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# Differential underestimation of work-related reinjury risk for older workers: Challenges to producing accurate rate estimates

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## Abstract

**Background:** Older workers are increasingly represented in the U.S. workforce, but frequently work part-time/intermittently, hindering accurate injury rate estimates. To reduce the impact of reporting barriers on rate comparisons, we focused on reinjury (both injury recurrence and new injury) among workers with a workers' compensation claim, assessing: (1) reinjury risk for workers age 65+ vs. <65; (2) importance of work-time at-risk measurement for rate estimates and comparisons; and (3) age distribution of potential risk factors.

**Methods:** Washington State workers' compensation claims for a retrospective cohort of workers with work-related permanent impairments were linked to state wage files. Reinjury rates were calculated for the cohort (N=11,184) and a survey sample (N=582), using both calendar time and full-time equivalent (FTE)-adjusted time. Risk differentials were assessed using rate ratios and adjusted survival models.

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**Authors' contributions:** JMS and SHJ participated in the conception and design of the work, JMS and DFK participated in acquisition of data, JMS conducted the analysis, and JMS drafted the work. All three authors participated in interpretation of data and revising the work critically for important intellectual content, provided final approval of the version to be published, and agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

**Institution and Ethics approval and informed consent:** This study was approved by the University of Washington Institutional Review Board. All survey participants gave informed consent. Administrative data provided to the researchers contained no direct identifiers.

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**Results:** The rate ratio for workers age 65+ (vs. <65) was 0.45 ($p$<0.001) using calendar time, but 0.70 ($p$=0.07) using FTE-adjusted time. Survey-based rates were 35.7 per 100 worker-years for workers age 65+, vs. 14.8 for <65. Workers age 65+ (vs. <65) were more likely to work <100% FTE, but were similar regarding job strain, ability to handle physical job demands, and comfort reporting unsafe conditions or injuries.

**Conclusions:** Accounting for work-time at risk substantially improves age-based reinjury comparisons. Although the marked elevation in self-reported reinjury risk for older workers might be a small-sample artifact (n=34), workers age 65+ are likely at higher risk than previously appreciated. Ongoing workforce trends demand increased attention to injury surveillance and prevention for older workers.

### Keywords

reinjury; occupational injuries; aged; workers' compensation; return to work; employment; workforce; permanent impairment; Medicare; surveillance

## 1 INTRODUCTION

Older workers account for an increasingly large share of the U.S. labor force.[1–3] Nearly 20% of Americans age 65 and older (65+) are employed.[3] Continued growth in labor force participation among older workers is anticipated, due to factors such as incentives designed to retain older workers for institutional memory and human capital, rising social security eligibility age, underfunded and vanishing pension programs, expanding options for part-time work after retirement, and increasing economic necessity.[1,2,4] Although participation in the labor force is increasing among older workers, older workers more frequently work part-time.[2,5] In fact, workers age 65+ are more than twice as likely to work part-time as are workers age 25–64.[5]

Work injuries among older workers are more severe, more costly, and more apt to result in work disability or death.[6–11] Workplace injuries constitute a significant threat to ongoing workforce participation by older adults; one study found that 17% of severely injured workers age 55+ planned to retire earlier due to their injury.[12] However, evidence for elevated incidence of work-related injuries among older workers is mixed. Same-level falls are more frequent among older workers,[9,13,14] and may lead to disproportionately severe injuries.[15] A study based on trauma registry data found markedly higher rates of serious work-related traumatic injuries among older workers; 2008 rates for workers 65+ were 31.8 per 100,000 workers, but 18.6 for age 55–64, and 17.9 for age 25–34.[16] In 2013, 4585 U.S. workers died from occupational injuries; the fatality rate for workers age 65+ was over twice the rate for those age 55–64, and over four times the rate for those age 20–24.[17] However, workers age 65+ are often excluded from studies of nonfatal work injuries, or grouped together with younger ages due to small numbers (i.e., older worker age categories specified as 40+, 50+, 60+, etc.).[18] Further, a few studies have reported markedly lower work-related injury risk beginning abruptly at the age 65+ threshold (compared to younger age categories; e.g., 55–64), which suggests that rate estimates may have been impacted by ascertainment and denominator issues.[19–22] For example, in one eight-state study, the rates of filed workers' compensation (WC) claims per 100,000 jobs were 5.0% lower for age 35–

44 compared to age 25–34, 8.5% lower for age 45–54 compared to age 35–44, 5.0% lower for age 55–64 compared to age 45–54, but a striking 45.2% lower for age 65+ compared to age 55–64.[19]

Despite the current sparsity and inconsistency of evidence for elevated occupational injury incidence among older workers (aside from same-level falls, severe trauma, and fatal injuries), there is ample reason to suspect that their risk may actually be higher than is currently understood, especially among workers age 65+. Aging-related health changes, including declines in vision and hearing, other functional disabilities, chronic health conditions, as well as cardiovascular, musculoskeletal, and neurological changes, impact risk of occupational injury.[4,11,23–26] Beyond health status, occupational injury risk is influenced by physical job demands, job strain, and other workplace factors.[26–29] In particular, a mismatch between physical ability and job demands among older workers has been associated with a higher risk of occupational injury.[30]

In addition to the many well-documented reporting barriers, ascertainment filters, and cost-shifting mechanisms that may affect surveillance and risk estimates for most injured workers,[31,32] there are at least two issues of particular concern with respect to accurately estimating work-related injury risk among older workers. First, work injury rate estimates—including those from nationally representative surveys—often use denominators based on resident or employed population size and calendar time, rather than individual work-time at risk. The use of calendar time assumes continuous employment and doesn't account for differences in work exposure between full-time and part-time workers. This approach may differentially underestimate injury rates for older workers, due to substantially higher part-time employment, intermittent work, delayed return to work after a previous injury, and/or retirement. An earlier related study provides an example of this phenomenon. Workers with permanent impairments were substantially (34%) more likely to be reinjured than other workers; but because workers with permanent impairments had more intermittent work patterns than other injured workers, their elevated reinjury risk was only detected when using denominators based on work-time at risk (vs. calendar time).[20]

Second, availability of another health insurer may reduce filing of WC claims and billing to WC by health care providers/facilities, and thereby reduce ascertainment of work-related injuries in health care databases. Multiple studies have found evidence of cost-shifting from WC to health insurance after occupational injuries.[32] Expanded health insurance coverage (i.e., via the Affordable Care Act or Massachusetts health care reform) was associated with 5% to 10% decreases in hospital and emergency department WC billing volume,[33–35] and conversely, a 10 percentage point decrease in health insurance coverage was associated with a 15% increase in Texas WC bills,[36] suggesting that broader access to health insurance may lower WC costs via cost-shifting mechanisms. Further, Medicare coverage is nearly universal beginning at age 65.[37] Workers age 65+ are the group most likely to have health insurance coverage and/or a funded retirement option as a potential alternative to filing a WC claim. For U.S. workers with Medicare, there is no question that WC should be the primary payer for occupational injuries. According to Medicare.gov, "If you have Medicare and get injured on the job, WC pays first."[38] However, a study using hospital discharge data from several states (1998–2009) found that roughly two-thirds of industrial injuries among

workers age 65+ were not billed to WC (and were primarily billed to Medicare instead); in stark contrast, approximately one-third of industrial injuries among workers under age 65 were not billed to WC (these were mostly billed to private health insurance or classified as self-pay).[39] Another study demonstrated that Washington State workers age 65+ with a work-related traumatic injury were substantially less likely to file a WC claim than workers under age 65 (64% vs. 39%, respectively).[40] Together, these two mechanisms (denominator-related or payer-related) could at least in part account for the lower work-related injury risk that is often reported to begin abruptly at the age 65+ threshold, via differentially hindering accurate rate estimates.

In the current study, we focused on risk of reinjury (vs. initial injury), in order to reduce the impact of barriers to WC claim filing on estimated rates and rate differentials (all workers included in this study had already filed at least one WC claim). Repeat work injuries affect as many as half of all injured workers.[41] Studies of work-related reinjury have generally found—paralleling more general occupational injury studies—that reinjury rates are lower for older workers.[6,41,42] However, only a few have estimated reinjury rates using at-risk denominators other than calendar time.[20,43] The aims of the current study were to use existing data for injured workers with work-related permanent impairments (a retrospective cohort and a survey sample) to further assess: (1) reinjury risk for older workers (defined for this study as workers 65+ years old), compared to younger workers (<65 years old); (2) the degree to which choice of timescale (at-risk denominator) affects reinjury risk estimates and comparisons by age; and (3) age distribution of health status, comorbidities, job strain, physical job demands, and other factors potentially associated with injury risk or injury reporting among older workers.

## 2 METHODS

### 2.1 Study setting

No-fault WC coverage for work-related injuries and illnesses is compulsory in Washington State.[44] The Washington State Department of Labor and Industries (L&I) administers the WC system, which includes the State Fund (covering about 70% of workers specified by Washington's Industrial Insurance Act[45]), and self-insured employers (covering the remaining 30%). Washington is one of only four states with no private WC insurers.[45,46] L&I administers the state WC system for both State Fund and self-insured employers, and maintains population-based administrative databases of WC claims, which facilitates population-based research.[45,46] In Washington State, impairment is defined as permanent anatomic or functional abnormality or loss of function, once maximum medical improvement has been achieved.[47] If, after completing treatment, workers have suffered permanent loss of function but are able to work, their degree of permanent impairment may be rated for a permanent partial disability (PPD) award at claim closure.[48]

### 2.2 Samples and data sources

This study relied on two distinct samples of workers with work-related permanent impairments: (1) a retrospective cohort, for whom we obtained administrative WC data and state wage data from mandatory unemployment insurance-related employer tax and

wage reports, and (2) a cross-sectional survey. A summary of similarities and differences in definitions and measures for the cohort and survey samples is presented in Table I. This study was approved by the University of Washington Institutional Review Board. All survey participants gave informed consent.

