Acute work-related injuries among older adults in the USA on Medicare, 2016–2019: a national longitudinal study

Matthew McFalls ,[1,2,3] Beth Virnig,[3,4] Andrew D Ryan,[2] Hyun Kim,[2] Bruce H Alexander,[2] Marizen Ramirez[1,2]

► Additional supplemental material is published online only. To view, please visit the journal online (https://doi.org/10.1136/ip-2024-045363).

[1]Department of Environmental and Occupational Health, UC Irvine Joe C. Wen School of Population and Public Health, University of California, Irvine, California, USA
[2]Division of Environmental Health Sciences, School of Public Health, University of Minnesota, Twin Cities, Minneapolis, Minnesota, USA
[3]Division of Health Policy and Management, School of Public Health, University of Minnesota, Twin Cities, Minneapolis, Minnesota, USA
[4]Office of the Dean, College of Public Health and Health Professions, University of Florida, Gainesville, Florida, USA

Correspondence to
Dr Matthew McFalls; mmcfalls@uci.edu

Received 23 July 2024
Accepted 23 March 2025

To cite: McFalls M, Virnig B, Ryan AD, *et al*. *Inj Prev* Epub ahead of print: [*please include* Day Month Year]. doi:10.1136/ip-2024-045363

ABSTRACT

Objectives Work-related injuries are only partially captured for older workers in the USA, likely due to low sensitivity of traditional data sources, such as workers' compensation, to capture non-fatal incidents. Using claims from Medicare, the primary health insurance of most US adults after age 65, we identified and described work-related injuries among Medicare enrollees aged 65 years and older.

Methods We identified injury claims from 2016 to 2019 Medicare inpatient and outpatient claims for aged 65+ Medicare fee-for-service enrollees. We then identified work-related injury claims using ICD-10-CM external cause codes and employment-related and workers' compensation codes used in Medicare claims processing. We calculated annual rates of work-related injuries among aged 65+ Medicare fee-for-service enrollees. We described demographics, injuries and their mechanisms, and healthcare encounter characteristics of Medicare enrollees with work-related injuries.

Results From 2016 to 2019, the average annual rate of work-related injuries was 27.6 per 100 000 Medicare fee-for-service enrollees aged 65+. Injury claims were most often for outpatient emergency department (ED) visits (58%), followed by non-ED outpatient visits (20%) and hospitalisations (19%). Falls, transportation and machinery-related mechanisms of injury each accounted for approximately 20% of injuries.

Conclusions Using the mechanism of injury, employment-related and workers' compensation codes, Medicare claims can be used to identify work-related injuries. Most work-related injuries appear in outpatient settings, although hospitalisations involve the most extensive care. Future research should validate and expand these methods, drawing on the depth of information in Medicare claims data to explore costs and health outcomes of work-related injuries in older populations.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ A variety of methods have been used to identify work-related injuries from administrative databases, including workers' compensation payer data and ICD-10-CM external cause of injury codes. Yet, work-related injuries are likely under-reported among older workers, who may be 3–4 times less likely to receive workers' compensation for their injuries.

WHAT THIS STUDY ADDS

⇒ This study used claims data from Medicare, the largest health insurer of adults aged 65 and older in the USA, to understand and provide national estimates of the incidence, severity and characteristics of work-related injuries experienced by older US adults. We described a method that uses workers' compensation payer and work-related ICD-10-CM codes to identify work-related injuries from Medicare inpatient and outpatient claims. We identified 29 664 work-related injuries from Medicare claims over 4 years, of which 7.4% were paid by workers' compensation.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ Medicare claims may support surveillance efforts for work-related injuries in the elderly and could also be used for longitudinal study of injured enrollees. Injury-related Medicare claims are infrequently paid by workers' compensation, even when a work-related nature is apparent. Further research is needed to estimate costs incurred by injured workers on Medicare.

INTRODUCTION

The older US workforce is growing rapidly, and by 2033, one in three adults aged 65–74 may be working.[1] Workers aged 65 and older have a high fatal work injury rate, creating an imperative to understand and mitigate the occupational injury burden in this population. According to the US Bureau of Labor and Statistics (BLS) Census of Fatal Occupational Injuries (CFOI) data, in 2019, there were 9.4 fatal work injuries per 100 000 full-time equivalent workers aged 65+, over twice the rate of workers aged 55–64.[2] Falls, a major source of morbidity and mortality in older adults, contributed half of non-fatal cases among workers aged 65+ in the BLS Survey of Occupational Injuries and Illnesses (SOII).[3 4] Although valuable, surveillance data are not without limitations and may underestimate work-related injuries to older adults.

Work-related injury surveillance is challenging for older adults, and available data sources are limited. While CFOI accurately captures fatal work-related injuries from sources such as death certificates, BLS SOII relies on employers to report non-fatal injuries, leading to under-reporting and excludes self-employed workers and farms with under 11 employees.[5 6] Occupational injuries in the

National Emergency Injury Surveillance System, sampling US hospital emergency departments (EDs), may have less precision for smaller, older subgroups.[7]

Workers' compensation (WC), which provides medical and wage benefits to injured workers, has limited data after age 65 as medical costs shift to primary health insurance such as Medicare.[8–11] WC should pay before Medicare for work-related injuries, though Medicare may cover over half of cases after age 65.[8 9 11 12] Barriers to filing WC claims, including fear of workplace retaliation, prevent workers from reporting injuries as work-related.[13] Alternatively, studies have identified work-related external causes (ICD-9-CM/ICD-10-CM) from hospital records but have not focused on older adults.[10 14–16]

