Journal of Occupational and Environmental Medicine, Publish Ahead of Print
DOI: 10.1097/JOM.0000000000003323

Medicare work-related injuries: Underutilization of workers' compensation leads to higher out-of-pocket costs for older adults

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Funding Sources: Matthew McFalls, Andrew Ryan, Darin Erickson, Bruce Alexander, Hyun Kim, and Marizen Ramirez – Midwest Center for Occupational Health and Safety (T42 OH 008434). Beth Virnig and Stephanie Jarosek – NONE DECLARED.

Conflicts of Interest for All Authors: Matthew McFalls: My employment at the University of Minnesota is funded through a contract with the Centers for Medicare and Medicaid Services (CMS). This contract did not contribute directly to this work. **Stephanie Jarosek:** My employment at the University of Minnesota is funded through contracts with the Centers for Medicare and Medicaid Services (CMS), the National Cancer Institute (NCI) and grant funding from the National Institute on Aging. None of these contracts or grants contributed directly to this work. **Marizen Ramirez, Andrew Ryan, Darin Erickson, Bruce Alexander, Hyun Kim:** NONE DECLARED.

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 (ResDAC) for analytic advice with Medicare claims data. **Specific Author Contributions:** M.M. designed the study, analyzed the data, interpreted the results, and drafted the manuscript. B.V. acquired data and assisted with analysis and interpretation. A.R. and D.E. assisted with study design and interpretation. H.K., S.J., and B.A. assisted with interpretation. M.R. supervised and assisted with study design, analysis, and interpretation. All authors provided critical review and feedback on the manuscript.
This work was part of the thesis, "A Study of Work-Related Injuries among Older Medicare Enrollees" completed by M.M. at the University of Minnesota. Another related manuscript, "Acute work-related injuries among older adults in the United States on Medicare, 2016-2019: a national longitudinal study" is currently under review with the journal Injury Prevention. We mention and reference these sources in the Methods, discuss them in the manuscript, and include

them in the submission references. We adhered to the STROBE guidelines for reporting observational studies. AI was not utilized in the formulation or writing of this manuscript.

Data Availability: The data used by this study was accessed through a Data Use Agreement (LDS-DUA-52351) with the Centers for Medicare and Medicaid Services (CMS), per the terms of the agreement they cannot be shared. Researchers may access the data from CMS.

Ethical Considerations and Disclosures:

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.

Medicare Enrollee Costs for Work-Related Injuries

ABSTRACT

Objective: Older adults may pay healthcare-related costs for work injuries if Medicare covers claims over workers' compensation (WC). We assessed Medicare enrollee costs after a work-related injury by WC status.

Methods: We longitudinally analyzed Medicare fee-for-service claims (2016-2019) for age 65+ Medicare enrollees with work-related injuries, estimating WC effects on healthcare use and enrollee costs using difference-in-differences and quantile regression models.

Results: WC covered at least one Medicare claim for 16% of the 13,039 enrollees with work-related injuries. Over 90 days, mean Medicare out-of-pocket costs were lower with WC ($447) than without ($778). With WC, enrollees owed $1,432 at the 90th percentile compared to $2,465 without, an adjusted difference of $600 (95% CL -767, -432).

Conclusions: While WC covers some costs, Medicare claim billing increases after a work-related injury, often leading to substantial patient expenses.

Keywords: Occupational injuries, aging workforce, healthcare expenditures, cost shift, difference-in-differences modeling

Learning Outcomes:

- After reading this article, the reader will be able to clearly understand how a work-related injury can immediately affect Medicare claim billing and increase out-of-pocket costs for Medicare enrollees over the age of 65, specifically for inpatient, outpatient, and skilled nursing facility care.
- Healthcare specialists and policymakers will be able to identify the benefits of improving workers' compensation coverage for older adults with work-related injuries, while also recognizing that current coverage may be inadequate to cover costs even in the short term.

INTRODUCTION

In the US, it is often financially necessary to continue working as an older adult, and over 10 million US adults are now working over the age of 65.[1,2] These workers may be in potentially hazardous occupations – in 2019, production, transportation, or material moving occupations accounted for nearly one-third of the 47,000 non-fatal cases of occupational injuries and illnesses to this age group.[3] After age 65, fatal work injuries occur at nearly twice the rate of any other age group, and non-fatal injuries tend to be more severe.[3,4] Work-related injuries may burden workers financially through healthcare costs and lost wages, and more severe injuries experienced by older workers may also make them mostly costly.[5-9] Workers' compensation (WC) is intended to help cover these costs but may not be adequate or available for all workers, andolder adults could be vulnerable topaying healthcare costs through Medicare.[10,11] Medicare, the primary health insurer for US adults over the age of 65, is not intended to pay first for work-related injuries, and this cost shift could create disparities in older adults' financial liability for healthcare.[12]

Less than half of medical costs for work-related injuries and illnesses may be covered by WC, with remaining costs going to public or private insurance and patients.[5] Studies often suggest a cost shift from WC to public insurance like Medicare.[10,11,13-16] Medicare instructs providers to bill work-related injuries with a statement of WC payment or denial, for Medicare to cover the balance.[12] Medicare is therefore a secondary payer to WC for work-related injuries, but self-employed workers, and notably workers in agriculture, may not have WC coverage.[10] Older adults could also experience barriers to WC reporting as seen in other age groups, such as fear of workplace retaliation.[17] For these reasons, Medicare potentially pays for work-related injuries more often than WC. A study of hospital discharges in California, Colorado, and New York

showed that WC covered 30-38% while Medicare covered 43-57% of industrial injuries to adults aged 65 and older.[10] From the Iowa Trauma Registry, 7% of agricultural work-related injuries after age 65 were paid by WC.[11] From Michigan hospital and outpatient records, WC paid for 24% of farm-related injuries to older adults.[18]

