the total sample and with individuals who died from nonfall causes, individuals who died from a fall were, on average, older, more likely to be white, and have household income above the poverty threshold at baseline. Individuals who died from falls were also less likely to have IADL, ADL, and mobility limitations than those who died from alternative causes.

Table 2 compares national incidence rate estimates of unintentional fall-related mortality from WONDER and HRS–NDI. When defining fall-related mortality as death due to any fall (ICD-10: W00–W19), the HRS–NDI estimated annual incidence rate was 22.9% greater than WONDER (WONDER: 42.00 deaths per 100,000; HRS–NDI: 51.6 deaths per 100,000). When restricting fall-related deaths to those that occurred on the same level, the overall HRS–NDI estimate was approximately 17% greater. Similarly, the estimated incidence rates for all gender and race categories were greater when estimated using HRS–NDI data (Table 2). However, the incidence rate differences between WONDER and HRS–NDI were greater for men (31.8% greater in HRS–NDI) than for women (15.2% greater in HRS–NDI) and greater among black respondents (38.1% higher in HRS–NDI) compared with white respondents (26.5% higher in HRS–NDI). By age category, the HRS–NDI estimate was greater for individuals aged 65–74 years (WONDER: 11.77 deaths per 100,000; HRS–NDI: 30.31 deaths per 100,000) but lower among individuals aged 85 years and older (WONDER: 160.00 deaths per 100,000; HRS–NDI: 88.57 deaths per 100,000).

Using Cox proportional hazards models, we found that male gender, older age, and prior fall history were associated with significantly greater hazard of fall-related mortality, after adjusting for other factors such as IADL limitations and participation in vigorous physical activity (Table 3). Despite a greater likelihood of reporting falls and fall-related injuries, women had 38% lower hazard of fall-related mortality than men (hazard ratio = 0.62, 95% confidence interval: 0.38, 1.00). Compared with adults aged 65–74 years, individuals aged 75–84 (hazard ratio = 2.03, 95% confidence interval: 0.97, 4.27) and individuals aged 85 years and older (hazard ratio = 3.70, 95% confidence interval: 1.82, 7.52) had greater hazard of fall-related mortality. Model results were similar using the restricted definition of fall-related mortality—falls occurring on the same level (Table 3). In addition to demographic characteristics, we found that individuals with a history of multiple falls had greater hazard of fall-related mortality (hazard ratio = 2.59, 95% confidence interval: 1.17, 5.73) compared with individuals who did not report a fall during a previous wave.

## Discussion

This study compared estimates of fall-related mortality incidence from a national vital record database (CDC WONDER) to estimates from a nationally representative cohort survey (HRS–NDI). Results suggest that annual fall-related mortality incidence rates based on aggregate vital record data may underestimate incidence rates based

**Table 2.** Average annual incidence rates from CDC WONDER and HRS–NDI (1999–2011)

| | Any Fall[a] | | Same-Level Fall[b] | |
|---|---|---|---|---|
| | WONDER[c] | HRS–NDI[d] | WONDER[c] | HRS–NDI[d] |
| | $n$ = 186,029 | $n$ = 341,898[e] | $n$ = 178,909 | $n$ = 252,270[e] |
| Total | 42.00 | 51.60 | 40.39 | 49.33 |
| 95% CI | (41.80, 42.19) | (42.02, 63.37) | (40.20, 40.57) | (39.98, 60.87) |
| Gender | | | | |
| Female | 39.19 | 45.15 | 38.59 | 44.16 |
| 95% CI | (38.95, 39.44) | (33.82, 60.27) | (38.34, 38.83) | (32.97, 59.15) |
| Male | 45.85 | 60.43 | 42.87 | 56.40 |
| 95% CI | (45.54, 46.16) | (45.12, 80.94) | (42.57, 43.16) | (41.68, 76.32) |
| Race | | | | |
| White | 45.02 | 56.95 | 43.31 | 54.89 |
| 95% CI | (44.81, 45.23) | (45.92, 70.61) | (43.10, 43.51) | (44.09, 68.33) |
| Black | 17.70 | 24.43 | 16.98 | 24.43 |
| 95% CI | (17.27, 18.12) | (10.98, 54.38) | (16.57, 17.40) | (10.98, 54.38) |
| Other | 25.95 | 33.24 | 24.87 | 16.62 |
| 95% CI | (25.17, 26.74) | (8.31, 132.91) | (24.10, 25.64) | (2.34, 117.99) |
| Age | | | | |
| 65–74 | 11.77 | 30.31 | 10.61 | 26.75 |
| 95% CI | (11.63, 11.91) | (18.85, 48.76) | (10.48, 10.74) | (16.13, 44.37) |
| 75–84 | 44.04 | 45.91 | 42.22 | 44.60 |
| 95% CI | (43.71, 44.37) | (32.96, 63.94) | (41.90, 42.54) | (31.87, 62.41) |
| ≥85 | 160.00 | 88.57 | 157.14 | 86.29 |
| 95% CI | (158.96, 161.04) | (64.70, 121.20) | (156.11, 158.18) | (62.78, 118.58) |