**2.2.1 Cohort—**We employed a retrospective cohort design, using administrative WC claims data along with state wage data to measure reinjury outcomes and work-time at risk among workers with a work-related injury involving a permanent impairment. The eligible cohort included injured workers with an accepted compensable State Fund WC claim that: (1) had an associated PPD award; (2) was the worker's first known WC claim filed in Washington State (i.e., the worker had no prior State Fund or self-insured claim); and (3) closed for the first time during 2009 to 2017, whether or not it later reopened (i.e., if there were multiple claim closure dates for a claim, the first claim closure date was used to determine cohort eligibility; claim reopenings or new claims subsequent to the first claim closure date were used to identify reinjury, as described in Section 2.3.1). Injured workers with self-insured employers were not included in the eligible cohort, due to incomplete medical billing data for those WC claims. Prior to delivering administrative data to the research team, L&I staff applied six exclusion criteria: (1) under age 18 when injured, (2) residence outside Washington State, (3) medical-only claims (<4 work days lost due to the injury, hence no time loss compensation), (4) fatal or total permanent disability claims, (5) confidentiality exclusions imposed by L&I (e.g., L&I employees), and (6) no valid Social Security number (necessary for linkage of administrative WC claims and quarterly wage data by L&I staff). Workers with no observed wages (no work-time at risk) during the follow-up period were excluded. The resulting eligible cohort consisted of 11,525 injured workers.

**2.2.2 Survey—**We also used data from a representative cross-sectional survey that we had conducted to gather information about the first year of work reintegration for a cohort of Washington State workers who had returned to work after a work-related permanent impairment and associated PPD award. The survey was conducted about a year after PPD rating and claim closure. Several months before the survey, we obtained L&I WC administrative data and contact information associated with closed claims for potentially eligible workers. We did not obtain state wage files for the survey sample, due to confidentiality restrictions.

Washington State workers were potentially eligible for this study if they met inclusion criteria by having an accepted State Fund or self-insured WC claim that closed with a PPD award between January 1, 2018 and April 30, 2018. Prior to delivering data to the research team, L&I staff applied six exclusion criteria: (1) no valid phone number on record; (2) under age 18 when injured; (3) total permanent disability (pension)—these workers are deemed unable to return to work; (4) residence outside Washington State; (5) L&I employees and other confidentiality exclusions imposed by L&I; and (6) fatality claims and deceased workers. L&I staff identified 2541 workers who were potentially eligible for the survey. Interviewers applied several additional exclusion criteria during eligibility screening: (1) language or comprehension barrier (excluded n=154); (2) no recall of WC claim or

impairment (excluded n=29); and (3) no return to work (excluded n=171), as determined by a worker's response to the question, "Have you returned to work since the injury that caused your impairment or disability, even if only very briefly?"

Trained interviewers conducted live telephone interviews using computer-assisted telephone interviewing technology (i.e., automated dialing, software-managed interview script, responses typed into the computer interface by interviewers). Interviews were conducted between February 6 and April 20, 2019, 11 to 15 months after claim closure (mean: 12.8 months). In total, 582 complete interviews were conducted, with a response rate of 52.2%. Respondents did not notably differ from nonrespondents with regard to age, gender, State Fund versus self-insured WC coverage, or the closed claim being their first Washington State WC claim. Further details regarding survey development, survey administration, numbers of ineligible workers excluded for specific criteria, response rate calculation, and nonresponse bias assessment are available in a previous publication.[49]

## 2.3 Reinjury outcomes

**2.3.1 Cohort—**After the eligible cohort was identified, further administrative data were obtained from L&I for these workers. These data included all WC claims subsequent to the initial claim through the end of 2018, regardless of claim status (e.g., medical-only, fatal, total permanent disability), and included both State Fund and self-insured claims. The operational definition of reinjury included both reopened claims (likely reflecting aggravation, exacerbation or recurrence of the initial injury) and new claims with dates of injury subsequent to the first closure of the initial claim (likely reflecting new injuries).[50,51]

**2.3.2 Survey—**For the survey sample, reinjury was ascertained by self-report. Reinjury was defined as an affirmative response to the question, "Since your claim closed about a year ago, have you had any new work injuries that resulted in at least one missed day from work?"

## 2.4 Predictors and covariates

**2.4.1 Cohort—**Worker and injury characteristics (i.e., gender, age at end of follow-up, preferred language, residence county, injured body part, degree of permanent impairment, comorbidities) were extracted from WC claims data. Urban-rural residence was based on the worker's residence county, and was classified using the six-level 2013 National Center for Health Statistics Urban-Rural Classification Scheme for Counties.[52] Degree of permanent impairment was classified into two mutually exclusive groups based on the permanent impairment rating for the initial injury: (1) a PPD award with whole body impairment (WBI) <10%, or (2) a PPD award with WBI ≥10%. We constructed a measure of WBI that would allow us to compare workers based on a conservative estimate of WBI percentage, regardless of the rating system used to produce an individual worker's rating or award. The resulting estimate can best be thought of as a lower bound estimate of WBI, based on the single largest contribution from the single impaired body part contributing most to WBI. A more detailed description of how WBI was constructed and classified can be found in an earlier publication.[49] Injured body part was based on the impaired body part used for the WBI percentage estimate, and categorized as spine/neck, upper extremity, lower extremity,

or other/multiple. We obtained WC medical billing data (professional and facility) for the first visit or admission for the initial injury, which was used to construct the Functional Comorbidity Index, which is an additive index of 18 chronic conditions, validated for predicting functional outcomes in community-based adult populations.[53,54]

Pre-injury quarterly wages were based on state wage data, averaged over the four quarters prior to the injury quarter, and adjusted to December 2018 dollars using the Consumer Price Index. Information about the job where the initial injury occurred included employer size, industry sector, and hazard group. Large employers were defined as those with ≥50 full-time equivalent (FTE) workers during the injury quarter. Industry sector was based on North American Industry Classification System (NAICS) two-digit sector codes, but was further collapsed into nine groups due to small numbers in some sectors: (1) Agriculture, Forestry, Fishing, Hunting (NAICS sector: 11); (2) Construction, Utilities, Mining (NAICS sectors: 21, 22, 23); (3) Manufacturing (NAICS sectors: 31, 32, 33); (4) Retail/Wholesale Trade (NAICS sectors: 42, 44, 45); (5) Transportation, Warehousing (NAICS sectors: 48, 49); (6) Information, Finance, Real Estate, Professional (NAICS sectors: 51, 52, 53, 54, 55); (7) Administrative, Support, Other Services (NAICS sectors: 56, 81, 92); (8) Education, Health Care, Social Services (NAICS sectors: 61, 62); and (9) Arts, Entertainment, Hospitality (NAICS sectors: 71, 72). Washington State assigns each employer to a hazard group, based on L&I-assigned employer risk class;[55] this was developed for WC insurance administration purposes, to estimate potential for loss (claim costs) by nature of business. Hazard group classifies employer risk from one (lowest risk) to nine (highest risk). We assigned a hazard group value for each worker in the cohort, based on the hazard group of the employer where the initial injury occurred.

**2.4.2 Survey—**Worker, injury, and job characteristics obtained or constructed from administrative data included gender, age when interviewed, WC coverage (State Fund versus self-insured employer), residence county, injured body part, degree of permanent impairment, industry sector, and hazard group. Industry sector and hazard group pertained to the employer where the worker was initially injured. Preferred language was based on self-reported data for the survey sample. Administrative data for pre-injury wages and employer size were not available for the survey sample; employer size was therefore based on self-reported data for the current/most recent job.

The survey provided data for a number of self-reported health and current/most recent job characteristics used to explore potential associations with age, including: health status (single item), presence and work interference for eight chronic conditions, presence and amount of pain and disability, health insurance coverage, work and retirement status, time worked in the same job (this refers to time worked in the worker's current/most recent job when interviewed, which may or may not have begun pre-injury), union membership, presence of health and safety committee, provision of job accommodations, health/care provider communication, safety training, safety climate,[56] social support (social, supervisor, coworker),[57] stigma, job strain, physical effort required by job, ability to handle the physical demands of the job, ability to take time off work for personal/family matters, comfort reporting unsafe work situations, comfort reporting work-related injuries, comfort filing a WC claim, perceived risk of reinjury, and perceived risk of losing job. Response categories

are listed in the pertinent Section 3 table. Further details about survey topics and questions can be found in two related publications.[27,49]

## 2.5 Time at risk

**2.5.1 Cohort—**A calendar timescale may overestimate work-time at risk (via the assumption of full employment during that time), yielding underestimated reinjury rates and potentially biased comparisons between worker subgroups having differential return-to-work patterns. In addressing this issue, state wage files provide an efficient but underused approach to identifying return-to-work patterns. State wage files from the Washington State Employment Security Department were used to construct at-risk denominators. These files include quarterly wages and hours worked for workers covered by unemployment insurance, which excludes self-employment and exempt occupations (e.g., independent contractors, real estate agents paid by commission, newspaper carriers, work for certain tax-exempt nonprofit organizations, domestic service workers and casual laborers not meeting specified dollar thresholds).[58] For comparison purposes, two timescales were used to measure time from first closure of the initial claim to the first reinjury or censoring: (1) calendar quarters (i.e., observed calendar time, regardless of wages/hours worked), and (2) FTE quarters (i.e., cumulative work hours divided by 520, approximating quarters of full-time work). Because a few workers had an impossibly high number of hours worked in some quarters, work hours were winsorized at 2,190 hours per quarter—the maximum possible hours if working around the clock (i.e., workers with >2,190 hours per quarter were retained but the value for hours was recoded to this cap). In sensitivity analyses, this procedure had negligible impact on estimates. Observation began at first closure of the initial claim, and data were censored on the earliest of four dates: (1) administrative follow-up end date (December 31, 2018), (2) total permanent disability effective date, (3) date of death, or (4) the end of the fourth quarter after the quarter during which the initial claim first closed (this provided a maximum follow-up time of 12–15 months after claim closure, comparable to survey timing).