When costs shift from WC to Medicare, Medicare enrollees are likely to pay healthcare costs as well. WC claimants are not expected to pay deductibles through WC, but Medicare has high patient cost-sharing, including a lack of a cap on out-of-pocket costs.[19,20] Medicare enrollees may obtain supplemental coverage, such as MediGap, to help cover their Medicare copays and deductibles, but these plans often have their own premiums and may not cover all costs.[21] Without WC, injuries may become costly to Medicare enrollees. In 2019, the Medicare inpatient deductible reached $1,364, while outpatient care included a $185 deductible and 20% copay.[22] Patients with more severe injuries may owe $170/day after the first 20 days of post-acute, skilled nursing care.[22]

While WC is intended to protect workers from paying medical costs for work-related injuries, the direct effects of WC on Medicare enrollee costs are not yet understood. Past research has found that after a WC claim is filed, adult patients have higher monthly costs billed on group health insurance (GHI) claims, suggesting a shift in medical costs from WC to the GHI system.[7] A similar study found patients with filed WC claims but no WC payments ("zero-cost WC claims") had higher inpatient and outpatient costs paid by their GHI plan 2-3 months following an injury compared to those with actual WC-paid claims.[6] For older adults on Medicare, these studies suggest that even approved WC claims may not cover the full cost of work-related injuries, and denied WC claims should not be interpreted as situations where there was no injury.

More severe work-related injuries after age 65 and a shift in costs to Medicare have made it necessary to understand if workers' compensation is meeting the healthcare needs of older adults who become injured from work. In this study, we identified patients with work-related injuries reported in Medicare claims data and summarized their Medicare claims and out-of-pocket costs billed for inpatient, outpatient, and skilled nursing care within 90 days of the injury. We compared this utilization before and after the injury to estimate the relative impact of WC coverage on costs and the use of these services over time. We hypothesized that following a work-related injury, Medicare enrollees would owe fewer out-of-pocket costs if WC paid the initial Medicare claim. In doing so, we estimate the excess healthcare out-of-pocket costs incurred by older Medicare enrollees from work-related injuries as well as the protective effects of WC coverage.

METHODS

We conducted a retrospective cohort study to examine longitudinal healthcare costs incurred by Medicare enrollees who sustained a work-related injury. We used this design to estimate the effects of WC coverage on Medicare enrollee costs and billing of inpatient, outpatient, and skilled nursing services to Medicare. We compared this healthcare utilization from 90 days before to 90 days after a work-related injury between two groups of enrollees – those with injuries covered by WC and those not covered by WC.[6,7,23] This study followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines (**STROBE Checklist**) (Supplemental Digital Content, http://links.lww.com/JOM/B824).[24]

Medicare enrollees: In each calendar year from 2016-2019, we identified enrollees who were at least 65 years old, resided in any of 50 US states or DC, and were enrolled continuously

in fee-for-service Medicare Part A, which covers hospital and skilled nursing care, and Medicare Part B, which includes outpatient care.[22] We excluded managed care plan enrollees to ensure complete claims for everyone in the cohort.

Medicare claims: We joined enrollees to their Medicare Inpatient and Outpatient claims for care received between January 1, 2016 and December 31, 2019 to identify those with potentially acute and traumatic work-related injuries. For this cohort, we selected all Inpatient, Outpatient, and Skilled Nursing Facility claims incurred within 90 days of the injury date.

Injury case definition

We identified injuries resulting in hospitalizations, emergency department visits, and non-emergency department hospital/clinic visits with ICD-10-CM diagnosis codes from the US Centers for Disease Control and Prevention (CDC) definition for injury-related emergency department visits.[25,26] We identified claims with an initial counter for an injury (ICD-10-CM S, T, O, and M codes) or external cause of injury (V00-V99, W00-X58, X71-X83, X92-Y09, Y21-Y33, Y35-Y38), excluding subsequent encounters and sequelae.[25,26] We grouped mechanisms of injury by the External Cause of Injury Mortality Matrix, retaining this mechanism of injury prior to any work-related filters.[27] Injury claims without a mechanism of injury were assigned an "Unspecified/Missing" value.

Work-related ascertainment in claims data

We used two strategies as previously used to identify work-related injuries from Medicare Inpatient and Outpatient claims.[28,29] These studies found acute work-related injuries in Medicare claims to primarily be from falls, machinery, and transportation-related mechanisms of injury, of which hospitalized cases often required a large volume of healthcare services. To be considered work-related, an injury claim had to meet the criteria for either strategy. We then

narrowed the cohort to claims with a recent "event date", as described further below, to more accurately assign pre- and post-injury claim costs.

First, we identified five variables used in Medicare billing to indicate that care is related to work.[12,30] We assumed that claims would be work-related if the claim was paid by WC, awaiting WC payment, or contained an employment-related code to alert Medicare to possible WC payers (see Appendix, http://links.lww.com/JOM/B825). Primary Payer: Claims paid by WC, with a positive payment amount. Claim Value Code: Claims with a "higher priority WC plan", paid conditionally by Medicare, although it is not indicated if WC ever reimbursed Medicare.[12] Claim-related Occurrence Code: Claims for an "accident" (event) with possible WC involvement. We used the claim-related occurrence code and date for "*Accident/employment related – The date of an accident relating to the patient's employment.*" Claim-related Condition: Work-related conditions that could be covered by WC may also appear on claims as "*Employment related – Patient alleged that the medical condition causing this episode of care was due to environment/events resulting from employment.*" Medicare non-payment reason: Lastly, Medicare may deny claims due to WC. We considered any injury claim work-related if it contained at least one of the above codes.