*Notes*: CDC = Centers for Disease Control and Prevention; CI = confidence interval; HRS = Health and Retirement Study; NDI = National Death Index; WONDER = Wide-ranging ON-line Data for Epidemiologic Research.

[a]Any fall-related cause of death (ICD-10 codes: W00–W19). [b]Fall occurring on same level (ICD-10 codes: W00–W10, W18, and W19). [c]Average annual death rate: deaths/100,000 person (assumes complete follow-up). [d]Annual incidence density: fall deaths/100,000 person-years. [e]Weighted estimated frequency accounting for HRS complex sampling and sampling probability.

**Table 3.** Weighted hazard ratios of Fall-Related Death in HRS–NDI (1999–2011)

| | Any Fall[a] | | Same Level[b] | |
|---|---|---|---|---|
| | HR | 95% CI | HR | 95% CI |
| Female | 0.62 | (0.38, 1.00) | 0.66 | (0.40, 1.09) |
| Age | | | | |
| 65–74 | Ref. | Ref. | Ref. | Ref. |
| 75–84 | 2.03 | (0.97, 4.27) | 2.18 | (1.03, 4.65) |
| ≥85 | 3.70 | (1.82, 7.52) | 3.94 | (1.93, 8.02) |
| Race | | | | |
| White | Ref. | Ref. | Ref. | Ref. |
| Black | 0.55 | (0.20, 1.53) | 0.58 | (0.21, 1.61) |
| Other | 0.71 | (0.10, 6.03) | 0.76 | (0.10, 5.98) |
| Self-reported baseline falls | | | | |
| 0 | Ref. | Ref. | Ref. | Ref. |
| 1 | 1.39 | (0.81, 2.38) | 1.47 | (0.88, 2.47) |
| ≥2 | 2.59 | (1.17, 5.73) | 2.78 | (1.26, 6.12) |
| Any IADL limitation | 0.72 | (0.36, 1.46) | 0.66 | (0.30, 1.44) |
| Participated in some vigorous activity | 0.84 | (0.44, 1.62) | 0.81 | (0.40, 1.62) |

*Notes:* HR = hazard ratio; CI = confidence interval; IADL = instrumental activities of daily living.
[a]Any fall-related cause of death (ICD-10 codes: W00–W19). [b]Fall occurring on same level (ICD-10 codes: W00–W10, W18, and W19).

on individual time at risk and that this underestimation varies by demographic characteristics such as gender and age. Furthermore, model-based estimates suggest that male gender, older age, and prior fall history are significant predictors of fall-related mortality risk independent of other risk factors for falls. These results highlight the need to consider complementary evidence from aggregate and individual level data in the study of fall-related mortality.

This study adds to a growing body of research regarding fall-related mortality among older adults by providing more precise incidence rate estimates than previously available. HRS–NDI incidence rate estimates were greater than WONDER estimates from this study and previous study (6–8,20–22). For instance, using CDC vital record data, Alamgir and colleagues reported that the national fall-related mortality rate among older adults between 2003 and 2007 ranged from 36.76 per 100,000 to 44.89 per 100,000 (8), consistently lower than the rate of 51.6 per 100,000 reported from HRS–NDI. Because mortality information was derived from death certificates for both samples, discrepancies between WONDER and HRS–NDI estimates are not probably a consequence of differences in reporting or attribution of cause of death but instead of differences in accounting for partial years at risk. WONDER estimates assume complete follow-up of individuals in the population over an entire year and thus provide inherently lower bound estimates of incidence rate, compared with HRS–NDI estimates based on individual person-time. Importantly, we also found that differences between the two data sources were greater among men, minorities, and individuals aged 65–74 years and aged 85 years and older. A potential explanation is that rate differences between the two sources reflect a greater likelihood of competing risks in some groups (eg, greater likelihood of death among men), which are more accurately measured using person-time estimates as in HRS–NDI. These differences may also reflect changes in cause of death reporting accuracy or temporal changes in death rates for chronic diseases associated with falls not captured in aggregate data (7,21,23). Indeed, the overall incidence rate in HRS–NDI (51.6 per 100,000) was similar to the 2010 incidence rate from WONDER (53.8 per 100,000).