**2.5.2 Survey—**In line with the rationale described in Section 2.5.1, two analogous timescales were used for the survey. Although not fully equivalent to the cohort timescales, the survey timescales allowed for comparable assessments of the importance of measuring work-time at risk: (1) calendar time (days between WC claim closure and the interview, regardless of time worked), and (2) FTE time (calendar time weighted by self-reported average percent time worked since WC claim closure, which was ascertained via the question, “Over the past year, since your claim closed, about what percent of the time have you worked, on average? For example, working half-time consistently would be 50%, or working full-time for 6 months and not at all for 6 months would also be 50%.”).

## 2.6 Data analysis

Analyses were conducted using Stata/MP 15.1 for Windows (StataCorp, College Station, TX, USA).[59] Level of significance was set at $p < 0.05$. For both the cohort and survey samples, crude reinjury rates per 100 worker-years were calculated using each of the two timescales (calendar time and FTE time). Age-based rate ratios were calculated using the Mantel-Cox method (finely stratified by time), and tested using the corresponding log-rank test.

**2.6.1 Cohort—**The amount of missing data was negligible (<2%) for all variables. We therefore used the subset of cases with complete data for all variables (retaining N= 11,184 injured workers, or 97.0% of the eligible cohort of 11,525 injured workers) for all analyses presented herein. Unadjusted and adjusted Cox proportional hazard regression models were used to estimate reinjury risk by age category (<65 vs. 65+); separate models were run using each of the two timescales. In line with methods used in a previously published related study of reinjury and permanent impairment,[20] adjusted models included all covariates described in Section 2.4.1 above, and were fully stratified by year of initial injury (i.e., coefficients were held equal across strata, but baseline hazards were unique to each initial injury year, which ran from 2003 to 2017). Robust variance estimates were used to produce 95% confidence intervals (CI). We also tested interactions between age category and degree of permanent impairment.

**2.6.2 Survey—**Survey data were used to assess associations between age category (<65 vs. 65+) and self-reported health and current/most recent job characteristics. Bivariate associations were tested using Pearson's chi-square test (binary or categorical variables), or unequal variances *t*-test (ordinal scales or continuous variables). Survey measures excluded the few workers who responded, "Don't know," or refused to answer. For many survey questions, responses were collapsed into binary variables or fewer categories for ease of presentation. Further details about the survey measures can be found in two related publications.[27,49]

## 3 RESULTS

Descriptive characteristics for the cohort and survey samples are presented in Table II. Workers ≥65 years old accounted for 4.5% (499/11,184) of the cohort sample, and 5.8% (34/582) of the survey sample ($p < 0.001$). Women workers accounted for 40.6% of the cohort sample, and 33.0% of the survey sample ($p < 0.001$). The cohort sample consisted solely of workers with State Fund WC claims; in contrast, 38.0% of the survey sample had WC claims covered by self-insured employers, which likely accounted for the higher prevalence of large employers in the survey sample (77.1%, relative to 50.9% for the cohort sample; $p < 0.001$). Both samples consisted solely of workers with a PPD award; 25.0% of workers in the cohort sample were in the WBI ≥10% category—a similar proportion as for the survey sample (22.5%; $p = 0.17$).

Pre-injury wages were based on state wage files, and available only for the cohort sample; the median adjusted pre-injury quarterly wage was $5823, and the mean was $7207 (SD: $6822). The Functional Comorbidity Index was also available only for the cohort sample, and ranged from 0 to 8 (of 18 chronic conditions); only 9.1% of the cohort had one or more chronic conditions, and the mean index value was 0.11 (SD: 0.39). Hazard group ranged from 1 to 9, with a median of 4 in both samples (hazard group was based on the employer where the initial injury occurred; a higher hazard group indicates higher estimated claim cost potential).

Cohort-based crude rates of first reinjury per 100 worker-years are presented for each timescale in Table III, stratified by age category. Very generally, use of the FTE timescale

nearly doubled the reinjury rates observed when using the calendar timescale. Notably, the lower reinjury risk observed for older workers when using the calendar timescale substantially narrowed and was no longer statistically significant when using the FTE timescale. The rate ratio for workers 65+ compared to workers <65 was 0.45 (95% CI: 0.30–0.67; $p < 0.001$) when using the calendar timescale, vs. 0.70 (95% CI: 0.47–1.04; $p = 0.07$) when using the FTE timescale.

Survey-based crude reinjury rates by age and timescale are presented in Table IV. There were substantial differences in self-reported average FTE over the past year for workers age 65+ compared to workers <65 (62.8% vs 83.5%; p = 0.003). Due to small numbers and few reinjuries in several cells, two age categories were collapsed into a single category containing workers age 18 to 34. Eight of the 34 workers age 65+ reported new injuries (23.5%), compared to 71 of the 548 workers <65 (13.0%; $p = 0.08$). In general, use of the FTE timescale produced higher rates than the calendar timescale, though not to the same degree as for the cohort-based analysis. Due to the relatively small sample size, confidence intervals were wide. The most striking difference from the cohort-based findings was that the survey-based reinjury rates for workers age 65+ were roughly double those for workers <65, using either timescale. The rate ratio for workers age 65+ compared to workers <65 was 1.92 (95% CI: 0.91–4.06; $p = 0.08$) using the calendar timescale, and 2.22 (95% CI: 1.05–4.66; $p = 0.03$) using the FTE timescale.

Using the cohort sample, we used unadjusted and adjusted regression models to estimate reinjury risk by age category, for each timescale in turn (Table V). Testing for interactions between age and degree of permanent impairment revealed no notable or statistically significant findings; therefore, interaction terms were dropped from all regression models. Adjustment for covariates tended to slightly narrow the observed age gap in reinjury risk using either timescale, with no impact on conclusions. However, adjustment for work-time at risk was more important and led to a greatly diminished—and statistically non-significant—risk differential (Table V).

Table VI presents exploratory data from the survey sample regarding associations between age category and self-reported health and job characteristics. The purpose of this analysis was to identify possible mechanisms for differential reinjury rates among older workers, with a focus on workers ≥65 years old. The survey included few workers ≥65 years old (n=34), and there were few statistically significant associations; thus, we focused on identifying general patterns. Compared to workers <65 years old, workers age 65+ had worked significantly and substantially longer in the same job, and were less likely to have changed occupations since their permanent impairment. Older workers were significantly less likely to work full-time, either in their current/most recent job or averaged over the previous year, and less likely to be union members when interviewed. Older workers were also significantly less certain they would be working in six months, less likely to be working for pay when interviewed, and—among the subset not working—more likely to report retirement as the primary reason for not working. All workers ≥65 years old reported having health insurance, compared to 90.2% of younger workers; however, workers ≥65 years old were significantly less likely to have health insurance coverage via an employer than were younger workers. Compared to workers <65 years old, workers age 65+ were more often

satisfied with their job (97.0% vs. 83.7%; $p = 0.04$). Though not statistically significant, workers age 65+ less often reported being at higher risk of reinjury or job loss due to their permanent impairment, but more often reported both comfort with filing WC claims and actually filing a WC claim for a reinjury they had incurred. Notably, there was no substantial or statistically significant difference by age category in self-reported ability to handle the physical demands of their current/most recent job, nor in whether their job requires a lot of physical effort.

In a previous related study of workplace organizational and psychosocial factors associated with return-to-work interruption and reinjury among workers with permanent impairments, which was based on the same survey, several workplace factors were found to be associated with lower reinjury risk (i.e., comfort reporting an unsafe situation at work, presence of health and safety committee, low job strain, ability to take time off work for personal/family matters, organization-level and group-level safety climate, social support, supervisor support).[27] Survey findings for these workplace factors are shown in Table VI. For this set of workplace factors, there were no significant associations with age category, and all leaned in the protective direction among older workers, with the sole exception of presence of a health and safety committee. We also assessed associations with a number of other workplace factors included in the survey (i.e., adequate health care/employer communication, adequate safety training, stigmatized for permanent impairment by supervisor or coworkers, provision of job accommodations, coworker support).[27] None of these additional factors were significantly associated with age category, patterns were unremarkable, and estimates generally leaned in the protective direction among older workers (data not shown).

Compared to workers <65 years old, workers age 65+ tended to report better health and functional status and less pain and pain interference with work, though differences were not statistically significant (Table VI). Workers age 65+ more frequently reported having five of the eight chronic conditions assessed compared to workers <65, though there were statistically significant differences for only two conditions. Older workers were significantly more likely to report arthritis (50.0% vs 24.6%; $p = 0.001$) and diabetes (23.5% vs 10.5%, $p = 0.02$). The mean number of self-reported chronic conditions was 1.53 (SD: 1.05) for workers age 65+ compared to 1.35 (SD: 1.37) among workers <65 ($p = 0.36$). Despite assessing only eight of the 18 Functional Comorbidity Index conditions, these estimates were higher than mean Functional Comorbidity Index estimates from the administrative cohort data (65+ = 0.29, <65 = 0.10; $p < 0.001$). However, mean differences in number of chronic conditions (65+ compared to <65) were roughly comparable for the survey and cohort samples (survey: 0.18 [95% CI: −0.21, 0.56]; cohort: 0.19 [95% CI: 0.13, 0.25]). The subset of workers with each chronic condition was asked to what degree the condition interfered with their ability to work. There were no statistically significant or remarkable patterns by age category, and for all conditions but chronic back pain/disease, estimates leaned in the direction of older workers less frequently reporting that the condition at least somewhat interfered with their ability to work (data not shown).