For our second method, we identified claims that included at least one ICD-10-CM diagnosis code for a possible work-related injury. The code list was compiled from prior literature specifying any mechanism, activity, place, or status for a work-related or agriculture-related injury (see Appendix, http://links.lww.com/JOM/B825).[31,32] We excluded several codes that seemed unlikely to involve older workers, such as codes involving the military.

After combining claims meeting the above injury and work-related definitions, we limited the cohort to enrollees with an injury event date no earlier than 30 days before the

hospitalization or outpatient visit. We often saw a spike in Medicare claims between the event date and the first work-related injury claim, suggesting they were from the injury episode. We therefore used this date to classify healthcare claims as occurring before or after the injury. Lastly, we stratified the work-related injury cohort into two groups: those with or without WC payment on their Medicare work-related injury claim.

Demographic and clinical measures

We used Medicare enrollment data to obtain demographic variables including age (continuous) and race and ethnicity categories from the Medicare record (White, Black, Asian, Hispanic, North American Native [referred to here as American Indian or Alaska Native], Other, Unknown). Rural and urban residence was determined from the enrollee county of residence by rural-urban continuum codes.[33] As a socioeconomic indicator, we noted if an individual was dually enrolled in Medicaid, since low-income enrollees may qualify for some healthcare benefits from their state Medicaid program.[34] Because patients with higher comorbidities could use more healthcare services and therefore have higher costs before and after an injury, we calculated the Charlson Comorbidity Index using a SAS macro from the National Cancer Institute (NCI).[35,36] We used inpatient claims to identify the length of hospital stay and receipt of intensive care unit services. We used both inpatient and outpatient claims to identify emergency department visits and surgical procedures.

Cost and healthcare utilization measures

We calculated patient out-of-pocket costs as the sum of all claim coinsurance/deductible amounts incurred in the relevant period (90-day immediate pre-injury and 90-day post-injury windows). This window was selected from past studies of healthcare utilization in the elderly.[37,38] We assigned costs from the injury event date onward to the "post-injury" phase. We

also measured total inpatient, outpatient, or skilled nursing facility claims incurred during the pre-injury and post-injury phases.

Statistical analysis

We compared WC and non-WC cohorts by demographic measures and characteristics of the initial injury claim using bivariate tests (chi-squared tests, t-tests or the Wilcoxon rank sum test as appropriate). We descriptively compared Outpatient, Inpatient, and Skilled Nursing Facility claims and patient costs in the 90 days pre and post-injury, comparing costs by claim type and in total. We assessed enrollment and claim variables to verify they were complete.

To estimate the effects of WC coverage on healthcare services and enrollee out-of-pocket costs, we compared pre/post-injury claim counts by claim type (outpatient or inpatient) with difference-in-differences and time series analyses. To fully capture this healthcare utilization, we included claims both paid and denied by Medicare. Using generalized estimating equation (GEE) models with a Poisson distribution and log link, we estimated the rate ratio (RR) of incurring a claim in the 90 days after the injury, compared to the 90 days before, and the relative rate ratio (RRR) between WC and non-WC groups. For the time series, we divided the study period into 24 weeks, with the injury occurring in week 13, allowing approximately 90 days of pre- and post-injury comparisons. For each week, we estimated the RR of incurring outpatient and inpatient claims, compared to the pre-injury week 1.

For out-of-pocket costs, we conducted a difference-in-differences analysis using linear mixed models to compare mean patient costs before and after the injury, by WC status. We ran quantile regression models to estimate the 50^{th}, 75^{th}, and 90^{th} quantiles of outpatient and total out-of-pocket costs at 30 and 90 days post-injury. Quantile regression presents a non-linear method of analyzing healthcare costs, which are often highly skewed in nature.[37,39]

For all models, we adjusted for age, race and ethnicity, sex, Medicare/Medicaid dual eligibility,rurality, state, mechanism of injury, total injury diagnoses, and comorbidity score. We also adjusted for the clinical treatment and outcomes of injury from hospital admission status total cost of the initial claim, and mortality within 90 days. We adjusted quantile regression models for 90-day pre-injury out-of-pocket costs. We performed all statistical analyses with SAS software version 9.4 (SAS Institute, Inc, Cary, NC, USA).

RESULTS

From 2016-2019, there were 13,039 Medicare fee-for-service enrollees with a Medicare work-related injury claim, and 16% of enrollees had this claim paid by WC (**Figure 1**). Compared to the non-WC group, the WC group was slightly younger, with a mean age of 71.3 vs 73.5 years, had a closer balance of male and female enrollees, a lower proportion of dually eligible enrollees, and less often resided in rural areas (**Table 1**). The non-WC group had slightly higher mean comorbidity scores and higher 90-day mortality than the WC group.

Table 1 also describes the index work-related injury claims. WC-paid and non-WC claims had similar rates of emergency department use, but the WC group was admitted to the hospital more often than the non-WC group (25.9% vs 21.8%). If hospitalized, both groups had a similar length of stay. Over half of WC-paid injuries were for falls, compared to 20.8% of the non-WC group, whose injuries were more often from transportation-related mechanisms. The mean cost of the initial claim, totaled from all payers, was over 2.5 times higher for the WC group than for the non-WC group.

