Final Progress Report

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Keys to Re-Injury Prevention and Sustained Return-to-Work for Disabled Workers

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List of Terms and Abbreviations

AMA	American Medical Association
AAPOR	American Association for Public Opinion Research
CI	Confidence interval
FCI	Functional Comorbidity Index
FTE	Full-time equivalent
HCUP	Healthcare Cost and Utilization Project
ICD	International Classification of Diseases
ICD-9-CM	International Classification of Diseases, Ninth Revision, Clinical Modification
ICD-10-CM	International Classification of Diseases, Tenth Revision, Clinical Modification
IME	Independent Medical Examination
JCQ	Job Content Questionnaire
L&I	Washington State Department of Labor and Industries
NAICS	North American Industry Classification System
OR	Odds ratio
PPD	Permanent partial disability
Q	Quarter
RTW	Return(ed) to work
SID	State Inpatient Databases
WBI	Whole body impairment
WHQ	Work History Questionnaire
WC	Workers' compensation

Abstract

Project title: Keys to Re-Injury Prevention and Sustained Return-to-Work for Disabled Workers

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Annually, about 300,000 U.S. workers incur serious work injuries resulting in permanent impairment and a permanent partial disability (PPD) award. The aims of this study were to: (1) characterize the first year of labor market participation after claim closure with a PPD award; (2) quantify time-varying risks of return-to-work (RTW) interruption and reinjury for workers with permanent impairments, comparing to risks for injured workers without permanent impairments, and assessing the impact of worker, injury, and job characteristics; and (3) prioritize modifiable workplace and workers' compensation (WC)-based contextual factors for future intervention development. WC and state wage data were used to measure long-term RTW patterns and reinjury outcomes for a retrospective cohort of workers with and without permanent impairments (N=43,968). A representative cross-sectional survey of workers with permanent impairments (N=599) was conducted to measure self-reported reinjury, health, workplace factors, and workers' suggestions for workplace and WC system improvements. This study documented long-term challenges related to health limitations, chronic pain, work reintegration, and economic impacts among workers with permanent impairments. Compared to other injured workers, workers with permanent impairments were at substantially higher risk of delayed RTW, RTW interruption, and reinjury. The first six months after RTW was identified as a particularly important window of opportunity for prevention efforts. Several modifiable workplace factors were associated with safe and sustained RTW, including safety climate, supervisor/coworker support, absence of stigmatization by supervisors/coworkers, health and safety committees, ability to take time off work for personal/family matters, adequate employer/health care provider communication, comfort reporting unsafe situations at work, and low job strain. Workers suggested numerous workplace improvements that could potentially support safe and sustained RTW. Suggested improvements most frequently fell into the major theme of work organization/arrangements/conditions, closely followed by the major theme of safety and safety climate. Many workers reported that their input was not sought or valued, and linked communication deficiencies to preventable deficiencies in safety practices, safety climate, and RTW practices. Most survey respondents appraised WC-based RTW programs favorably; however, responses also portrayed substantial room for WC system improvement. Reduce delays/ simplify process/improve efficiency was the most frequent theme with respect to the WC system overall. More worker choice/input into the vocational retraining plan was the most frequent theme with respect to vocational rehabilitation. Workers often directly linked administrative burdens to negative impacts on health and recovery. This study also made several methodological contributions: (1) it demonstrated the value of using state wage files to identify long-term RTW patterns and to measure work-time at-risk to improve reinjury rate estimates, (2) a two-factor safely climate scale was validated for this population, and (3) updated diagnosis code lists for the Functional Comorbidity Index were produced. In summary, this study documented the magnitude and elevated risk of RTW interruption and reinjury among workers with permanent impairments. It also identified workplace and WC-based contextual factors that may be amenable to WC system-level intervention. These findings may motivate and support investment in policy changes and prevention opportunities targeted at safe and sustained RTW for this priority population.