Medicare provides health insurance to over 93% of aged 65+ adults in the USA and could serve as a comprehensive source of work-related injury data for this older population.[17] Since Medicare may coordinate with WC payers, WC activity can appear on injuries billed to Medicare, while injuries without WC may still have work-related ICD-10-CM codes.[18] Once identified, unique enrollee identifiers on Medicare claims enable individual case counts to avoid double-counting single events, which prior research has been unable to do. Our recent study used these methods to estimate costs of a work-related injury to Medicare enrollees.[18] Prior to this, only one study, to our knowledge, broadly described WC-paid Medicare claims for injuries and illnesses, without exploring work-related injuries unpaid by WC.[19]

To better understand the burden of work-related injuries to older adults, we analysed Medicare claims in a national cohort of Medicare fee-for-service enrollees aged 65 and older in the USA. We calculated annual rates of work-related injuries resulting in hospitalisations, ED visits and outpatient facility visits from 2016 to 2019. We then characterised work-related injuries by enrollee demographics, payer and healthcare encounter characteristics.

METHODS

Data source and eligibility criteria

To identify work-related injuries among aged 65+ Medicare enrollees, we used annual 100% Medicare enrolment and fee-for-service claims data from 2016 to 2019, prior to pandemic-related disruptions to Medicare billing.[20 21] By calendar year, we restricted eligibility to enrollees who were aged 65 or older, resided in the 50 US states or District of Columbia (D.C.), and continuously enrolled in fee-for-service Medicare part A, for inpatient care, and part B, for outpatient care and certain inpatient services.[20] Benefits are administered through original Medicare (fee-for-service) or privately run Medicare Advantage plans, which may not submit claims to Medicare.[22] For complete claims data, we required continuous fee-for-service enrolment for the full year or all months alive with Medicare, excluding managed care. This created an open cohort of adults aged 65+ with Medicare fee-for-service coverage for inpatient and outpatient care from 2016 to 2019, allowing longitudinal capture of their work-related injuries. This cohort contributed both the numerator of work-related injury cases and the denominator for annual rate calculations. We analysed inpatient and outpatient claims for this cohort, submitted by healthcare facilities in the USA, dated from 1 January 2016 to 31 December 2019.

Injury case definition

We identified injury claims for hospitalisations, ED visits and non-ED outpatient visits using injury surveillance definitions from the US Centers for Disease Control and Prevention.[23 24] We searched 25 ICD-10-CM diagnoses and an external cause field to apply definitions. Injuries were defined by a claim principal or other diagnosis of injury (ICD-10-CM S, T, O and M codes) for an initial encounter (seventh character of ICD-10-CM code is A, B or C) or an external cause of injury (V00–V99, W00–X58, X71–X83, X92–Y09, Y21–Y33 and Y35–Y38) for an initial encounter.[23 24] We excluded injuries for subsequent encounters and sequelae (7th character of ICD-10-CM code is D-R or S).

Table 1 Medicare claim fields and sources for work-related claim ascertainment

Claims data element	Value/description
Primary payer code	'E'/Workers' compensation paid claim
Claim value code	15/Claims may have a Medicare conditional payment before a WC settlement
Claim-related occurrence code	04/Employment-related event
Claim condition code	02/Employment-related condition
Medicare non-payment reason code	14, 15/Workers' compensation is the reason for a Medicare claim denial
Claim diagnosis E code/claim diagnosis code	Work-related/agricultural ICD-10-CM* codes[14 15]

*International Classification of Diseases, Tenth Revision, Clinical Modification

Work-related ascertainment in claims data

We used two methods to identify a more comprehensive set of work-related injury claims.[18] For method 1 (WC Indicator), we used five variables, based on Medicare provider instructions for billing work-related injuries, to identify actual or potential WC activity on the claim (table 1).[12] Claims could be paid by WC, have a WC plan identified (even if paid by Medicare), or indicate an employment-related event/condition.[12] For method 2 (ICD Indicator), we compiled work-related or agricultural ICD-10-CM external causes of morbidity from two prior studies.[14 15] We made exclusions where codes seemed unlikely to involve older workers (eg, military). We searched diagnosis and external cause variables for these codes (see online supplemental appendix).

Demographics

From Medicare enrolment data, we used age, race and ethnicity, county, state, and Medicare/Medicaid enrolment variables. We grouped age into categories (65–69, 70–74, 75–79, 80–84, 85+), while sex (male/female) and race and ethnicity (white, black, Asian, Hispanic, North American Native (referred to here as American Indian or Alaska Native), other, unknown) were kept as reported in a single variable by Medicare. We grouped counties (metro/rural) with rural–urban continuum codes and states by Census region (Northeast, Midwest, South, West).[25 26] Medicare-Medicaid dual-enrolment was used as a low-income proxy, since some enrollees qualify for state Medicaid benefits by income.[27]

Healthcare encounter

We categorised claims by facility (hospital, outpatient, rural health clinic), and services for ED, intensive care unit (ICU), operating room, radiology, respiratory, blood administration and occupational/physical therapy.[28] Inpatient length of stay was calculated as the number of days between admission and discharge dates. We grouped discharge status (home/self-care, hospital transfer, postacute care transfer, expired in the facility)