Pre- and post-injury differences in healthcare utilization and out-of-pocket costs

For both WC and non-WC groups, healthcare utilization and out-of-pocket costs overall increased after a work-related injury (**Table 2**). However, compared with non-WC, the WC group had a 12% lower rate ratio of an outpatient claim after injury (RRR=0.88, 95% Confidence Limit (CL)=0.83, 0.93). Unique patterns emerge in healthcare utilization over the 90-day post-injury window. After the injury (Week 13), outpatient visits increased for the WC group (adjusted RR=1.86, 95% CL=1.53, 2.26) and the non-WC group (RR=3.20, 95% CL=3.05, 3.36) when compared to the pre-injury period (**Figure 2**). However, the WC group had a lower RR of an outpatient visit than the non-WC group (RRR=0.58, 95% CL=0.50, 0.67) (**Figure 2**). This difference persisted until four weeks after the injury (Week 16, RRR=0.72, 95% CL=0.61, 0.85). Thereafter, the WC group's outpatient visit rate did not differ from before the injury, but the non-WC group continued to have a higher rate of outpatient visits (Week 24 RR=1.31, 95% CL=1.24, 1.39). Both groups had an elevated risk of an inpatient stay from Week 13 to Week 17 compared to before the injury, but the trend persisted to Week 21 for the non-WC group. These rate increases did not differ by WC status after the injury (RRR=1.30, 95% CL=0.50, 3.37) or afterward.

The difference-in-differences analysis showed out-of-pocket costs increased in both groups after the injury (**Table 2**). The WC group's mean outpatient cost increased by $117 (95% CL= 91, 43) from the pre- to post-injury phase, which was $193 less (95% CL= -222, -165) than the mean increase of the non-WC group. Adding outpatient, inpatient, and skilled nursing facility costs together, the WC group saw a pre/post mean increase of $447 (95% CL=391, 503), still $331 less (95% CL=-392, -270) than the mean increase in the non-WC group.

Quantile regression revealed lower out-of-pocket costs for the WC group at the 50th, 75th, and 90th cost percentile, at 30 and 90 days post-injury (**Table 3**). After adjusting for pre-injury

out-of-pocket costs, demographic, and clinical characteristics, the WC group consistently owed less than the non-WC group for outpatient care alone and combined outpatient, inpatient, and SNF care. At 90 days, there was a $72 adjusted difference (95% CL= -87, -57) between median costs of $190 for the WC and $367 for non-WC groups. Costs differed greatly at the 90th percentile, where outpatient, inpatient, and SNF costs were $1,432 and $2,465 for WC and non-WC groups, respectively, an adjusted difference of $600 (95% CL= -767, -432).

DISCUSSION

As occupational injury costs are shifted from WC to public insurance like Medicare, older adults may be burdened with healthcare costs.[10,11,13] In this study, we identified Medicare fee-for-service enrollees with a work-related injury, grouped them into WC and non-WC cohorts, and compared post-injury changes to their healthcare services and costs incurred through Medicare. Regardless of WC status, Medicare inpatient and outpatient claim billing increased after a work-related injury, compared to before. Work-related injuries were associated with higher out-of-pocket costs for patients, but those with WC had lower out-of-pocket costs from the injury than those without WC.

Medicare was designed as a secondary payer to WC, but increases in Medicare billing after work-related injuries suggest that WC does not completely cover the costs of injury-related care. Whether Medicare enrollees obtain supplemental insurance, such as Medi-Gap, or have other health insurance besides Medicare, this likely creates a burden of patient cost, particularly without WC. Even with additional insurance options, Medicare enrollees may not foresee needing them before an injury, and supplemental plans may not cover deductibles. When surveyed on the affordability of healthcare, an estimated 12% of older Medicare enrollees report

problems paying medical bills or cost-related delays in care, increasing to 25% with lower health status.[40]

Our findings are consistent with other research. Asfaw et al. explored WC and commercial group health insurance claims, finding that compared to WC-paid claims, having an unpaid WC claim (i.e. zero cost) would result in at least 41% higher outpatient costs and 32% higher inpatient costs to patient GHI plans in the first 2-3 months after an injury.[6] In our model, mean out-of-pocket costs for outpatient services increased by approximately 120% for the WC-paid group and 300% for the non-WC-paid group, while total (inpatient, outpatient, and skilled nursing) costs increased by 220% for the WC-paid group and 300% for the non-WC-paid group (**Table 3**). Our results confirm that excess costs of work-related injuries are found in Medicare, and these costs are attenuated, at least in part, when WC is involved.

There are several possible explanations as to why the WC-paid group had lower out-of-pocket costs after a work-related injury than the non-WC-paid group. Patient responsibility may be lower on WC-paid Medicare claims. After confirming a WC payer, providers may have submitted fewer claims to Medicare, billing patients less often. Providers are instructed to bill Medicare with a zero-cost claim even when billing WC insurance, but our results could suggest this routine is not always followed.[12] WC claims would not be expected to have costs for the patient, so although we observed fewer Medicare inpatient and outpatient claims for the WC group, we have some certainty that *patient* costs were not billed elsewhere.

We complemented our difference-in-differences analysis with quantile regression, targeting higher cost percentiles. Of the services examined, quantile regression identified 10% of those without WC owing nearly $2,500 or more within 90 days of the injury. After adjustment, the WC group owed $600 less than the non-WC group at this percentile. This 90th percentile

group appeared to be older and more likely to live in rural areas (57% vs. 39%) than those in the lower percentiles. This reflects a broader pattern in healthcare literature that a smaller, more medically vulnerable group of patients often incurs the highest burden of healthcare costs.[20,40] For the work-related injury cohort, this vulnerability may come from age-related factors or difficulty obtaining workers' compensation.