Section 1

Significant or Key Findings

This research relied on two distinct samples of Washington State injured workers: (1) a large retrospective cohort of workers with and without permanent impairments (administrative data), and (2) a cross-sectional survey of 599 workers with work-related permanent impairments.

Injured workers with permanent impairments face long-term challenges related to health limitations, chronic pain, work reintegration, and economic impacts. Workers with a higher degree of impairment more frequently reported several economic and job security challenges. The most frequently reported reason for return-to-work (RTW) interruption was impairment, disability, and/or pain from the previous work injury. Workers in (1) nonstandard jobs (compared to full-time, permanent jobs) and (2) precarious jobs (compared to less precarious jobs) had higher adjusted odds of low expectations for sustained RTW. Additionally, workers in precarious jobs had higher odds of reporting fair/poor health and unmet need for disability accommodation.

Workers with permanent impairments were at substantially higher risk of both poorer employment outcomes and reinjury, compared to other workers. Compared to workers without a permanent partial disability (PPD) award, workers with whole body impairment (WBI) ≥10% had delayed RTW, shorter average times to first RTW interruption, and higher rates of both RTW interruptions and quarters without wages. About 9% overall—and 27% of workers with ≥10% WBI—had no observed wages after claim closure. Workers with ≥10% WBI had a 34% higher risk of reinjury compared to workers with no PPD award.

The first six months after RTW was identified as a particularly important window of opportunity for prevention efforts. Reinjury rates were highest in the first two quarters after initial injury, remaining elevated for about four years.

Several potentially modifiable organizational and psychosocial factors were associated with safe and sustained RTW among injured workers with permanent impairments. These factors included safety climate, supervisor support, coworker support, absence of stigmatization by supervisors or coworkers, health and safety committees, ability to take time off work for personal or family matters, adequate employer/health care provider communication, comfort reporting unsafe situations at work, and low job strain. The lack of interaction between degree of impairment and any of these factors suggests generalizability to all workers.

Workers suggested a number of workplace improvements that could potentially support safe and sustained RTW. Modifiable workplace factors that frequently emerged included (but were not limited to): safety, safety climate, adequate staffing, ergonomics, rest breaks, job strain, predictability and flexibility in work scheduling practices, employer response to injury, social support, communication, and respect. Suggested improvements most frequently fell into the major theme of work organization/arrangements/conditions (37.2%), closely followed by the major theme of safety and safety climate (35.4%). Many workers reported that they were not listened to, or that their input was not sought or valued. Workers often linked communication deficiencies to preventable deficiencies in safety practices, safety climate, and RTW practices.

Most survey respondents appraised workers' compensation (WC)-based RTW programs favorably; however, responses suggested that there remains substantial room for improvement in such programs, as well as in the WC system more generally. Overall, 28.0% reported that no change was needed to the WC system, while 57.6% provided suggestions/critiques. Reduce delays/ simplify process/improve efficiency was the most frequent theme with respect to the WC system overall (34.9%). More worker choice/input into the vocational retraining plan was the most frequent theme with respect to vocational

rehabilitation (33.9% of vocational rehabilitation participants). Many themes related to the general concept of administrative burden. Workers often directly linked administrative burdens to negative impacts on health or recovery time.

State wage files provide an efficient approach to identifying RTW patterns. State wage files can be used as an alternative to proxies that overestimate successful RTW (e.g., the end of time loss compensation, WC claim closure). Linking wage data to WC claims facilitated measurement of long-term employment, yielding more accurate reinjury estimates and comparisons between groups with differential RTW patterns.

A two-factor safely climate scale was validated for use with workers with permanent impairments who have RTW. Consistent with general worker populations: (1) the two-factor safety climate structure outperformed the single-factor structure; (2) correlations demonstrated that workplace safety training, decision latitude, supervisor support, coworker support, and job demands could predict safety climate; and (3) safety climate may positively impact reinjury risk, work-family conflict, and may increase job performance and job security.