Our findings provide comparisons of fall-related mortality incidence using alternative fall definitions. Studies using vital record estimates often conflate falls that occur “on the same level” with falls “to a different level.” This probably dilutes age-related and demographic differences in fall-mortality incidence, as less-severe falls on the same level, which are more likely to result in death among older adults, are less likely to be identified as underlying causes of death (7,21). Previous work has demonstrated that increasing fall rates for older adults are primarily attributable to increases in reporting of falls on the same level (7,21). Similarly, approximately 96% of falls leading to deaths in the present sample occurred on the same level. Together, these results indicate that measurements of fall-related mortality should use more restrictive definitions of fall mechanism and consider available information regarding severity of injury. Death from falls that occur on the same level, as opposed to more severe falls to a different level, are probably more indicative of individuals’ physiological vulnerability, frailty, or treatment access and preferences following injury.

Last, study results provide the first model-based national estimates of fall-mortality risk factors. We found that greater age, male gender, and fall history were associated with significantly greater risk of fall-related mortality, independent of functional limitations and physical activity. Consistent with previous research, women were more likely to report falls and fall injuries; however, women were significantly less likely to die from a fall, even when controlling for previous fall history (20,21). Furthermore, we found, paradoxically, that having an IADL limitation was associated with lower likelihood of fall-related mortality, although this association was not statistically significant in multivariable models. Together these findings suggest that fall-related mortality risk is a complex balance of opportunity to fall and individual resilience to falls. For instance, the protective effect of IADL limitations may indicate greater supervision of those in need of functional assistance and thus fewer fall opportunities, or it may indicate poorer health and death due to causes other than falls.

Study findings should be interpreted considering potential limitations. First, although HRS sampling procedures are designed to produce nationally representative estimates, random or systematic variability may limit direct comparisons to WONDER data. Nonetheless, the calculation of incidence rate based on person-time provides a more accurate reflection of individual risk than WONDER estimates, the comparability of the two data sources notwithstanding. Second, as fall-related deaths are relatively rare (only 0.6% of respondents died from a fall-related injury), this study addresses a limited but important aspect of fall epidemiology. The rarity of fall-related deaths probably limited power to detect certain risk and protective factors in our exploratory analysis. Despite this limitation, we did identify factors related to greater risk of fall-related mortality, including age, gender, and self-reported fall history. Finally, as reported in other studies, fall-mortality estimates based on death certificate data may underestimate the actual frequency of fall-related mortality due to misattribution of causes of death by physicians and medical examiners (24,25). Although we are unable to evaluate influence of death certificate errors, misclassification is not likely to have caused differences between data sources, as both NDI and WONDER are derived from the same death certificate information.

Accurate estimation of fall-related mortality burden is essential for developing effective prevention strategies and identifying high-risk groups. Results of the present study suggest that vital record data may offer a limited understanding of incidence and risk factors for fall-related mortality, as they do not account accurately for changes in populations over time or for individual time at risk. Underestimation of fall-related mortality incidence in specific groups, as found in the current study, could lead to distorted estimates of risk. For instance, as calculated from estimates in Table 2, the RR of fall-related mortality for men would be approximately 17% greater compared with women (RR = 45.85/39.19 = 1.17) according to WONDER. In contrast, the RR according to HRS–NDI would be approximately 34% greater for men compared with women (RR = 60.43/45.15 = 1.34). Similarly, the RR of fall mortality comparing individuals aged 85 years and older with those aged 65–74 years would be more than four times greater using WONDER estimates (WONDER RR = 160.0/11.8 = 13.6; HRS–NDI RR = 88.6/30.3 = 2.9). As risk estimates often inform clinical and public health recommendations, underestimation of risk may lead to lower rates of fall risk screening and referral to fall prevention resources for vulnerable groups. Complementary strategies for estimating mortality incidence are thus needed to accurately describe the burden of fall-related mortality and to determine the most effective allocation of preventive resources.

These findings have implications for future fall-mortality research. Results suggest that although risk for falls and fall mortality are closely linked, individuals who are more likely to fall are not necessarily more likely to die from fall-related injuries. Fall-related mortality prevention efforts should focus on combined strategies to reduce fall hazards (26–30) and to identify individuals who may be less resilient to falls (31–33). Further consideration of the methodological challenges of reporting and estimating fall-related mortality incidence is also warranted.

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## Conflict of Interest

None reported.

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