# 4 DISCUSSION

## 4.1 Choice of timescale (at-risk denominator)

In this study, we demonstrated the importance of using a timescale that reflects work-time at risk (versus calendar time) when estimating reinjury risk by age. Using calendar time consistently underestimated reinjury rates for all groups, as compared to using FTE time; moreover, accounting for work-time at risk was particularly important when comparing age groups with differential employment patterns (i.e., differential prevalence of part-time work or employment interruptions). The survey documented substantial differences in self-reported average FTE over the past year since claim closure between workers age 65+ and workers under age 65. We have previously demonstrated the importance of using appropriate at-risk denominators/timescales when assessing reinjury risk elevation associated with work-related permanent impairment, which also impacts employment patterns.[20] The remainder of this discussion focuses on estimates produced using the FTE timescale, which we consider to be more accurate.

## 4.2 Reinjury risk by age

Using cohort data and the FTE timescale, the unadjusted rate ratio for workers age 65+ compared to workers <65 was 0.70 ($p = 0.07$). (In adjusted models, the risk gap narrowed to 0.77; $p = 0.20$.) However, using survey data and the FTE timescale, we found that unadjusted reinjury rates for workers age 65+ were over twice those for workers <65 (2.22; $p = 0.03$). Although we don't want to make too much of this survey's findings, which included only a small number of workers age 65+ (n=34 of N=582), we must note that these findings provide no support for the frequent statement that workers age 65+ are at lower risk of injury compared to younger workers—quite the opposite. Our findings reinforce the prospect that surveillance challenges and ascertainment biases may be driving that common perception.

## 4.3 Age distribution of factors potentially associated with injury risk, reporting, or ascertainment

In our exploratory analysis of associations between age category and self-reported health and job characteristics, we focused on identifying possible mechanisms for the markedly higher self-reported reinjury rate among workers ≥65 years old (vs. younger workers). We found no evidence that higher reinjury rates among workers ≥65 years old were related to being at higher risk due to health status, chronic conditions, or impact of permanent impairment. On the contrary, older workers tended to report better health and functional status, less pain and pain interference with work, and lower perceived risk of reinjury or job loss due to their permanent impairment. Only arthritis and diabetes were significantly more frequent among older workers. Among workers reporting a chronic condition, age was generally not associated with whether the condition interfered with work; this counterintuitive finding might be due to the healthy worker effect, i.e., older workers who experienced such interference may have retired rather than returning to work at all, which would have made them ineligible for this survey.

Beyond health status, occupational injury risk is influenced by physical job demands, job strain, and other workplace factors.[26–29] In particular, a mismatch between physical ability and job demands among older workers has been associated with a higher risk of occupational injury.[30] However, in this survey, we found no evidence that higher reinjury rates were related to being at higher risk due to job demands or workplace conditions. On the contrary, older workers were more often satisfied with their job, and age was not associated with ability to handle physical job demands, job strain, or physical effort required. This may in part reflect voluntary or involuntary sorting into lower-risk jobs or tasks. Age was also not associated with workplace psychosocial and organizational factors; in fact, most of these factors leaned in the protective direction for older workers. In general, these findings align with findings from a large population-based occupational injury outcomes study that compared numerous health and workplace factors by age.[7]

One possible explanation for the higher survey-based rate among workers age 65+ (vs. younger workers) might be higher levels of part-time, contingent, or precarious employment among older workers on average,[2,5,23] and particularly among older workers with disabilities.[60] In our study, older (vs. younger) workers were less likely to: be working in a full-time traditional job, be union members, have a health and safety committee at work, or have employer-based health insurance. Although older (vs. younger) workers had worked substantially longer in the same job, they were less certain they would still be working in six months. Many of these indicators of job precarity may be tied to beneficial/adaptive employment choices and/or easing into elective retirement; nevertheless, they may have an impact on reinjury risk. Workers age 65+ did not significantly differ from younger workers regarding several measures of occupational health and safety vulnerability sometimes used to indicate job precarity,[61,62] including comfort with reporting an unsafe work situation, reporting a work injury, or filing a WC claim. These issues related to job precarity will require further research to untangle.

It is also possible that the higher survey-based rate among workers age 65+ (vs. younger workers) is, at least in part, related to the reinjury definition. Workers were asked about injuries resulting in at least one missed day from work. Older workers are more likely to have more serious injuries,[6–11] and thus more likely to need—and perhaps also more likely to be able—to take time off work in response to a work injury. In general, databases with a higher severity bar (e.g., trauma registries, hospital discharge databases, death registries) tend to include more older injured workers than those with a low severity bar (e.g., self-reported injury with no work loss requirement). However, it seems unlikely that the fairly low-bar severity threshold used in the survey could fully account for the more than two-fold difference in self-reported reinjury rates for workers age 65+ compared to workers under age 65. Though somewhat speculative, it is possible that the combination of more part-time/intermittent work and more serious injury consequences among older workers may contribute to their higher self-reported reinjury rates compared to younger workers.

This study's focus on reinjury incidence among workers who had already filed a WC claim may have partially mitigated the impact of underreporting on WC-based ascertainment, and hence for cohort-based rates. Once rates from both data sources were adjusted for FTE time, survey-based rates were lower than cohort-based rates for workers <65 years

old (14.8 vs. 18.2 per 100 worker-years, respectively), perhaps related to differences in the reinjury definition. The survey definition required at least one day of missed work, regardless of whether a WC was reopened or filed, while reopening or filing a WC claim to meet the cohort definition did not necessarily require any missed days of work (the cohort definition of reinjury included new medical-only claims). However, survey-based rates were substantially higher than cohort-based rates for workers age 65+ (35.7 vs. 13.2 per 100 worker-years, respectively). The fact that payer (i.e., use of Medicare or other health insurance for a work injury, rather than WC) would be expected to impact the cohort estimates (reinjury based on WC claim filing) but not the survey estimates (reinjury based on self-report), may at least partially account for this observation. Almost all workers are eligible for Medicare at age 65, so access to health insurance (and potential cost-shifting) escalates abruptly at that age threshold.[37,39] The availability of retirement as an alternative to WC claim filing also might differentially reduce filing of WC claims by workers age 65+.

### 4.4 Implications for equity, policy, surveillance, and research

This study focuses on an issue of increasing interest to the occupational health field–the aging workforce.[4,23] Workers age 65+ constitute a growing segment of the workforce, and one for whom the risks and burdens of workplace injury (aside from falls) have been underappreciated to date. An enhanced focus on injury prevention, one that includes attention to the exposure risks most affecting older workers (the identification of which could be facilitated by more accurate surveillance among older workers), could reduce occupational injury and death among a group at high risk of poor outcomes, and could also reduce injury-related early retirement.[4,12]

This study did not find evidence that age-related associations with workplace factors such as physical job demands, job strain, and other workplace factors might account for the increased reinjury rates reported by older workers; however, previous research has found that a mismatch between physical ability and job demands among older workers has been associated with a higher risk of occupational injury.[30] Further research in this area is needed, as well as more research on the topic of how the higher prevalence of part-time/intermittent work among older workers and women workers might affect (1) injury risk and (2) prevention strategies.

To improve surveillance accuracy for older workers and other worker subgroups who may have differential employment patterns (e.g., women workers, disabled workers), researchers need easier access to FTE/work hour-based denominators, whether via state wage data or other sources. The National Academies of Sciences, Engineering, and Medicine[63] report presented recommendations for more comprehensive national and state-based occupational injury/illness surveillance. Although our study did not specifically address cost-shifting mechanisms (e.g., billing work injuries to Medicare or private health insurance vs. WC), it does reinforce the importance of understanding their potential implications for rates estimated from administrative data sources. Cost-shifting can occur for many reasons, including not reporting or documenting the work-relatedness of a particular injury/illness (e.g., a worker might wish to avoid stigma or employer retribution,[64] or a health care provider might wish to minimize administrative/legal burden or maximize reimbursement[65]).

Cost-shifting mechanisms can negatively impact accurate occupational injury surveillance and identification of particular subgroups at risk, by leading to differential underestimates of risk and burden.[20,32] As the working population ages and more workers continue working past age 65, cost-shifting from WC to Medicare may increasingly impair surveillance efforts.[39] Shifting costs away from WC also obscures responsibility for identifying and mitigating occupational injury/illness.[32]

### 4.5 Strengths and limitations

Strengths of this study included the large population-based cohort with linkage to state wage files. This enabled us to avoid conflating the end of time loss compensation with actual return to work, thereby avoiding an inherent limitation of reinjury studies that rely solely on WC claims data and do not measure employment directly.[41,42,66,67] Though common practice, using the end of time loss compensation as a proxy for return to work leads to underestimation of time lost from work,[68] as well as to underestimation of reinjury rates via inflated at-risk denominators. State wage files are an efficient but underused approach for identifying return-to-work patterns.[69] Using wage files, we were able to measure time worked (and thus reinjury rates) irrespective of time loss payments.