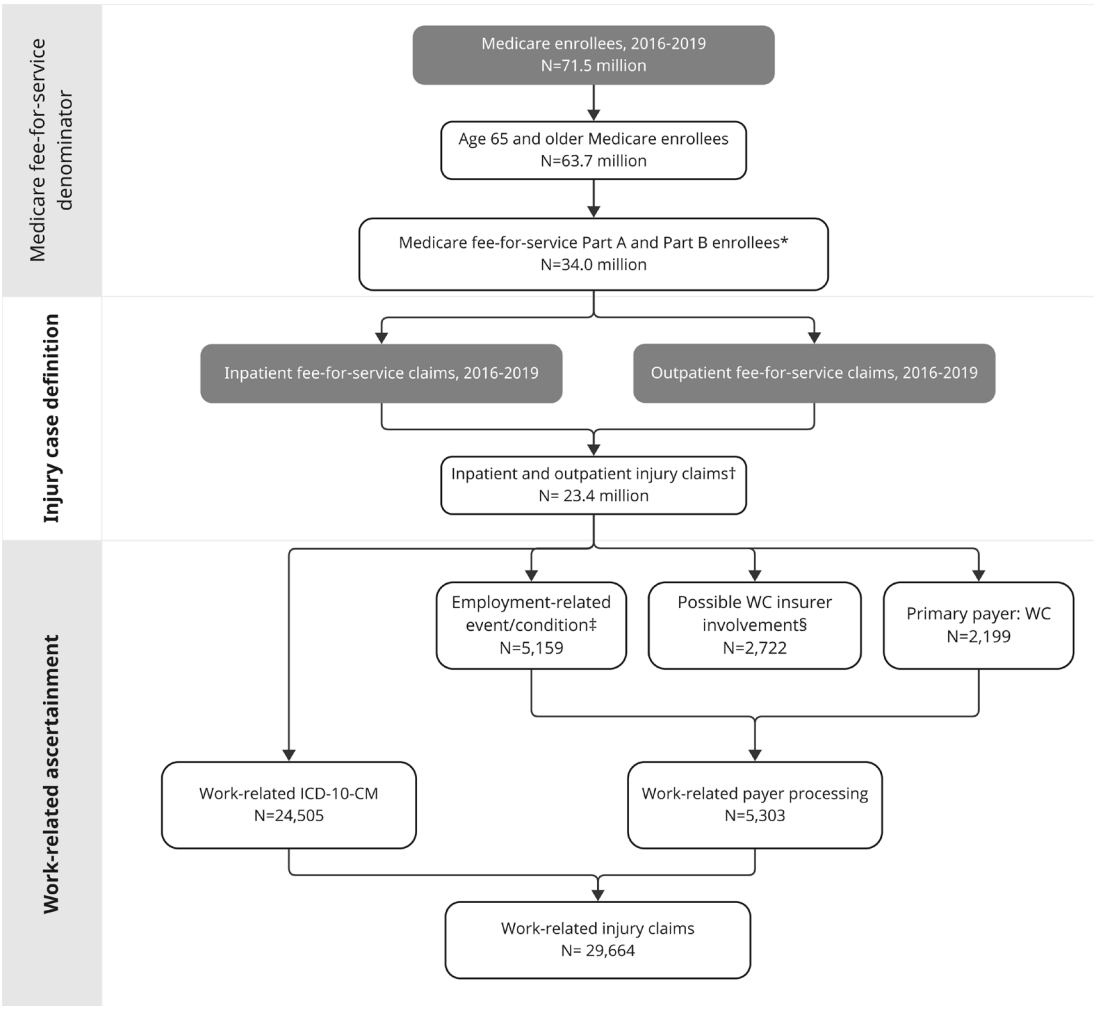

Figure 1 Work-related injury ascertainment process from Medicare inpatient and outpatient fee-for-service claims, 2016–2019. *Continuous annual enrollment in Medicare fee-for-service part A and part B. †Injury claims: Inpatient or outpatient claim with International Classification of Diseases, Tenth Revision, Clinical Modification (ICD-10-CM) diagnosis of injury (S, T, M, O codes), initial encounter, in any diagnosis position OR an ICD-10-CM external cause of injury, initial encounter. ‡Employment-related occurrence/condition code. §Claim value code for WC. WC, workers' compensation.

and primary payer as Medicare, WC, employer-group health plans, no-fault automobile insurance, or 'other' insurance (Black Lung Program, Veteran's Affairs, other liability insurance).

Data analysis

After pooling claims meeting all definitions above, we estimated work-related injury rates as the total number of work-related injury claims per 100 000 Medicare fee-for-service enrollees by year. We produced descriptive analyses of injury, demographic and healthcare encounter characteristics, comparing inpatient and outpatient claims with χ^2 tests. We coded mechanisms of injury by the ICD-10-CM External Cause Matrix.[29 30] We characterised injuries by nature and body region using the ICD-10-CM Injury Mortality Matrix.[30 31]

Patient and public involvement

Patients or the public were not involved in the design, or conduct, or reporting, or dissemination plans of our research.

RESULTS

Work-related injuries identified by method

From 2016 to 2019, 23.4 million inpatient and outpatient injury-related claims were filed among 34.0 million Medicare fee-for-service enrollees (figure 1). Of these, we identified 5303 work-related injury claims by method 1 (WC Indicator) and 24 505 claims by method 2 (ICD Indicator). Of the total work-related injury claims (N=29 664), 144 claims (0.5%) were found by both methods. Claims represented 27 471 unique enrollees (mean 1.1 claims/enrollee, SD=0.5). By method 1, claims were paid by WC (41.5%); had a WC payer identified, but Medicare paid the claim (9.9%); were only identified by an employment-related event/condition (45.6%) or denied by Medicare due to WC, but unpaid by WC (3.0%).

Work-related injury rates

From 2016 to 2019, enrollees averaged 27.6 work-related injury claims per 100 000 Medicare fee-for-service enrollees aged 65+ (figure 2). With 30.7 claims per 100 000 enrollees in 2016, rates levelled to 26.1–27.4 claims per 100 000 enrollees from 2017 to 2019. Outpatient ED claims comprised 58.3% of cases, followed by outpatient non-ED claims (22.2%) and inpatient hospitalisations (19.4%).