Strengths and Limitations

A strength of our study was our precise estimate of enrollee costs, using exact dollar amounts from Medicare administrative claims. With individual identifiers in Medicare data, we were able to explore longitudinal costs before and after injuries. This allowed for the difference-in-differences design, a strong, quasi-experimental method used for causal inference in economic studies.[41] We could then identify excess costs beyond patients' typical healthcare use. Our study also uniquely leveraged the "accident" date from Medicare claims to define pre- and post-injury phases, which could precede the date of a work-related injury claim. Where these dates differed, our study was potentially still sensitive to pre- and post-injury changes in healthcare use.

Our study also benefits from a varied definition of work-related injuries, which allows us to test the sensitivity of our methods within subgroups. Using the more certain work-related codes that Medicare instructs providers to use, we still find an effect of WC on patient costs. For example, if we limit the non-WC group to Medicare codes for work-related "accidents" or "conditions" (N=1,742), their mean cost increase is still $204 higher over 90 days, compared to the WC group.

Our study also has limitations that must be acknowledged. First, these results are based on people enrolled in fee-for-service Medicare, ages 65 and older, with both Part A and B coverage. Those enrolled in Medicare Advantage or only Medicare Part A could be more or less

likely to utilize Medicare coverage for work-related injuries. Due to Medicare coding rules, we did not measure care (including follow-up) for minor injuries seen in offices or clinic settings. We focused on a 90-day post-injury window and did not attempt to estimate the long-term effects of work-related injuries. We still observed an elevated number of weekly claims at 90 days post-injury compared to 90 days before the injury. Future research may seek to estimate longer-term costs of injuries.

We adjusted for state in our models, considering variation is likely to occur from state WC policies and income limits to enroll in Medicaid, which could help pay for costs. While we observed state variation, our sample size limited comparisons between states. Notably, work-related injuries were associated with increased Medicare out-of-pocket in nearly every state. States averaged a pre-post injury increase of $648 in mean costs, from $376 (Delaware) to $1,367 (North Dakota), suggesting work-related injuries have financial impacts to Medicare enrollees throughout the US.

We are also limited by our time period. We establish effects before the COVID-19 pandemic, when Medicare billing trends were disrupted. Traditional Medicare spending fell by 6% in 2020, over half of which was for inpatient and outpatient hospital billing.[42] Labor force participation among older adults may be recovering from unemployment and labor force exit during the pandemic.[43] Still, factors driving this work persist – there were 10.8 million workers age 65 and older in 2023, and work fatality rates are still highest among 65 and older workers (8.8 fatal work injuries per 100,000 FTE in 2022), above all other age groups.[2,4] We have established effects here that may inform further research through these disruptions.

Lastly, our analysis relies only on information included in submitted claims, which cannot capture the full context of the injury or how workers' lives were impacted. Some enrollees

could have received WC only after claims were submitted. However, WC payments should result in claim adjustments, which would be included in the data. We also cannot determine work-related injuries that are not coded as such. Furthermore, we do not include all possible healthcare-related costs that could be the result of a work-related injury. We did not include data from all Medicare claim types, such as claims for physician office visits or prescription drugs. We cannot estimate lost wages or medical debt, which can be substantial.[5,23] We also cannot know whether the injured worker covered the out-of-pocket costs since Medicare data does not include an indicator for supplemental insurance, such as Medi-Gap policies, which can help Medicare enrollees with out-of-pocket costs.[21] Still, 1 in 10 traditional Medicare enrollees, as from the population in this study, has no other coverage besides Medicare, and Medicare enrollees often report problems paying their medical bills.[40,44] Despite these limitations, we believe the strengths of this work outweigh any weaknesses.

Conclusion

With more older adults working than ever before, work-related injuries will continue to impact the health of older Medicare enrollees and their costs for healthcare. In this study, we found evidence that workers' compensation may pay some healthcare costs for Medicare enrollees' work-related injuries but is overall inadequate, based on increases in healthcare billing through Medicare. The excess costs of work-related injuries potentially owed by Medicare enrollees appears higher than past studies of the general population. Even with WC, older adults may experience high combined costs from Medicare outpatient, inpatient, and skilled nursing claims. Future research is needed to explore these effects in the long term and understand barriers experienced by older adults to accessing workers' compensation. These findings

highlight a need to examine how state WC policies and the Medicare program may better serve the healthcare of older workers, so that among the many serious, lasting impacts of work-related injuries, paying for healthcare may not be a concern.

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Figure Legends

Figure 1. Medicare enrollees with a recent work-related injury, selection of WC and non-WC work-related injury cohorts.

Workers' compensation (WC)