This study also had several limitations. First, both the cohort and survey sample were limited to workers with work-related permanent impairments, which may limit generalizability. Second, identification of reinjury among the cohort sample relied on reopening or filing a WC claim, and many work-related injuries are not reported to WC, particularly among workers age 65+.[31,39,70] This limitation may have been mitigated by the fact that this cohort of workers had already filed an initial WC claim. However, reinjury definitions based on WC claims generally result in lower risk estimates compared to definitions based on recurrence of pain or health care utilization;[71] as such, our WC-based reinjury estimates are likely to be conservative. Third, state wage files do not capture earnings for workers who are self-employed or work in exempt occupations.[58] A study based on the Current Population Survey found that self-employment rates were higher among workers with limitations, compared to workers without limitations, and the self-employment differential also increased with education and age.[72] Such differential inclusion in wage files may have affected our reinjury estimates for age subgroups, to an unknown degree. Fourth, covariates based on administrative data have measurement limitations. For example, the WBI variable was essentially a lower bound estimate.[49] Further, the finding that only 9.1% of the cohort had one or more of the chronic conditions contained in the Functional Comorbidity Index was almost certainly an underestimate, because diagnoses unrelated to the WC injury may not be reported to WC for billing purposes.[54] Fifth, it is possible that workers who were reinjured may have been either more or less likely to participate in the survey. We identified no consequential nonresponse bias for a number of variables (e.g., State Fund vs. self-insured coverage, age at injury, gender, adjusted pre-injury wage, urban–rural residence, injury type, injury severity),[49] but did not have the necessary data to assess nonresponse bias related to reinjury outcomes. Sixth, although no consequential nonresponse bias was identified, the survey had some features that may limit generalizability, including: (1) interviews were conducted only in English; and (2) respondents reported a high prevalence of union membership (42.2%), more than double the estimated 19.8% for Washington State

in 2018.[73] Finally, and perhaps most importantly, very few workers in the survey sample were age 65+ (n=34). This was an exploratory study; more research is needed to replicate and extend these findings.

## 5 CONCLUSIONS

Using calendar time (vs. FTE-adjusted time) underestimates reinjury risk. Accounting for work-time at risk substantially improves comparisons by age category, due to differential employment patterns. When using calendar time, workers age 65+ appeared less than half as likely to be reinjured as workers under age 65; in contrast, when using FTE-adjusted time, the observed risk differential was halved and no longer statistically significant. Furthermore, survey data suggested that workers age 65+ may have well over twice the self-reported reinjury rate of younger workers. This increased risk was not explained by differences in self-reported ability to handle physical job demands, job strain, or various other work factors. It must be noted that this increased reinjury risk might be an artifact of the small number of interviewed workers who were age 65+ (n=34). Although further research is needed to assess whether these conclusions hold for larger samples of older workers, and for initial injury incidence in addition to reinjury, workers age 65+ are likely at higher risk of work-related injury and reinjury than is generally appreciated. The common perception that older workers are injured less frequently may be due to inadequate measurement of work-time at risk and/or to incomplete injury ascertainment in administrative databases related to differential health insurance coverage and reporting (e.g., related to older workers' use of Medicare and/or retirement as an alternative to WC claim filing). Ongoing workforce trends demand increased attention to injury surveillance and prevention for older workers.

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## Data Availability Statement:

The data that support the findings of this study are not available for data-sharing due to privacy and third party restrictions.

## REFERENCES

1. Kromer B, Howard D. Labor Force Participation and Work Status of People 65 Years and Older. American Community Survey Briefs; U.S. Census Bureau. ACSBR/11–09.Washington, DC: U.S. Government Printing Office; 2013.
2. U.S. Census Bureau. 65+ in the United States: 2010. P23–212.Washington, DC: U.S. Government Printing Office; 2014.
3. DeSilver D More older Americans are working, and working more, than they used to. Pew Research Center. 2016; http://www.pewresearch.org/fact-tank/2016/06/20/more-older-americans-are-working-and-working-more-than-they-used-to/. Accessed September 9, 2021.

4. Silverstein M Meeting the challenges of an aging workforce. Am J Ind Med. 2008;51(4):269–280. [PubMed: 18271000]
5. Schramm J Older Workers and Part-Time Employment. Fact Sheet 640, February 2018. 2018; https://www.aarp.org/ppi/info-2018/older-workers-and-part-time-employment.html. Accessed July 30, 2020.
6. Berecki-Gisolf J, Clay FJ, Collie A, McClure RJ. The impact of aging on work disability and return to work: insights from workers' compensation claim records. J Occup Environ Med. 2012;54(3):318–327. [PubMed: 22371057]
7. Pransky GS, Benjamin KL, Savageau JA, Currivan D, Fletcher K. Outcomes in work-related injuries: a comparison of older and younger workers. Am J Ind Med. 2005;47(2):104–112. [PubMed: 15662646]
8. Mallon TM, Cherry SE. Investigating the relationship between worker demographics and nature of injury on Federal Department of Defense workers' compensation injury rates and costs from 2000 to 2008. J Occup Environ Med. 2015;57 Suppl 3:S27–30. [PubMed: 25741611]
9. Centers for Disease Control and Prevention. Nonfatal occupational injuries and illnesses among older workers --- United States, 2009. MMWR Morb Mortal Wkly Rep. 2011;60(16):503–508. [PubMed: 21527887]
10. Steege AL, Baron SL, Marsh SM, Menendez CC, Myers JR. Examining occupational health and safety disparities using national data: A cause for continuing concern. Am J Ind Med. 2014;57(5):527–538. [PubMed: 24436156]
11. Smith P, Bielecky A, Ibrahim S, et al. Impact of pre-existing chronic conditions on age differences in sickness absence after a musculoskeletal work injury: a path analysis approach. Scand J Work Environ Health. 2014;40(2):167–175. [PubMed: 24173365]
12. Pransky GS, Benjamin KL, Savageau JA. Early retirement due to occupational injury: who is at risk? Am J Ind Med. 2005;47(4):285–295. [PubMed: 15776469]
13. Layne LA, Pollack KM. Nonfatal occupational injuries from slips, trips, and falls among older workers treated in hospital emergency departments, United States 1998. Am J Ind Med. 2004;46(1):32–41. [PubMed: 15202123]
14. Drebit S, Shajari S, Alamgir H, Yu S, Keen D. Occupational and environmental risk factors for falls among workers in the healthcare sector. Ergonomics. 2010;53(4):525–536. [PubMed: 20309748]
15. Sterling DA, O'Connor JA, Bonadies J. Geriatric falls: injury severity is high and disproportionate to mechanism. J Trauma. 2001;50(1):116–119. [PubMed: 11231681]
16. Sears JM, Bowman SM, Adams D, Silverstein BA. Occupational injury surveillance using the Washington State Trauma Registry. J Occup Environ Med. 2011;53(11):1243–1250. [PubMed: 22068129]
17. U.S. Department of Labor, Bureau of Labor Statistics. Injuries, Illnesses, and Fatalities. http://www.bls.gov/iif/data.htm. Accessed July 17, 2018.
18. Peng L, Chan AHS. A meta-analysis of the relationship between ageing and occupational safety and health. Saf. Sci 2019;112:162–172.
19. Tattrie D, Gotz GA, Liu T. Workers' compensation and the changing age of the workforce. WC-00–6. Cambridge, MA: Workers Compensation Research Institute; 2000.
20. Sears JM, Schulman BA, Fulton-Kehoe D, Hogg-Johnson S. Estimating time to reinjury among Washington State injured workers by degree of permanent impairment: using state wage data to adjust for time at risk. Am J Ind Med. 2021;64(1):13–25. [PubMed: 33210293]
21. Fan J, McLeod CB, Koehoorn M. Descriptive epidemiology of serious work-related injuries in British Columbia, Canada. PLoS One. 2012;7(6):e38750. [PubMed: 22723884]
22. Schoenfisch AL, Lipscomb H, Phillips LE. Safety of union home care aides in Washington State. Am J Ind Med. 2017;60(9):798–810. [PubMed: 28744929]
23. Bohle P, Pitts C, Quinlan M. Time to call it quits? The safety and health of older workers. Int J Health Serv. 2010;40(1):23–41. [PubMed: 20198802]
24. Zwerling C, Sprince NL, Davis CS, Whitten PS, Wallace RR, Heeringa SG. Occupational injuries among older workers with disabilities: a prospective cohort study of the Health and Retirement Survey, 1992 to 1994. Am J Public Health. 1998;88(11):1691–1695. [PubMed: 9807538]