Injury characteristics

Overall, 60.7% of work-related injury claims were fall-related, machinery-related or transportation-related, 20.9% of claims

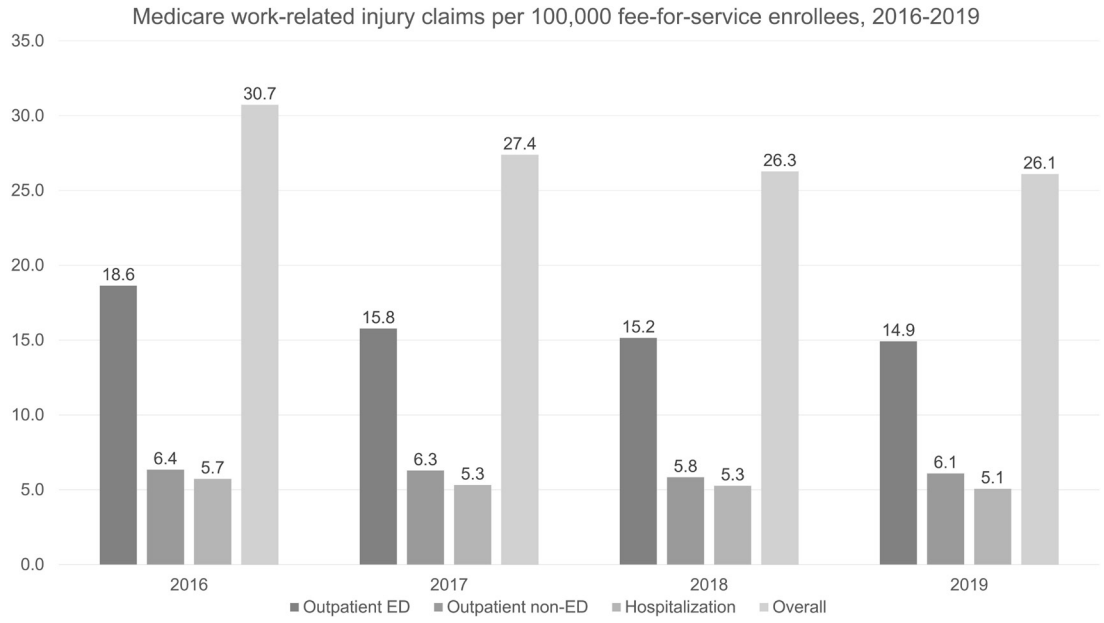

Figure 2 Rate of work-related injuries from Medicare claims for age 65+ denominator population, 2016–2019. ED, emergency department.

listed other causes in table 2, and 18.4% of claims had missing or unspecified causes. About 99% were unintentional. Inpatient claims (N=5759) had a higher share of falls (27.3% vs 18.7%, p<0.001), machinery (21.3% vs 19.8%, p=0.014) and transportation-related causes (27.0% vs 19.7%, p<0.001) than outpatient (N=23 905) claims. Of less common causes, altogether struck by/against, cut/pierce and overexertion were more frequent in outpatient claims (12.0%) than inpatient claims (3.7%) (p<0.001).

Claims often listed multiple injuries to the upper/lower extremities (72.1%), head/neck (30.9%), torso (24.3%) or the spine/back (9.3%). Fractures were most common (28.5%), followed by superficial injuries/contusions (25.8%), open wounds (25.3%), sprain/strains (13.1%), internal organ injuries (8.0%) and burns (4.3%). The most frequent inpatient principal diagnoses were hip fracture (11.3%), traumatic brain injury (9.0%), chest fracture (7.4%), lower leg/ankle fracture (6.2%) and injury to chest internal organs (4.9%). Outpatient principal diagnoses most often involved open wounds to the wrist/hand/fingers (9.6%), head (3.5%), or lower leg/ankle (2.6%), and fractures to the wrist/hand/fingers (2.8%) or chest (2.7%).

Demographic characteristics

Enrollees with work-related injuries had a median age of 72 and were mostly male (74.8%) compared with female (25.2%).

Table 2 ICD-10-CM external causes of injury present on work-related injury claims (N=29 664)*

	Inpatient claims (N=5759)	% of claims	Outpatient claims (N=23 905)	% of claims	P value†
Falls	1575	27.3	4462	18.7	<0.001
Machinery	1226	21.3	4744	19.8	0.014
Transportation					
Motor vehicle: traffic	527	9.2	1646	6.9	<0.001
Motor vehicle: non-traffic	974	16.9	2520	10.5	<0.001
Other transport	195	3.4	546	2.3	<0.001
Struck by/against	142	2.5	1314	5.5	<0.001
Cut/pierce	59	1.0	950	4.0	<0.001
Overexertion	<11	<0.2	592	2.5	<0.001
Natural/environmental, other	60	1.0	302	1.3	0.169
Bites and stings	<11	<0.2	197	0.8	<0.001
Hot object/substance	24	0.4	79	0.3	0.318
Fire/flame	81	1.4	66	0.3	<0.001
Firearm	13	0.2	<11	<0.1	<0.001
Other specified causes	18	0.3	1428	6.0	<0.001
Unspecified	80	1.4	641	2.7	<0.001
Missing mechanism	735	12.8	4576	19.1	<0.001

*Mechanism counts may exceed the total as some claims have more than one mechanism of injury.
†From 1 df χ^2 test.
‡International Classification of Diseases, Tenth Revision, Clinical Modification
§

Table 3 Demographic characteristics of Medicare enrollees with work-related injuries (N=27 471), by claim source