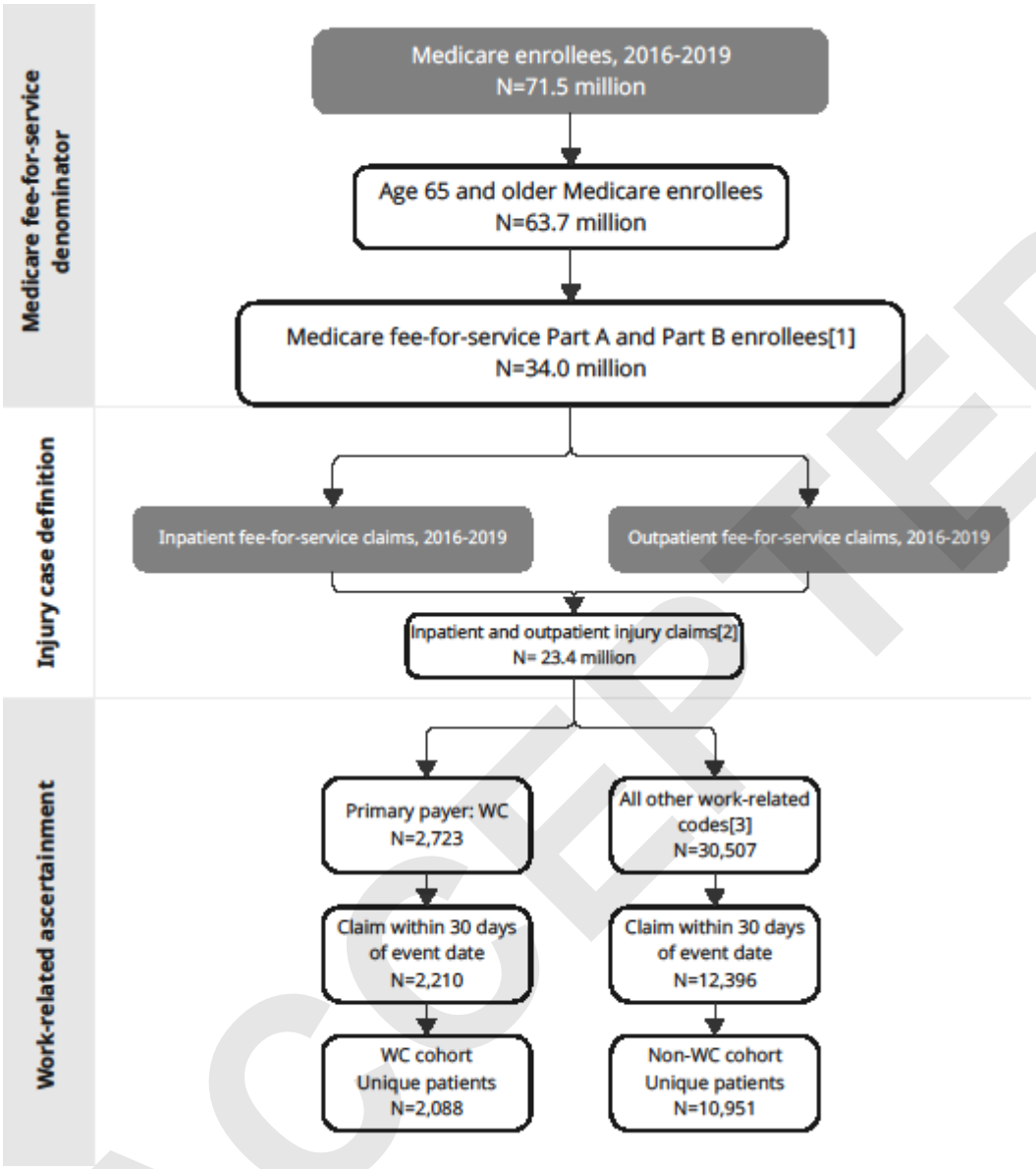
[1]Continuous annual enrollment in Medicare fee-for-service Part A and Part B

[2]Injury claims: any Inpatient or Outpatient claim with 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.

[3]Work-related ICD-10-CM codes, "higher priority WC plan" (but no WC payment), employment-related "accident" or condition

Figure 2. Time series analysis for rate ratio (RR) of Medicare Outpatient and Inpatient claims following a work-related injury, by workers' compensation status, 2016-2019.