25. Zwerling C, Whitten PS, Davis CS, Sprince NL. Occupational injuries among older workers with visual, auditory, and other impairments. A validation study. J Occup Environ Med. 1998;40(8):720–723. [PubMed: 9729756]
26. Zwerling C, Sprince NL, Wallace RB, Davis CS, Whitten PS, Heeringa SG. Risk factors for occupational injuries among older workers: an analysis of the Health and Retirement Study. Am J Public Health. 1996;86(9):1306–1309. [PubMed: 8806386]
27. Sears JM, Schulman BA, Fulton-Kehoe D, Hogg-Johnson S. Workplace organizational and psychosocial factors associated with return-to-work interruption and reinjury among workers with permanent impairment. Annals of Work Exposures and Health. 2021;65(5):566–580. [PubMed: 33843964]
28. Smith P, Bielecky A, Koehoorn M, et al. Are age-related differences in the consequence of work injury greater when occupational physical demands are high? Am J Ind Med. 2014;57(4):438–444. [PubMed: 24464769]
29. Smith PM, Berecki-Gisolf J. Age, occupational demands and the risk of serious work injury. Occup Med (Lond). 2014;64(8):571–576. [PubMed: 25168227]
30. Fraade-Blanar LA, Sears JM, Chan KC, Thompson HJ, Crane PK, Ebel BE. Relating older workers' injuries to the mismatch between physical ability and job demands. J Occup Environ Med. 2017;59(2):212–221. [PubMed: 28166127]
31. Azaroff LS, Levenstein C, Wegman DH. Occupational injury and illness surveillance: conceptual filters explain underreporting. Am J Public Health. 2002;92(9):1421–1429. [PubMed: 12197968]
32. 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(3):223–235. [PubMed: 31018756]
33. Armour P, Goutam P, Heaton P. Health Insurance and Workers' Compensation Claiming: Evidence from the Affordable Care Act. Santa Monica, CA: RAND Institute for Civil Justice; 2016.
34. Bronchetti ET, McInerney MP. Does Increased Access to Health Insurance Impact Claims for Workers' Compensation? Evidence from Massachusetts Health Care Reform. Upjohn Institute Working Paper 17–277. Kalamazoo, MI: W.E. Upjohn Institute for Employment Research; 2017.
35. Heaton P The Impact of Health Care Reform on Workers' Compensation Medical Care: Evidence from Massachusetts. Santa Monica, CA: RAND Corporation; 2012.
36. Dillender M The effect of health insurance on workers' compensation filing: Evidence from the affordable care act's age-based threshold for dependent coverage. J Health Econ. 2015;43:204–228. [PubMed: 26272545]
37. Cohen RA, Terlizzi EP, Cha AE, Martinez ME. Health insurance coverage: early release of estimates from the National Health Interview Survey, 2020. 2021; 10.15620/cdc:108816. Accessed March 28, 2022.
38. Centers for Medicare and Medicaid Services. Which insurance pays first. 2015; http://www.medicare.gov/supplement-other-insurance/how-medicare-works-with-other-insurance/who-pays-first/which-insurance-pays.html#collapse-2507. Accessed July 11.
39. Sears JM, Bowman SM, Blanar L, Hogg-Johnson S. Industrial injury hospitalizations billed to payers other than workers' compensation: characteristics and trends by state. Health Serv Res. 2017;52(2):763–785. [PubMed: 27140591]
40. Sears JM, Bowman SM, Adams D, Silverstein BA. Who pays for work-related traumatic injuries? Payer distribution in Washington State by ethnicity, injury severity, and year (1998–2008). Am J Ind Med. 2013;56(7):742–754. [PubMed: 23460116]
41. Ruseckaite R, Collie A. The incidence and impact of recurrent workplace injury and disease: a cohort study of WorkSafe Victoria, Australia compensation claims. BMJ Open. 2013;3(3):e002396.
42. Cherry NM, Sithole F, Beach JR, Burstyn I. Second WCB claims: who is at risk? Can J Public Health. 2010;101 Suppl 1:S53–57. [PubMed: 20629448]
43. Lipscomb HJ, Cameron W, Silverstein B. Incident and recurrent back injuries among union carpenters. Occup Environ Med. 2008;65(12):827–834. [PubMed: 18611968]
44. Rothkin K Workers' Compensation Laws as of January 1, 2019. WC-19–22. Cambridge, Mass.: Workers Compensation Research Institute; 2019.

45. Franklin GM, Wickizer TM, Fulton-Kehoe D, Turner JA. Policy-relevant research: when does it matter? NeuroRx. 2004;1(3):356–362. [PubMed: 15717038]
46. Franklin GM, Fulton-Kehoe D. Outcomes research in Washington state workers' compensation. Am J Ind Med. 1996;29(6):642–648. [PubMed: 8773724]
47. Washington State Department of Labor and Industries. Medical Examiners' Handbook. Publication F252–001-000. Olympia, WA 2019.
48. Washington State Department of Labor and Industries. Permanent Partial Disability. PPD Award Schedules. https://lni.wa.gov/claims/for-workers/claim-benefits/permanent-partial-disability. Accessed May 17, 2020.
49. Sears JM, Schulman BA, Fulton-Kehoe D, Hogg-Johnson S. Workforce reintegration after work-related permanent impairment: a look at the first year after workers' compensation claim closure. J Occup Rehabil. 2021;31(1):219–231. [PubMed: 32651725]
50. Gross DP, Battie MC. Work-related recovery expectations and the prognosis of chronic low back pain within a workers' compensation setting. J Occup Environ Med. 2005;47(4):428–433. [PubMed: 15824635]
51. Oranye NO. Nature of Injury and risk of multiple claims among workers in Manitoba health care. Workplace Health Saf. 2018;66(2):70–83. [PubMed: 28918696]
52. Ingram DD, Franco SJ. 2013 NCHS Urban–Rural Classification Scheme for Counties. Vital Health Statistics. Vol 2. Washington, DC: National Center for Health Statistics; 2014.
53. Groll DL, To T, Bombardier C, Wright JG. The development of a comorbidity index with physical function as the outcome. J Clin Epidemiol. 2005;58(6):595–602. [PubMed: 15878473]
54. Sears JM, Rundell SD. Development and testing of compatible diagnosis code lists for the Functional Comorbidity Index: International Classification of Diseases, Ninth Revision, Clinical Modification and International Classification of Diseases, 10th Revision, Clinical Modification. Med Care. 2020;58(12):1044–1050. [PubMed: 33003052]
55. State of Washington. Washington Administrative Code 296–17-901. Risk classification hazard group table. Effective June 30, 2017. https://apps.leg.wa.gov/wac/default.aspx?cite=296-17-901. Accessed June 18, 2020.
56. Huang Y, Lee J, Chen Z, Perry M, Cheung J, Wang M. An item-response theory approach to safety climate measurement: the Liberty Mutual Safety Climate Short Scales. Accid Anal Prev. 2017;103:96–104. [PubMed: 28391093]
57. Landsbergis PA, Schnall PL, Pickering TG, Schwartz JE. Validity and reliability of a work history questionnaire derived from the Job Content Questionnaire. J Occup Environ Med. 2002;44(11):1037–1047. [PubMed: 12448355]
58. Washington State Employment Security Department. Occupations Exempted from Unemployment Insurance Coverage. https://esdorchardstorage.blob.core.windows.net/esdwa/Default/ESDWAGOV/employer-Taxes/ESD-exempt-professions-chart.pdf. Accessed October 1, 2020.
59. StataCorp. Stata Statistical Software: Release 15. College Station, TX: StataCorp LLC; 2017.
60. Jetha A, Martin Ginis KA, Ibrahim S, Gignac MAM. The working disadvantaged: the role of age, job tenure and disability in precarious work. BMC Public Health. 2020;20(1):1900. [PubMed: 33302930]
61. Edmonds AT, Sears JM, O'Connor A, Peckham T. The role of nonstandard and precarious jobs in the well-being of disabled workers during workforce reintegration. Am J Ind Med. 2021;64(8):667–679. [PubMed: 34003515]
62. Lay AM, Saunders R, Lifshen M, et al. The relationship between occupational health and safety vulnerability and workplace injury. Saf. Sci 2017;94:85–93.
63. National Academies of Sciences, Engineering, and Medicine. A Smarter National Surveillance System for Occupational Safety and Health in the 21st Century. Washington, DC: The National Academies Press; 2018.
64. Galizzi M, Miesmaa P, Punnett L, Slatin C. Injured workers' underreporting in the health care industry: an analysis using quantitative, qualitative, and observational data. Ind Relat (Berkeley). 2010;49(1):22–43. [PubMed: 29725137]

65. Butler RJ, Hartwig RP, Gardner H. HMOs, moral hazard and cost shifting in workers' compensation. J Health Econ. 1997;16(2):191–206. [PubMed: 10169094]

66. Berecki-Gisolf J, Clay FJ, Collie A, McClure RJ. Predictors of sustained return to work after work-related injury or disease: insights from workers' compensation claims records. J Occup Rehabil. 2012;22(3):283–291. [PubMed: 22143197]

67. Ruseckaite R, Collie A. Repeat workers' compensation claims: risk factors, costs and work disability. BMC Public Health. 2011;11:492–499. [PubMed: 21696637]

68. Dasinger LK, Krause N, Deegan LJ, Brand RJ, Rudolph L. Duration of work disability after low back injury: a comparison of administrative and self-reported outcomes. Am J Ind Med. 1999;35(6):619–631. [PubMed: 10332515]

69. Reville RT, Bhattacharya J, Sager Weinstein LR. New methods and data sources for measuring economic consequences of workplace injuries. Am J Ind Med. 2001;40(4):452–463. [PubMed: 11598994]

70. Fan ZJ, Bonauto DK, Foley MP, Silverstein BA. Underreporting of work-related injury or illness to workers' compensation: individual and industry factors. J Occup Environ Med. 2006;48(9):914–922. [PubMed: 16966958]

71. Wasiak R, Pransky GS, Webster BS. Methodological challenges in studying recurrence of low back pain. J Occup Rehabil. 2003;13(1):21–31. [PubMed: 12611028]

72. Gouskova E Why self-employment rates are higher among people with work limitations. J. Disabil. Policy Stud 2020;31(1):15–25.

73. Bureau of Labor Statistics. Union Membership (Annual) News Release, 2018. https://www.bls.gov/news.release/archives/union2_01182019.htm. Accessed January 21, 2021.

**Table I**

Summary of similarities and differences in definitions and measures for the cohort and survey samples

| Feature | Cohort (administrative data) | Survey (self-reported data) |
|---|---|---|
| Sample size | N=11,184 | N=582 |
| WC claim closure dates | January 1, 2009 through December 31, 2017 | January 1, 2018 through April 30, 2018 |
| First known WC claim | Cohort identification based on first WC claim in Washington State | Not restricted to first-known WC claims; 68.2% of 582 respondents had a prior WC claim in Washington State |
| WC coverage | Initial cohort restricted to workers with State Fund claims; among that cohort, both State Fund and self-insured subsequent claims were used to measure reinjury | Workers with either State Fund or self-insured claims |
| Reinjury definition | Initial State Fund claim was reopened, or new State Fund or self-insured WC claim was filed, after initial WC claim closure | Self-reported presence of at least one new injury since WC claim closure that resulted in at least one day lost from work |
| PPD eligibility | Restricted to workers with a PPD award | Restricted to workers with a PPD award |
| Return to work eligibility | Workers with no observed wages (no work-time at risk) during the follow-up period were excluded | Workers with a negative response to the following question were excluded: “Have you returned to work since the injury that caused your impairment or disability, even if only very briefly?” |
| Observation period | The quarter during which the initial WC claim first closed and 4 additional quarters (12–15 months after WC claim closure) | Time since WC claim closure (11–15 months) |
| Timescales | (1) Calendar quarters; (2) FTE quarters: hours worked/520 (state wage data) | (1) Calendar time (days between WC claim closure and the interview); (2) FTE time (calendar time weighted by self-reported average percent time worked since WC claim closure) |
| Year of injury | Ranged from 2003 through 2017; median 2011; 13% injured before 2008 | Ranged from 1991 through 2018; median 2016; <10% injured before 2013 |
| Age | Measured at end of follow-up | Measured at interview date |
| Chronic conditions | Professional/facility WC billing data for the first visit/ admission for the initial injury was used to construct the Functional Comorbidity Index (18 chronic conditions) | Self-reported presence of each of 8 specified chronic conditions since WC claim closure |

Abbreviations: FTE, full-time equivalent; PPD, permanent partial disability; WC, workers’ compensation.