	Inpatient claims		Outpatient claims		
	Enrollee N	% of enrollees	Enrollee N	% of enrollees	P value (df)*
Demographic characteristics					
Age					<0.001 (4)
65–69	1635	29.5	8494	38.7	
70–74	1407	25.4	5890	26.9	
75–79	1102	19.9	3849	17.6	
80–84	781	14.1	2220	10.1	
85+	621	11.2	1472	6.7	
Sex					<0.001 (1)
Male	4435	80.0	16 118	73.5	
Female	1111	20.0	5807	26.5	
Race/ethnicity					<0.001 (5)
White	5106	92.1	19 648	89.6	
Black	176	3.2	1167	5.3	
Asian	38	0.7	125	0.6	
Hispanic	41	0.7	219	1.0	
North American Native	31	0.6	163	0.7	
Other	53	0.8	173	0.8	
Unknown	102	1.8	430	2.0	
Medicaid dual					0.221 (1)
Yes	505	9.0	1880	8.5	
No	5128	91.0	20 321	91.5	
County of residence					0.003 (1)
Metro	3306	59.6	12 590	57.4	
Rural	2240	40.4	9335	42.6	
Census region					<0.001 (3)
Northeast	885	16.0	3314	15.1	
Midwest	1647	29.7	7166	32.7	
South	2207	39.8	8124	37.1	
West	807	14.6	3321	15.2	
Total enrollees*	5546	100.0	21 925	100.0	

*From χ^2 test.

Overall, 8.6% of cases were dual-eligible for Medicaid. Cases resided more often in metropolitan (57.9%) vs rural (42.1%) counties and in the South (37.6%) or Midwest (32.1%). Enrollees were most often white (90.1%), followed by black (4.9%), Hispanic (1.0%), other (0.8%), American Indian or Alaska Native (0.7%), Asian (0.6%), or unknown race/ethnicity (1.9%). Inpatient and outpatient cases differed by age and sex. Inpatient cases were more often aged 75 years or older (45.1%) than outpatient cases (34.4%), as well as male (80.2%) vs female (73.7%) (p<0.001) (table 3).

Healthcare encounter characteristics

Most injuries were from the outpatient ED (58.3%) or hospitalised (19.4%), followed by non-ED hospital outpatient settings (16.1%), rural health clinics (5.1%) or other outpatient facilities (1.3%). Inpatient cases more often involved occupational/physical therapy, respiratory and blood administration services than outpatient cases (p<0.001) (table 4). These hospitalisations usually involved the ICU (41.0%) and/or operating room (49.5%) and averaged 5.9 days (SD=8.4), although ICU-involved stays averaged 8.0 days (SD=8.9). Hospitalisations often resulted in postacute care transfer (51.8%). Medicare paid for most work-related injury claims (89.0%), followed by WC (7.4%) and other insurance (3.6%). WC paid more often for inpatient than outpatient claims (9.7% vs 6.9%, p<0.001).

DISCUSSION

Summary

This study demonstrates the utility of Medicare claims as an occupational injury data source for older adults. A total of 29 664 work-related injury cases were sustained by Medicare fee-for-service enrollees aged 65+ in the USA from 2016 to 2019, for an average annual rate of 27.6 per 100 000. Injuries were mainly from falls, machinery or transportation-related mechanisms, often related to agriculture. Most injuries appeared in the outpatient ED. Medicare, rather than WC, paid for most work-related injury claims.

Work-related injury estimates

Work-related injury cases that we have estimated from Medicare claims differ from national non-fatal estimates from BLS.[3] Not surprisingly, compared with BLS estimates, Medicare claims from 2016 to 2019 captured substantially fewer falls (6037 vs 78 100) and non-agricultural transportation cases (1907 vs 10 550) to aged 65+ workers during the same period. We used hospital claims data, whereas employers report injuries to BLS that are not necessarily seen in hospitals. However, Medicare claims identified more agricultural injuries over BLS SOII. We identified 10 044 claims for agricultural injuries, over five times the 1960 BLS-reported non-fatal work-related injuries and

Table 4 Encounter characteristics of work-related injury claims by admission status (N=29 664)

	Inpatient claims		Outpatient claims		
	N	% of claims	N	% of claims	P value (df)*
Total claims	5759	100.0	23 905	100.0	
Encounter setting					<0.001 (3)
Hospital—ED	5018	87.1	17 307	72.4	
Hospital—non-ED	741	12.9	4751	19.9	
Rural health clinic	0	0.0	1519	6.4	
Other facility	0	0.0	328	1.4	
Accommodations and services					
Intensive care unit (iInpatient only)	2359	41.0			
Operating room	2851	49.5	1091	4.6	<0.001 (1)
Radiology	5041	87.5	11 773	49.2	<0.001 (1)
Occupational/physical therapy	4629	80.4	833	3.5	<0.001 (1)
Respiratory services	2159	37.5	320	1.3	<0.001 (1)
Blood administration	1185	20.6	63	0.3	<0.001 (1)
Length of stay (inpatient only)					
1–2 days	1678	29.1			
3–7 days	2835	49.2			
8–14 days	816	14.2			
15–30 days	324	5.6			
30+ days	94	1.6			
Discharge indicators					<0.001 (4)
Home	2269	39.4	22 841	95.5	
Hospital transfer	155	2.7	396	1.7	
Transfer to postacute care	2985	51.8	212	0.9	
Other/unknown	99	1.7	177	0.7	
Expired	250	4.3	70	0.3	
Payers					<0.001 (5)
Medicare	4761	82.7	20 911	87.5	
Medicare conditional payment	199	3.5	543	2.3	
WC	560	9.7	1639	6.9	
Employer Group Health Plan	89	1.5	470	2.0	
No fault auto	131	2.3	298	1.2	
Other	19	0.3	44	0.2	

*From χ^2 test.
ED, emergency department; WC, workers' compensation.

illnesses to aged 65+ agricultural workers. BLS SOII potentially misses these injuries by not covering small farms, self-employed or family workers.[5 6] Medicare claims may, therefore, augment occupational injury surveillance among adults aged 65+, especially for agriculture, while adding important injury and healthcare measures as our study demonstrates.