Diagnosis code lists for the Functional Comorbidity Index (FCI), compatible across the 2015 International Classification of Diseases (ICD) lexicon change, were developed and published. Using these ICD-9-CM and ICD-10-CM code lists, the FCI demonstrated general concordance and similar distribution across lexicons.

Translation of Findings

Although this study did not result in a product directly transferable to workplaces, the primary translation goal was to address the dearth of epidemiological evidence regarding RTW interruption and reinjury among workers with permanent impairments, and thereby to lay the groundwork for future development of WC system-level interventions targeted at modifiable contextual factors supporting safe and sustained RTW in this priority population. The information produced by this study can be used to motivate and support investment in policy changes and prevention opportunities targeted at safe and sustained RTW. This study involved ongoing collaboration with the Washington State Department of Labor and Industries (L&I). In addition to numerous publications and presentations at research conferences, this study was also the focus of a session in the Policy and Research Discussion Series (Life and Work after a Workplace Injury) sponsored by Bancroft Institute for Studies on Workers' Compensation and Work Injury, formed by injured workers, advocates and academics.

Research Outcomes/Impact

There are several important potential outcomes of this research. First, it provided documented evidence for the nature and magnitude of RTW interruption and reinjury that can be used to support policy changes and investment in intervention programs. Second, it identified workplace and WC-based contextual factors that may be amenable to WC system-level intervention. Third, this study involved ongoing collaboration with L&I staff and stakeholders, enhancing translation potential. Findings and implications were regularly reported to and discussed with L&I, to lay the groundwork for proactive focus of resources where most needed to facilitate sustained injury-free RTW. In sum, this research bolsters the sparse epidemiological evidence regarding RTW interruption and reinjury among workers with permanent impairments, and will facilitate future development of WC system-level interventions targeted at modifiable contextual factors in order to support sustained RTW—both for this priority population and for all workers.

Section 2

Scientific Report

Background

Roughly 10% of the nearly 3 million annual nonfatal occupational injuries and illnesses in the U.S. result in permanent impairment and a permanent partial disability (PPD) award.[1] Workers' compensation (WC)-based PPD awards provide limited compensation to injured workers for permanent impairment resulting from work injuries or illnesses (e.g., vision or hearing loss, amputation, spinal impairment) that prevent a worker from working at full physical capacity, but do not completely preclude return to work (RTW). Throughout this report, *permanent impairment* is used specifically in the context of a WC-based PPD award, while *disability* is used to refer to functional limitations more generally.

Workers disabled by an occupational injury face substantial employment challenges, even after vocational retraining to facilitate RTW.[2] Despite having been deemed able to work, many workers with PPD awards do not RTW.[3,4] Those who do RTW face elevated risks of delayed RTW, RTW interruption (breaks in employment), and reinjury (relative to workers without PPD awards).[4-6] This may be related to factors associated with work-related permanent impairments, such as long-term functional disability, pain, unstable health, layoff, early retirement, negative treatment by managers and coworkers, lack of accommodation, and discrimination.[2,3,5-14] Work-related permanent impairments are also associated with substantial subsequent wage and wealth losses relative to both uninjured workers[15,16] and injured workers without permanent impairments.[4,17,18] Moreover, workers with permanent impairments are at higher risk for reinjury[5] and mortality.[19] Workplace functional limitations are prevalent—reported by 22% of employed U.S. workers.[20] Physical disability is the most common reason to exit the workforce before age 60.[21]

Sustained RTW. Initial RTW does not necessarily indicate successful RTW. A study of Ontario injured workers with permanent impairment found long-term intermittent impacts on RTW; 85% of workers were observed to RTW at least briefly, while only 50% exhibited sustained RTW.[6] A more recent Australian study, which did not specifically assess permanent impairment, found that time to sustained RTW was 1.8 times longer than time to initial RTW (proxied by cessation of time loss payments); further, although 94% of injured workers had RTW at least briefly, only 79% achieved sustained RTW during the two-year follow-up period.[22] Among Canadian workers who were 50-64 years of age and had a permanent impairment, a higher (more severe) impairment rating was associated with earlier labor force exit.[23]