## Table II

Worker, injury, and pre-injury job characteristics for cohort and survey samples (unless otherwise noted, variables for both samples were comparably constructed using administrative data)

| Characteristic | Cohort (N=11,184) | | Survey (N=582) | | *p* [a] |
|---|---|---|---|---|---|
| | n | (%) | n | (%) | |
| Age category (years) | | | | | <0.001 |
| 18–24 | 901 | (8.1%) | 14 | (2.4%) | |
| 25–34 | 2749 | (24.6%) | 62 | (10.7%) | |
| 35–44 | 2774 | (24.8%) | 115 | (19.8%) | |
| 45–54 | 2442 | (21.8%) | 159 | (27.3%) | |
| 55–64 | 1819 | (16.3%) | 198 | (34.0%) | |
| ≥65 | 499 | (4.5%) | 34 | (5.8%) | |
| Women (vs. men) | 4540 | (40.6%) | 192 | (33.0%) | <0.001 |
| Preferred language [b] | | | | | <0.001 |
| English | 8686 | (77.7%) | 569 | (97.8%) | |
| Spanish | 2149 | (19.2%) | 11 | (1.9%) | |
| Other | 349 | (3.1%) | 2 | (0.3%) | |
| Urban-rural residence county | | | | | <0.001 |
| Large central metropolitan | 2603 | (23.3%) | 116 | (20.2%) | |
| Large fringe metropolitan | 3337 | (29.8%) | 202 | (35.2%) | |
| Medium metropolitan | 2165 | (19.4%) | 126 | (22.0%) | |
| Small metropolitan | 1796 | (16.1%) | 58 | (10.1%) | |
| Micropolitan | 1034 | (9.2%) | 55 | (9.6%) | |
| Noncore | 249 | (2.2%) | 17 | (3.0%) | |
| Injured body part | | | | | 0.001 |
| Upper extremity | 5074 | (45.4%) | 282 | (48.5%) | |
| Lower extremity | 2939 | (26.3%) | 174 | (29.9%) | |
| Spine/neck | 2569 | (23.0%) | 92 | (15.8%) | |
| Other/multiple | 602 | (5.4%) | 34 | (5.8%) | |
| Whole body impairment (WBI) ≥10% (vs. <10%) | 2791 | (25.0%) | 131 | (22.5%) | 0.17 |
| Large employer, ≥50 FTE (vs. <50 FTE) [c] | 5694 | (50.9%) | 433 | (77.1%) | <0.001 |
| Industry sector | | | | | <0.001 |
| Agriculture, Forestry, Fishing, Hunting | 949 | (8.5%) | 6 | (1.0%) | |
| Construction, Utilities, Mining | 1757 | (15.7%) | 75 | (12.9%) | |
| Manufacturing | 960 | (8.6%) | 78 | (13.4%) | |
| Retail/Wholesale Trade | 1692 | (15.1%) | 74 | (12.7%) | |
| Transportation, Warehousing | 501 | (4.5%) | 36 | (6.2%) | |
| Information, Finance, Real Estate, Professional | 767 | (6.9%) | 25 | (4.3%) | |
| Services: Administrative, Support, Waste, Other | 1902 | (17.0%) | 144 | (24.7%) | |

| Characteristic | Cohort (N=11,184) | | Survey (N=582) | | *p* [a] |
|---|---|---|---|---|---|
| | n | (%) | n | (%) | |
| Education, Health Care, Social Services | 1545 | (13.8%) | 112 | (19.2%) | |
| Arts, Entertainment, Hospitality | 1111 | (9.9%) | 32 | (5.5%) | |
| State Fund coverage (vs. self-insured employer) | 11,184 | (100%) | 361 | (62.0%) | N/A[d] |

Abbreviations: FTE, full-time equivalent; N/A, not applicable.

[a] *p* value reflects two-sample Chi-square test of independence.

[b] Preferred language: For cohort, based on administrative data; for survey sample, based on self-report.

[c] Employer size: For cohort, based on administrative data for pre-injury employer; for survey sample, based on respondent's estimate of current/most recent employer's total number of employees.

[d] Statistical testing not feasible due to lack of variation in cohort

## TABLE III

Cohort data (N=11,184): Reinjury rates per 100 worker-years (unadjusted), by age and timescale

| | | Calendar quarters | | FTE quarters (hours worked/520) | |
|---|---|---|---|---|---|
| | | **Rate** | **(95% CI)** | **Rate** | **(95% CI)** |
| Overall | 11,184 | 11.0 | (10.4–11.7) | 18.0 | (17.0–19.1) |
| 18–24 | 901 | 15.5 | (13.1–18.4) | 23.5 | (19.8–27.8) |
| 25–34 | 2749 | 11.7 | (10.5–13.1) | 18.2 | (16.3–20.4) |
| 35–44 | 2774 | 12.0 | (10.7–13.4) | 19.5 | (17.4–21.7) |
| 45–54 | 2442 | 10.4 | (9.2–11.8) | 17.2 | (15.2–19.5) |
| 55–64 | 1819 | 9.0 | (7.7–10.6) | 14.6 | (12.5–17.0) |
| 65+ | 499 | 5.1 | (3.5–7.6) | 13.2 | (8.9–19.5) |
| <65 | 10,685 | 11.3 | (10.7–12.0) | 18.2 | (17.1–19.2) |

Abbreviations: CI, confidence interval; FTE, full-time equivalent.

## Table IV

Survey data (N=582): Reinjury rates per 100 worker-years (unadjusted), by age and timescale

| | | Calendar time | | FTE time | |
|---|---|---|---|---|---|
| **Category** | **N** | **Rate** | **(95% CI)** | **Rate** | **(95% CI)** |
| Overall | 582 | 12.9 | (10.4–16.1) | 15.7 | (12.6–19.6) |
| 18–34 | 76 | 11.3 | (5.9–21.6) | 13.5 | (7.0–25.9) |
| 35–44 | 115 | 13.3 | (8.2–21.8) | 15.5 | (9.5–25.4) |
| 45–54 | 159 | 13.2 | (8.7–20.1) | 16.2 | (10.7–24.6) |
| 55–64 | 198 | 11.5 | (7.7–17.2) | 13.7 | (9.2–20.5) |
| 65+ | 34 | 22.7 | (11.4–45.5) | 35.7 | (17.8–71.3) |
| <65 | 548 | 12.3 | (9.8–15.6) | 14.8 | (11.7–18.7) |

Abbreviations: CI, confidence interval; FTE, full-time equivalent; WC, workers' compensation.

## TABLE V

Cohort data (N=11,184): Unadjusted and adjusted regression models of reinjury risk, by age and timescale

| Characteristic/Model | Calendar quarters | | | FTE quarters (hours worked/520) | | |
|---|---|---|---|---|---|---|
| **Unadjusted: Age** | **HR** | **95% CI** | ***p*** | **HR** | **95% CI** | ***p*** |
| 65+ years old (Ref: <65 years old) | 0.45 | 0.31–0.67 | <0.001 | 0.70 | 0.47–1.03 | 0.07 |
| **Adjusted** | **HR** | **95% CI** | ***p*** [a] | **HR** | **95% CI** | ***p*** [a] |
| 65+ years old (Ref: <65 years old) | 0.46 | 0.31–0.68 | <0.001 | 0.77 | 0.52–1.15 | 0.20 |
| Women (Ref: Men) | 0.83 | 0.72–0.95 | 0.007 | 0.95 | 0.82–1.09 | 0.46 |
| Preferred language (Ref: English) | | | 0.048 | | | 0.02 |
| Spanish | 1.02 | 0.86–1.20 | | 0.95 | 0.80–1.12 | |
| Other | 0.60 | 0.39–0.90 | | 0.55 | 0.36–0.84 | |
| Urban-rural residence county (Ref: Large central metropolitan) | | | 0.053 | | | 0.005 |
| Large fringe metropolitan | 1.07 | 0.92–1.25 | | 1.17 | 1.00–1.37 | |
| Medium metropolitan | 0.98 | 0.82–1.17 | | 1.02 | 0.85–1.22 | |
| Small metropolitan | 0.93 | 0.76–1.13 | | 0.93 | 0.76–1.14 | |
| Micropolitan | 0.84 | 0.66–1.06 | | 0.80 | 0.63–1.02 | |
| Noncore | 0.54 | 0.32–0.90 | | 0.61 | 0.36–1.03 | |
| Injured body part (Ref: Spine/neck) | | | 0.12 | | | 0.80 |
| Upper extremity | 1.18 | 1.00–1.39 | | 1.04 | 0.87–1.23 | |
| Lower extremity | 1.21 | 1.01–1.44 | | 1.02 | 0.85–1.23 | |
| Other/multiple | 0.96 | 0.71–1.30 | | 0.89 | 0.66–1.20 | |
| WBI ≥10% (Ref: WBI <10%) | 1.02 | 0.88–1.19 | 0.77 | 1.28 | 1.09–1.51 | 0.002 |
| Functional Comorbidity Index | 0.94 | 0.80–1.12 | 0.50 | 0.99 | 0.83–1.18 | 0.88 |
| Pre-injury wages ($10,000 increments) | 1.00 | 0.92–1.08 | 0.97 | 0.61 | 0.54–0.68 | <0.001 |
| Large employer, ≥50FTE (Ref: <50 FTE) | 1.13 | 1.00–1.27 | 0.045 | 1.03 | 0.91–1.16 | 0.66 |
| Industry sector (Ref: Information, Finance, Real Estate, Professional) | | | 0.02 | | | 0.07 |
| Agriculture, Forestry, Fishing, Hunting | 1.19 | 0.85–1.66 | | 1.15 | 0.82–1.61 | |
| Construction, Utilities, Mining | 0.80 | 0.60–1.07 | | 0.93 | 0.69–1.26 | |
| Manufacturing | 1.26 | 0.95–1.68 | | 1.19 | 0.89–1.59 | |
| Retail/Wholesale Trade | 0.85 | 0.65–1.12 | | 0.81 | 0.62–1.07 | |
| Transportation, Warehousing | 1.05 | 0.74–1.48 | | 1.09 | 0.77–1.54 | |
| Administrative, Support, Other Services | 1.05 | 0.81–1.36 | | 1.09 | 0.84–1.42 | |
| Education, Health Care, Social Services | 1.07 | 0.81–1.40 | | 1.09 | 0.82–1.44 | |
| Arts, Entertainment, Hospitality | 1.05 | 0.78–1.43 | | 1.11 | 0.81–1.51 | |
| Hazard group [b] | 1.02 | 0.98–1.05 | 0.37 | 1.04 | 1.00–1.07 | 0.048 |