Demographic characteristics

Work-related injury rates decreased with age, but older enrollees were more often hospitalised. The 65–74 age group averaged 31.4 cases per 100 000 enrollees, compared with 22.9 for ages 75+. This likely reflects occupations, or roles within an occupation, with lower injury risk, along with lower employment in older age groups.[1] However, age may contribute to complications from an injury.[32] After age 75, 25% of work-related injury cases in our study were hospitalised compared with 18% for ages 65–74, suggesting greater morbidity of work-related injuries with age.

We noted disparities by sex, race and ethnicity, and rurality. Male Medicare enrollees sustained work-related injuries nearly four times as often as female enrollees (47.6 vs 12.1 per 100 000 enrollees) and were more likely to be hospitalised (21.6% vs 16.1%) for their injuries. Work-related external causes likely contribute to these differences, and studies of industrial and agricultural injury hospitalisations often report more male than female patients.[8 9 11] By race and ethnicity, while most enrollees were reported as white, Medicare data undercounts those who self-identify as Hispanic, Asian, Native Hawaiian and other Pacific Islander, or American Indian or Alaska Native.[33] With only one variable available for race and ethnicity, Medicare data likely underestimated occupational injuries among racially or ethnically diverse populations. Lastly, 42% of work-related injuries in our study were in rural areas, despite only 23% of Medicare enrollees residing there.[34] In rural areas, agricultural injuries may be cost-shifted to Medicare.[9]

Injury and encounter characteristics

One in five work-related injuries involved a fall, and consistent with prior studies, most hospitalisations were for hip fractures.[35] While outpatient visits were more frequent, hospitalisations had greater intensity of healthcare services. Hospitalisations, particularly ICU-level stays, often lasted three or more days, with 23% receiving blood, possible indicators of major trauma.[36] Complications from trauma

may add to the risk of mortality from an injury for older adults.[32] These higher-acuity hospitalisations also suggest that Medicare covers significant care for work-related injuries, possibly outside of its intended role.

This study builds on research suggesting a cost shift of work-related injuries from WC to Medicare.[9 11] In California, Colorado and New York, WC paid for 43%–57% of aged 65+ industrial injury hospitalisations.[11] In the Iowa Trauma Registry, WC paid for 7% of agricultural and 55% of non-agricultural rural occupational injuries after age 65.[9] In our study, Medicare paid for 86.5%, while WC paid for just 7.4% of acute work-related injuries, and less for agricultural injuries (<1%). In Medicare claims, we find a greater cost burden to Medicare and its enrollees than previously calculated. Future research may consider Medicare enrollees' barriers to WC coverage, whether from age, gender, income, education, race and ethnicity, immigration status, or non-standard employment.[13 37]

Strengths and limitations

A major strength of our study is our comprehensive strategy to identify work-related injuries in an older population. By using data from Medicare, the largest healthcare insurer of adults aged 65+ in the USA, we may mitigate some issues of underdetection by surveillance systems such as WC. Medicare appears to capture a higher proportion of work-related injuries ineligible for WC and thus billed to Medicare. WC data may underestimate work-related injuries to older adults, to a greater degree than noted previously.[9 11]

There are several limitations to this study. Our sample may be less representative of all adults aged 65+ with work-related injuries. We excluded Medicare Advantage enrollees, although 37% of Medicare enrollees had these privately managed plans in 2019.[38] Although we have a large Medicare fee-for-service denominator, we generalise to all Medicare enrollees with caution since we cannot know if work-related injuries differ in Medicare Advantage. Since we do not know who was employed in this denominator, we cannot calculate rates among workers.

There is a need to improve on work-related injury codes for older adults. Method 1 claims were potentially paid by WC (and 42% were paid by WC). However, 82% of our sample was found only by International Classification of Diseases, Tenth Revision, Clinical Modification (ICD-10-CM) external cause codes. We draw from two studies using work-related or agriculture-related ICD-10-CM codes, which compiled their code lists through a careful process of team review.[14 15] We do not know how sensitive these methods are to identify all older Medicare enrollees with work-related injuries or how they differ from the subset here. We found no workplace violence injuries, which were likely missed through our identification methods. Newer methods that use ICD 'proxy codes' could improve violence capture in hospital data.[39] With these limitations, future research should expand and validate these methods.

Our study period has limitations, as Medicare billing and aged 65+employment declined with the COVID-19 pandemic.[21 40] To initially explore Medicare as an occupational injury data source, we analysed data before these disruptions. Thus, this research gives an important viewpoint of prepandemic trends in the USA. As more recent Medicare claims become available, future research should examine prepandemic to postpandemic changes in Medicare work-related injuries alongside potential employment shifts among older adults.

Lastly, to provide simple estimates, annual rates include only enrollees' first instance of a work-related injury, by year. In our study, 5.8% of the cohort had more than one claim meeting the study criteria for a work-related injury, possibly for the same injury or a reinjury, which we did not attempt to discern. Future research could attempt to follow individuals in Medicare claims more closely, an advantage over existing surveillance systems, to understand long-term consequences of injuries, including the risk of reinjury. These healthcare encounters may represent a life-altering injury requiring greater care for months or years after the injury, especially in older populations. Future studies should seek a more complete picture of hospital transfers, readmissions and follow-up care.