Figure 1



Fifure 2

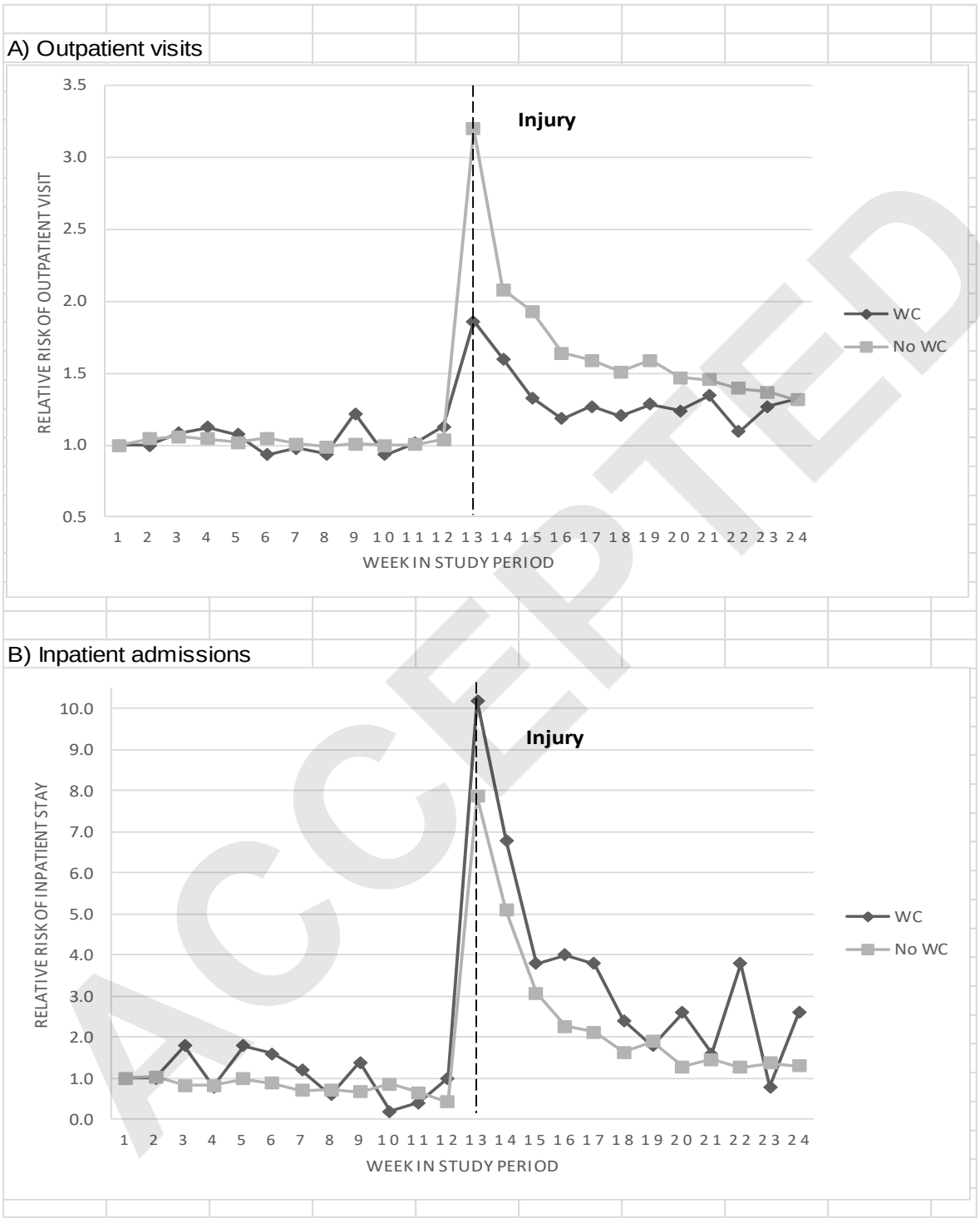


Table 1. Medicare enrollees with work-related injuries in the US from 2016-2019 (N=13,039), demographic and clinical characteristics by WC payment status.

		WC group (N=2,088)	Non-WC group (N=10,951)	*P* value[4]
Enrollee characteristics				
Age, Mean (SD)		71.3 (5.4)	73.5 (6.8)	< .001
Sex, N (%)				
	Male	1,157 (55.4)	8,384 (76.6)	< .001
	Female	931 (44.6)	2,567 (23.4)	
Race and ethnicity, N (%)				
	White	1,835 (87.9)	10,006 (91.4)	< .001
	Black	144 (6.9)	472 (4.3)	
	Asian	23 (1.1)	54 (0.5)	
	Hispanic	23 (1.1)	82 (0.8)	
	American Indian or Alaska Native	< 11 (<0.5)	47 (0.4)	
	Other	25 (1.2)	91 (0.8))	
	Unknown	< 42 (<2.0)	199 (1.8)	
Medicare/Medicaid dual-eligible, N (%)		103 (4.9)	837 (7.8)	< .001
Residence, N (%)				
	Rural	445 (21.3)	4,620 (42.9)	< .001
	Urban	1,643 (78.7)	6,160 (57.1)	
Year, N (%)				
	2016	491 (23.5)	3,132 (28.6)	< .001
	2017	533 (25.5)	2,735 (25.0)	

2018	539 (25.8)	2,590 (23.7)	
2019	525 (25.1)	2,494 (22.8)	
Injury characteristics			
Initial encounter setting, N (%)			
Outpatient	1,548 (74.1)	8,562 (78.2)	< . 001
Inpatient	540 (25.9)	2,389 (21.8)	
Services rendered, N (%)			
ED use, any	1,817 (87.0)	9,516 (86.9)	.882
OR use, any	372 (17.8)	1,533 (14.0)	< .001
ICU use, any	140 (6.7)	1,128 (10.3)	< .001
Mechanism of injury, N (%)			
Fall	1,058 (50.7)	2,277 (20.8)	< .001
Transportation	248 (11.9)	2,782 (25.4)	
Machinery	33 (1.6)	2,455 (22.4)	
Other mechanism	446 (21.4)	1,790 (16.4)	
Unspecified/missing	303 (14.5)	1,647 (15.0)	
Inpatient length of stay (days)			
Mean (SD)	5.7 (6.7)	6.0 (6.9)	.345
Median (IQR)	4.0 (2,6)	4.0 (2,7)	.701
Initial claim cost, $ (all payers)			
Mean (SD)	11390 (40,717)	4291 (15,533)	< .001
Median (IQR)	1455 (657, 7,714)	571 (231, 2,171)	< .001
Charlson Comorbidity Score			
Mean (SD)	0.8 (1.3)	1.1 (1.5)	< .001

Median (IQR)	0 (0,1)	0 (0,2)	< .001
Mortality within 90 days of injury, N (%)	28 (1.3)	301 (2.8)	<.001

Standard Deviation (SD); Emergency department (ED); Operating Room (OR); Intensive Care Unit (ICU); Interquartile range (IQR)

[4]*P*-value from Chi-square test (categorical variables), t-test (means), Wilcoxon rank-sum test (medians)

Table 2. Difference-in-differences analysis of Medicare claim counts and out-of-pocket costs (in USD), by workers' compensation status, 2016-2019.