*Note:* In addition to covariates shown, models were fully stratified by year of initial injury (baseline hazard unique to each year).

Abbreviations: CI, confidence interval; FTE, full-time equivalent; HR, hazard ratio; WBI, whole body impairment; Ref, reference category.

[a] *p* value on referent line reflects joint test for set of categories within variable.

[b] The HR represents the estimated increase in risk for each one-unit increase in hazard group (values ranged from 1 to 9).

**Table VI.**

Survey data (N=582): Self-reported health and job characteristics, by age

| Characteristics | Overall (N=582) | | <65 years old (n=548) | | 65+ years old (n=34) | | *p* |
|---|---|---|---|---|---|---|---|
| **Categorical measures** | **n** | **(%)** | **n** | **(%)** | **n** | **(%)** | |
| Current/most recent job is full-time traditional (vs. part-time, temporary, seasonal, self-employed) | 482 | (83.0%) | 460 | (84.1%) | 22 | (64.7%) | 0.004 |
| Worked 100% FTE over past year, on average (vs. <100%) | 359 | (61.7%) | 345 | (63.0%) | 14 | (41.2%) | 0.01 |
| Returned to work with different (vs. same) employer where injured | 161 | (27.7%) | 156 | (28.5%) | 5 | (14.7%) | 0.08 |
| Current occupation different than (vs. same as) when injured | 173 | (29.9%) | 169 | (31.0%) | 4 | (11.8%) | 0.02 |
| Working for pay (vs. not) when interviewed | 513 | (88.1%) | 489 | (89.2%) | 24 | (70.6%) | 0.001 |
| Retirement was primary reason not working when interviewed (N=69) | 20 | (29.0%) | 13 | (22.0%) | 7 | (70.0%) | 0.002 |
| Certain (vs. uncertain) will be working in 6 months | 451 | (80.7%) | 431 | (81.5%) | 20 | (66.7%) | 0.046 |
| Current union member (vs. not) | 246 | (42.5%) | 239 | (43.9%) | 7 | (20.6%) | 0.008 |
| Health insurance coverage (vs. not) from employer) | 360 | (62.9%) | 346 | (64.3%) | 14 | (41.2%) | 0.007 |
| Health insurance coverage from any source (vs. none) | 520 | (90.8%) | 486 | (90.2%) | 34 | (100%) | 0.055 |
| Satisfied (vs. dissatisfied) with job | 483 | (84.4%) | 451 | (83.7%) | 32 | (97.0%) | 0.04 |
| At (vs. not at) higher risk of being reinjured at work due to impairment, compared to before injury | 365 | (65.2%) | 347 | (65.8%) | 18 | (54.5%) | 0.19 |
| At (vs. not at) higher risk of being reinjured at work due to impairment, compared to others doing same job | 300 | (54.2%) | 285 | (54.7%) | 15 | (45.5%) | 0.30 |
| At (vs. not at) higher risk of losing current job due to impairment | 101 | (20.3%) | 98 | (20.7%) | 3 | (12.5%) | 0.33 |
| Comfortable (vs. not comfortable) reporting unsafe situation at work to supervisor/employer | 553 | (95.8%) | 520 | (95.8%) | 33 | (97.1%) | 0.71 |
| Comfortable (vs. not comfortable) reporting work-related injury to supervisor/employer | 547 | (95.1%) | 515 | (95.2%) | 32 | (94.1%) | 0.78 |
| Comfortable (vs. not comfortable) filing WC claim for work-related injury | 515 | (90.4%) | 484 | (90.1%) | 31 | (93.9%) | 0.47 |
| Most recent work injury resulted (vs. did not result) in WC claim (N=70) | 53 | (75.7%) | 46 | (74.2%) | 7 | (87.5%) | 0.41 |
| Presence (vs. absence) of health and safety committee | 408 | (76.1%) | 387 | (76.6%) | 21 | (67.7%) | 0.26 |
| High (vs. low) job strain | 85 | (15.4%) | 81 | (15.5%) | 4 | (13.3%) | 0.75 |
| Job requires a lot of physical effort (vs. does not) | 438 | (76.7%) | 415 | (77.1%) | 23 | (69.7%) | 0.33 |
| Current health status is good/very good/excellent (vs. fair/poor) | 422 | (72.5%) | 395 | (72.1%) | 27 | (79.4%) | 0.35 |
| Current work function ability is good/very good/excellent (vs. fair/poor) | 399 | (69.0%) | 372 | (68.4%) | 27 | (79.4%) | 0.18 |
| Still have (vs. do not have) disability/pain/limitation due to work injury | 538 | (92.6%) | 509 | (93.1%) | 29 | (85.3%) | 0.09 |
| Bodily pain in past 4 weeks was moderate to very severe (vs. none/very mild) | 381 | (65.5%) | 362 | (66.1%) | 19 | (55.9%) | 0.23 |
| Pain interfered with work in past 4 weeks somewhat to very much (vs. not at all/a little bit) | 231 | (39.8%) | 221 | (40.4%) | 10 | (29.4%) | 0.20 |
| Presence of chronic conditions | | | | | | | |
| Arthritis | 151 | (26.1%) | 134 | (24.6%) | 17 | (50.0%) | 0.001 |
| Chronic back pain/disease | 140 | (24.3%) | 136 | (25.0%) | 4 | (12.1%) | 0.09 |
| Depression | 122 | (21.0%) | 119 | (21.8%) | 3 | (8.8%) | 0.07 |

| Characteristics | Overall (N=582) | | <65 years old (n=548) | | 65+ years old (n=34) | | *p* |
|---|---|---|---|---|---|---|---|
| Anxiety | 94 | (16.2%) | 91 | (16.6%) | 3 | (8.8%) | 0.23 |
| Obesity | 83 | (14.5%) | 78 | (14.4%) | 5 | (14.7%) | 0.97 |
| Upper gastrointestinal disease | 71 | (12.2%) | 66 | (12.1%) | 5 | (14.7%) | 0.65 |
| Asthma | 68 | (11.7%) | 61 | (11.2%) | 7 | (20.6%) | 0.10 |
| Diabetes | 65 | (11.2%) | 57 | (10.5%) | 8 | (23.5%) | 0.02 |
| **Continuous measures (for all, higher values are protective)** | **Mean** | **(SD)** | **Mean** | **(SD)** | **Mean** | **(SD)** | |
| Years in the same job | 9.2 | (10.4) | 8.7 | (9.9) | 18.5 | (14.0) | <0.001 |
| Able to handle physical job demands | 7.9 | (2.3) | 7.9 | (2.3) | 7.7 | (2.3) | 0.56 |
| Able to take time off work for personal/family matters | 4.0 | (1.3) | 4.0 | (1.3) | 4.2 | (1.1) | 0.17 |
| Organization-level safety climate[a] | 4.0 | (1.2) | 4.0 | (1.2) | 4.1 | (0.9) | 0.51 |
| Group-level safety climate[b] | 3.9 | (1.3) | 3.9 | (1.3) | 3.9 | (1.2) | 0.95 |
| Social support[c] | 6.8 | (1.3) | 6.8 | (1.3) | 7.0 | (1.3) | 0.40 |
| Supervisor support[d] | 3.3 | (0.9) | 3.3 | (0.9) | 3.5 | (0.9) | 0.33 |

Abbreviations: FTE, full-time equivalent.

[a]Mean of 4-item instrument, each item with 5-point scale; Safety Climate Short Scales - organization level (top management) subscale[56]

[b]Mean of 4-item instrument, each item with 5-point scale; Safety Climate Short Scales - group level (direct supervisor) subscale[56]

[c]Sum of 2-item instrument (coworker and supervisor helpfulness), each with 4-point scale; Work History Questionnaire[57]

[d]Single item (supervisor helpfulness) with 4-point scale; Work History Questionnaire[57]