CONCLUSIONS

With more adults working after age 65, work-related injuries continue to be a concern for older adults in the USA. Using Medicare inpatient and outpatient claims, we estimated work-related injury rates in the older Medicare population. Falls are an important mechanism to consider for work-related injury prevention in older adults, as well as agriculture-related transportation and machinery incidents. Many injuries involved extensive hospital care. Work-related injuries concentrated close to age 65, when older workers could be close to retirement age. We find Medicare may cover a larger portion of the payment burden for work-related injuries than previously expected for older adults. Future research may benefit from applying, validating and expanding on these methods, as well as analysing the costs and outcomes of these injuries.

Acknowledgements We would like to gratefully acknowledge the Midwest Center for Occupational Health and Safety (T42 OH 008434) for supporting this work. We would like to acknowledge the Research Data Assistance Center for exceptional analytic advice during this process. The data used by this study were accessed through a Data Use Agreement (LDS-DUA-52351) with the Centers for Medicare and Medicaid Services (CMS).

Contributors MM conceived and designed the study, performed data analysis, drafted the manuscript and was guarantor. BV contributed to data acquisition. BV, ADR, HK, BHA and MR provided guidance and expertise during data analysis and helped with interpretation. MR also contributed to the study design. All authors critically reviewed and approved the final version of the manuscript.

Funding MM was supported by a traineeship from the Midwest Center for Occupational Health and Safety (T42 OH 008434).

Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not applicable.

Ethics approval This research was conducted under expedited approval from the University of Minnesota, Twin Cities Institutional Review Board (STUDY00002511). Due to minimal risk to human subjects, informed consent was waived by the IRB.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data may be obtained from a third party and are not publicly available. Data used in this study are available through a Data Use Agreement with the Centers for Medicare and Medicaid Services.

accuracy and reliability of the translations (including but not limited to local regulations, clinical guidelines, terminology, drug names and drug dosages), and is not responsible for any error and/or omissions arising from translation and adaptation or otherwise.