Medicare claim counts billed by service type[5]

	WC group (N=2088)		**Non-WC group (N=10951)**		
Claim category	**Post / Pre Injury RR**	**(95% CL)**	**Post / Pre Injury RR**	**(95% CL)**	**RRR (95% CL)**
Outpatient	1.19	(1.13, 1.26)	1.36	(1.33, 1.38)	0.88 (0.83, 0.93)
Inpatient	2.88	(2.64, 3.16)	2.89	(2.64, 3.16)	1.00 (0.75, 1.32)

Medicare enrollee costs (total deductibles/coinsurance)[6]

	WC group (N=2088)			**Non-WC group (N=10951)**			
Enrollee cost category ($)	Pre-injury (95% CL)	Post-injury (95% CL)	Diff (95% CL)	Pre-injury (95% CL)	Post-injury (95% CL)	Diff (95% CL)	D-I-D (95% CL)
Outpatient costs, $	99 (53, 145)	216 (170, 263)	117 (91, 143)	101 (59, 144)	412 (370, 455)	310 (299, 322)	-193 (-222, -165)
Total costs[b], $	206	653	447	260	1,038	778	-331

(125, 287)	(571, 735)	(391, 503)	(187, 333)	(965, 1,112)	(754, 803)	(-392, -270)

Relative rate (RR); Relative rate ratio (RRR); Difference-in-differences (D-I-D)

[5]Models adjusted for age, race and ethnicity, sex, Medicare/Medicaid dual eligibility, rural residence, state, Charlson comorbidity index, the initial work-related injury claim type, initial claim year, total cost of the initial claim, mortality, the initial claim's mechanism of injury, and total number of injury diagnoses.

[6]Total of outpatient, inpatient, and SNF claim costs.

Table 3. Quantile regression estimates of the effect of WC status on Medicare enrollee out-of-pocket costs (in USD) after a work-related injury, 2016-2019.

	Enrollee cost percentile					
	50th	(95% CL)	75th	(95% CL)	90th	(95% CL)
Outpatient costs, $						
30-day						
WC	72	(59, 85)	170	(141, 198)	340	(246, 434)
Non-WC	147	(142, 151)	343	(331, 355)	863	(824, 903)
Diff (unadjusted)	-74	(-83, -66)	-174	(-190, -157)	-523	(-578, -469)
Diff (adjusted)[7]	-35	(-41, -29)	-75	(-87, -63)	-192	(-237, -148)
90-day						
WC	105	(91, 119)	224	(179, 269)	538	(423, 652)
Non-WC	203	(198, 209)	523	(503, 542)	1,287	(1,241, 1,333)
Diff (unadjusted)	-99	(-108, -89)	-298	(-324, -273)	-750	(-818, -681)
Diff (adjusted)[7]	-50	(-59, -40)	-129	(-150, -109)	-293	(-346, -241)
Total cost[8], $	**50th**	**95% CI**	**75th**	**95% CI**	**90th**	**95% CL**
30-day						
WC	141	(116, 167)	1,065	(821, 1,310)	1,352	(1,274, 1,430)
Non-WC	230	(222, 239)	1,316	(1,292, 1,330)	1,777	(1,741, 1,813)
Diff (unadjusted)	-89	(-106, -73)	-251	(-471, -30)	-425	(-467, -384)
Diff (adjusted)[7]	-45	(-52, -38)	-121	(-151, -92)	-357	(-495, -219)
90-day						

WC	190	(152, 229)	1,288	(1,238, 1,338)	1,432	(1,271, 1,593)
Non-WC	367	(350, 384)	1,438	(1,418, 1,458)	2,465	(2,387, 2,544)
Diff (unadjusted)	-177	(-198, -155)	-150	(-180, -120)	-1033	(-1,116, -951)
Diff (adjusted)[7]	-72	(-57, -87)	-210	(-269, -151)	-600	(-767, -432)

[7]Models adjusted for age, race and ethnicity, sex, Medicare/Medicaid dual eligibility, rural residence, state, Charlson comorbidity index, the initial work-related injury claim type, initial claim year, total cost of the initial claim, mortality, the initial claim's mechanism of injury and total number of injury diagnoses.

[8]Total enrollee Inpatient, Outpatient, and Skilled Nursing costs.

Clinical Significance: This study informs policies to expand workers' compensation access and reduce the financial burden of work-related injuries on older adults. It highlights implications for healthcare professionals, noting that medically vulnerable patients may incur higher costs from Medicare, particularly without workers' compensation.

STROBE Statement—Checklist of items that should be included in reports of ***cohort studies***

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	1
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	2
Objectives	3	State specific objectives, including any prespecified hypotheses	3
Methods			
Study design	4	Present key elements of study design early in the paper	4
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	4
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed	n/a
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5-7
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	5-7
Bias	9	Describe any efforts to address potential sources of bias	7,8

Study size	10	Explain how the study size was arrived at	6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	5-7
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	6,7
		(*b*) Describe any methods used to examine subgroups and interactions	11
		(*c*) Explain how missing data were addressed	6,8
		(*d*) If applicable, explain how loss to follow-up was addressed	8
		(*e*) Describe any sensitivity analyses	13
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	8,9
		(b) Give reasons for non-participation at each stage	8,9
		(c) Consider use of a flow diagram	8,9
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	8,9
		(b) Indicate number of participants with missing data for each variable of interest	8,9
		(c) Summarise follow-up time (eg, average and total amount)	8,9
Outcome data	15*	Report numbers of outcome events or summary measures over time	8
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	9
		(b) Report category boundaries when continuous variables were categorized	9
		(c) If relevant, consider translating estimates of relative risk into absolute risk	

		for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	13
Discussion			
Key results	18	Summarise key results with reference to study objectives	10,11
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	13,14
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	11,12
Generalisability	21	Discuss the generalisability (external validity) of the study results	13,14
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	Title page

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at http://www.strobe-statement.org.