Economic impact of permanent impairment. Substantial economic disparities for workers with permanent impairments have been documented using a variety of economic measures, including wage losses (based on unemployment insurance data),[16,18,24] earnings losses more broadly (based on tax data),[17] and poverty.[15] Estimates of the magnitude of these disparities vary substantially by jurisdiction, which may be due in part to the impairment rating system used, and to jurisdictional variation in benefit adequacy.[24] Nevertheless, there is consistent evidence that workers with permanent impairments are less likely to be fully employed compared to other workers and are economically disadvantaged relative to the general working population,[15] to matched uninjured workers,[16] and to injured workers without permanent impairment.[17,18] The negative economic impact of permanent impairment may lessen over time, but it persists long-term. For example, a RAND study of California workers with permanent

impairments documented that earnings for workers with permanent impairments in the first quarter after injury were 60% of earnings for a matched control group of uninjured workers; at five years after injury, earnings remained only 72% of those for the control group.[16] Compared to other workers, disabled workers have unemployment rates that are 50% higher, and they are more likely to work part-time and in entry-level jobs.[25,26]

Reinjury. As many as half of all injured workers are reinjured,[22,27-29] and repeat work injuries are more severe and more costly than initial injuries.[29,30] Compared to the initial injury, subsequent work injuries tend to result in longer work disability and higher costs.[29,31] Injured workers are at heightened risk of both injury exacerbation and new work-related injuries, particularly during the first 12 to 18 months after initial injury and when working conditions have not changed.[28,29,32,33] A prior work injury significantly increases the odds of a new or recurrent work injury.[34,35] More specifically, workers who have RTW after an injury involving time loss compensation are more likely to have a subsequent injury than other workers in the same firms.[36] Risk of reinjury among workers with permanent impairments is of particular concern given evidence that occupational injuries are more common, more severe, and more costly among workers with persistent disabilities.[8,37-41]

Estimating reinjury risk. While many injured workers are reinjured at work, reinjury risk is challenging to quantify, in part because accurate estimation of work reinjury risk is dependent on identifying an appropriate at-risk denominator. Few studies have estimated time-dependent work reinjury rates using at-risk denominators other than calendar time. Most studies have used a calendar timescale (e.g., amount of calendar time between initial injury and reinjury) to calculate reinjury rates. But workers who have not yet RTW are not at risk of a subsequent work-related injury, and workers who are working part-time or intermittently would generally be at lower risk than full-time workers. Hence, this approach may underestimate risk by falsely assuming continuous employment during the calendar time period; and it also may not account for differences in work exposure between full-time and part-time workers. In particular, because injured workers with permanent impairment are less likely to be fully employed compared to other workers, the use of a calendar timescale to calculate time at risk could lead to underestimates of work reinjury risk for these workers.

Impact of workplace factors on RTW and reinjury. Much RTW and reinjury research has been focused on worker-level risk factors (e.g., age, health status, health behaviors, depression, catastrophizing, fear avoidance). Less is known about workplace-level factors, which may be amenable to workplace or WC system-based interventions—thereby having potentially broader impact.[42,43] Moreover, most studies of workplace accommodations have focused on assistive technology and specialized equipment, rather than on policy-related solutions (e.g., flexible work schedules, telework) or workplace culture.[44] Yet, modifiable workplace or system-level factors (e.g., workplace, WC system, health care) were the most commonly described employment barriers in a study of RTW experiences among 150 injured workers who had used vocational rehabilitation services in the Massachusetts WC system.[45] Further, a recent study ranked organizational and psychosocial exposures as among the most prevalent workplace exposures in the northwest region of the U.S.[46] Although few studies have focused specifically on workers with permanent impairments, there is accumulating evidence that modifiable workplace organizational and psychosocial factors (e.g., job accommodation, safety climate, job strain, social support) can impact successful RTW, injury/reinjury, and work absence.[47-58] There remain substantial knowledge gaps regarding the full constellation of salient workplace factors that may be amenable to intervention, particularly with respect to injured workers who have RTW with a work-related permanent impairment.