ORCID iD
Matthew McFalls http://orcid.org/0000-0001-9487-4507

REFERENCES

1 US Bureau of Labor Statistics. Civilian labor force participation rate by age, sex, race, and ethnicity. 2021. Available: https://www.bls.gov/emp/tables/civilian-labor-force-participation-rate.htm [Accessed 18 Nov 2024].
2 US Bureau of Labor Statistics. Census of fatal occupational injuries (CFOI) - current and revised data. 2023. Available: https://www.bls.gov/iif/oshcfoi1.htm [Accessed 01 Feb 2024].
3 US Bureau of Labor Statistics. Survey of occupational injuries and illnesses data. 2023. Available: https://www.bls.gov/iif/soii-overview.htm [Accessed 01 Feb 2024].
4 Guirguis-Blake JM, Michael YL, Perdue LA, *et al*. Interventions to Prevent Falls in Older Adults: Updated Evidence Report and Systematic Review for the US Preventive Services Task Force. *JAMA* 2018;319:1705–16.
5 Wiatrowski WJ. Examining the completeness of occupational injury and illness data: an update on current research: monthly labor review: U.S. bureau of labor statistics. 2014. Available: https://www.bls.gov/opub/mlr/2014/article/examining-the-completeness-of-occupational-injury-and-illness-data-an-update-on-current-research.htm [Accessed 08 Oct 2021].
6 US Bureau of Labor Statistics. Concepts: handbook of methods. 2020. Available: https://www.bls.gov/opub/hom/cfoi/concepts.htm
7 Lundstrom EW, Hendricks SA, Marsh SM, *et al*. Temporal trends in occupational injuries treated in US emergency departments, 2012-2019. *Inj Epidemiol* 2023;10:13.
8 Kica J, Rosenman KD. Multisource surveillance for non-fatal work-related agricultural injuries. *J Agromedicine* 2020;25:86–95.
9 Missikpode C, Peek-Asa C, Wright B, *et al*. Characteristics of agricultural and occupational injuries by workers' compensation and other payer sources. *Am J Ind Med* 2019;62:969–77.
10 Harduar Morano L, Richardson D, Proescholdbell S. Descriptive evaluation of methods for identifying work-related emergency department injury visits. *Am J Ind Med* 2019;62:568–79.
11 Sears JM, Bowman SM, Blanar L, *et al*. Industrial Injury Hospitalizations Billed to Payers Other Than Workers' Compensation: Characteristics and Trends by State. *Health Serv Res* 2017;52:763–85.
12 Centers for Medicare and Medicaid Services. Chapter 3 - MSP provider, physician, and other supplier billing requirements. In: *Medicare Secondary Payer (MSP) manual, (100-05*). 2023. Available: https://www.cms.gov/Regulations-and-Guidance/Guidance/Manuals/Downloads/msp105c03.pdf
13 Green DR, Gerberich SG, Kim H, *et al*. Knowledge of work-related injury reporting and perceived barriers among janitors. *J Safety Res* 2019;69:1–10.
14 Bush AM, Bunn TL, Liford M. Identification of work-related injury emergency department visits using International Classification of Diseases, Tenth Revision, Clinical Modification (ICD-10-CM) codes. *Inj Prev* 2021;27:i3–8.
15 Scott E, Hirabayashi L, Graham J, *et al*. Using hospitalization data for injury surveillance in agriculture, forestry and fishing: a crosswalk between ICD10CM external cause of injury coding and The Occupational Injury and Illness Classification System. *Inj Epidemiol* 2021;8:6.
16 Alamgir H, Koehoorn M, Ostry A, *et al*. An evaluation of hospital discharge records as a tool for serious work related injury surveillance. *Occup Environ Med* 2006;63:290–6.
17 US Census Bureau. Health insurance coverage in the United States: 2022. 2023. Available: https://www.census.gov/library/publications/2023/demo/p60-281.html [Accessed 02 Oct 2023].
18 McFalls M, Virnig BA, Andrew Ryan MS, *et al*. Medicare work-related injuries: Underutilization of workers' compensation leads to higher out-of-pocket costs for older adults. *J Occup Environ Med* 2025.
19 Kurth L, Casey M, Chin B, *et al*. Medical claims paid by workers' compensation insurance among US Medicare beneficiaries, 1999-2016. *Am J Ind Med* 2021;64:185–91.
20 HealthAPT. Codebook: medicare fee-for-service claims (for version K), version 1.6. 2020. Available: https://www2.ccwdata.org/documents/10280/19022436/codebook-ffs-claims-archive-l.pdf
21 Biniek JF, Cubanski J, Neuman T. Traditional medicare spending fell almost 6% in 2020 as service use declined early in the COVID-19 pandemic. KFF; 2022. Available: https://www.kff.org/medicare/issue-brief/traditional-medicare-spending-fell-almost-6-in-2020-as-service-use-declined-early-in-the-covid-19-pandemic/ [Accessed 06 Oct 2024].
22 Centers for Medicare and Medicaid Services. Medicare claims processing manual Chapter 25 - completing and processing the form CMS-1450 data set. In: *Medicare claims processing manual*. 2023. Available: https://www.cms.gov/Regulations-and-Guidance/Guidance/Manuals/downloads/clm104c25.pdf
23 Hedegaard H, Johnson RL. An Updated International Classification of Diseases, 10th Revision, Clinical Modification (ICD-10-CM) Surveillance Case Definition for Injury Hospitalizations. *Natl Health Stat Report* 2019;1–8.
24 Hedegaard H, Garnett MF, Johnson RL, *et al*. A Revised ICD-10-CM Surveillance Case Definition for Injury-related Emergency Department Visits. *Natl Health Stat Report* 2021;1–8.
25 USDA Economic Research Service. USDA ERS - rural-urban continuum codes. 2024. Available: https://www.ers.usda.gov/data-products/rural-urban-continuum-codes.aspx [Accessed 01 Feb 2024].
26 US Census Bureau. Geographic levels. 2021. Available: https://www.census.gov/programs-surveys/economic-census/guidance-geographies/levels.html [Accessed 01 Feb 2023].
27 Peña M, Mohamed M, Ochieng N. A profile of medicare-medicaid enrollees (dual eligibles), PCP, 2023. KFF; 2023. Available: https://www.kff.org/medicare/issue-brief/a-profile-of-medicare-medicaid-enrollees-dual-eligibles/ [Accessed 02 Feb 2023].
28 Centers for Medicare and Medicaid Services. Medicare claims processing manual Chapter 3 - inpatient hospital billing. In: *Medicare claims processing manual, (100-04*). 2023. Available: https://www.cms.gov/regulations-and-guidance/guidance/manuals/downloads/clm104c03.pdf
29 Annest JL, Hedegaard H, Chen LH, *et al*. Proposed framework for presenting injury data using ICD-10-CM external cause of injury codes. Atlanta, GA National Center for Injury Prevention and Control, National Center for Health Statistics, Centers for Disease Control and Prevention; 2014. Available: https://www.cdc.gov/injury/wisqars/pdf/ICD-10-CM_External_Cause_Injury_Codes-a.pdf
30 National Center for Health Statistics. Injury data and resources - tools and frameworks. 2021. Available: https://www.cdc.gov/nchs/injury/injury_tools.htm [Accessed 14 Mar 2025].
31 Fingerhut LA, Warner M. The ICD-10 injury mortality diagnosis matrix. *Inj Prev* 2006;12:24–9.
32 Stonko DP, Etchill EW, Giuliano KA, *et al*. Failure to Rescue in Geriatric Trauma: The Impact of Any Complication Increases with Age and Injury Severity in Elderly Trauma Patients. *Am Surg* 2021;87:1760–5.
33 Zaslavsky AM, Ayanian JZ, Zaborski LB. The validity of race and ethnicity in enrollment data for Medicare beneficiaries. *Health Serv Res* 2012;47:1300–21.
34 Smith AS, Trevelyan E. The older population in rural America: 2012-2016, Report No: ACS-41. United States Census Bureau; 2019. Available: https://www.census.gov/library/publications/2019/acs/acs-41.html [Accessed 03 Feb 2023].
35 Weiss AJ, Reid LD, Barrett ML. Overview of emergency department visits related to injuries, by cause of injury, 2017 #266. Agency for Healthcare Research and Quality; 2020. Available: https://www.hcup-us.ahrq.gov/reports/statbriefs/sb266-Injuries-Causes-ED-Visits-2017.jsp [Accessed 03 Feb 2023].
36 Roden-Foreman JW, Rapier NR, Yelverton L, *et al*. Asking a Better Question: Development and Evaluation of the Need For Trauma Intervention (NFTI) Metric as a Novel Indicator of Major Trauma. *J Trauma Nurs* 2017;24:150–7.
37 Sears JM, Edmonds AT, Coe NB. Coverage Gaps and Cost-Shifting for Work-Related Injury and Illness: Who Bears the Financial Burden? *Med Care Res Rev* 2020;77:223–35.
38 KFF. Total number of medicare beneficiaries by type of coverage. 2022. Available: https://www.kff.org/medicare/state-indicator/total-medicare-beneficiaries/ [Accessed 04 Mar 2023].
39 Santaularia NJ, Ramirez MR, Osypuk TL, *et al*. Measuring the hidden burden of violence: use of explicit and proxy codes in Minnesota injury hospitalizations, 2004-2014. *Inj Epidemiol* 2021;8:63.
40 Goda GS, Jackson E, Nicholas LH, *et al*. The impact of Covid-19 on older workers' employment and Social Security spillovers. *J Popul Econ* 2023;36:813–46.