WC-based vocational rehabilitation and other RTW programs. Some of the multiple factors predisposing workers to negative outcomes—particularly workers with permanent impairments—may be amenable to intervention via WC-based vocational rehabilitation and other RTW programs, and overall WC system improvements. The purpose of WC-based RTW programs, which may include features such as worker assessments, vocational retraining, job accommodation subsidies, or incentives to employers for injured worker hiring/retention, is to facilitate RTW for workers who have faced RTW barriers or have been unable to return to their previous job after an occupational injury. Vocational rehabilitation programs are particularly important to workers with permanent impairments, who account for the overwhelming majority (roughly 90%) of WC-based vocational rehabilitation program participants.[4,5] These programs play a critical role in retraining workers to RTW in a new occupation when needed, yet substantial service delivery problems have been identified.[2,59-63] Accumulating evidence suggests that vocational rehabilitation and other RTW programs affect injured workers in both positive and negative ways.[2,63-67] Even after vocational retraining to facilitate RTW, workers disabled by an occupational injury face substantial employment challenges.[2] A Washington State study found that about 50% of workers who completed a vocational retraining plan RTW within two years, while fewer than 45% of workers with incomplete plans had RTW nearly five years later.[63] However, there is little existing research on the impact of WC-based programs on employment outcomes beyond initial RTW, such as sustained RTW and RTW interruption. To understand how vocational rehabilitation and other RTW programs can best assist workers, we need to better understand the impact of these programs on specific employment patterns.

WC system factors. Improvements to administrative features of the WC system may enhance RTW outcomes. Just as patients' experience of care has long been recognized as an important indicator of health service quality, injured workers' experience of and satisfaction with service delivery could be used to inform WC-focused quality improvement efforts.[68,69] In particular, there is growing evidence that administrative burdens may influence how social insurance programs such as WC are experienced, with implications for the effectiveness and equity of these programs.[70,71] Administrative burdens in the WC system could include learning about and navigating WC benefits and programs, interacting with potentially unsupportive claim managers, and complying with WC rules. Such burdens could increase stress, hinder the delivery and effectiveness of high-quality health care and RTW services, and compound the substantial economic burden of workplace injury shouldered by injured workers and their families.[72,73] The Washington State Department of Labor and Industries (L&I) has a history of collaborative efforts with stakeholders to improve the performance of their vocational rehabilitation and other RTW programs, as well as the WC system overall.[59,63,74] Further understanding of injured workers' experiences in these arenas, as well as their suggestions for administrative change, have the potential to provide critical information about opportunities for WC program and system improvement.

Specific Aims

Aim 1: Characterize the first year of labor market participation after claim closure with a PPD award (e.g., work history, job characteristics, comorbidity, pain, reinjury), for permanently impaired workers.

Aim 2: Quantify time-varying risks of RTW interruption and reinjury for permanently impaired workers who have RTW, compare to risks for injured workers without a PPD award, and assess the impact of worker/injury/job characteristics (e.g., age, gender, language, percent/type of permanent impairment, wage level, occupation, industry) on these outcomes. We hypothesize

that permanently impaired workers are at higher risk of these outcomes compared to other injured workers, particularly in the first year after RTW.

Aim 3: Prioritize modifiable workplace and WC-based contextual factors (e.g., job accommodation, safety climate, job strain, supervisor/coworker support) for future intervention development by testing associations with RTW interruption and reinjury among permanently impaired workers who did RTW.

General methodology

Study population

Washington State has a single payer WC system (the State Fund) that covers approximately 70% of workers specified by Washington's Industrial Insurance Act.[75] L&I performs the functions of an insurer for State Fund claims and administers the state WC system for both State Fund and self-insured employers (who account for the remaining 30%). Private WC insurers do not operate in Washington State, which facilitates population-based research.[76]

Data definitions

PPD and whole body impairment (WBI) percentage. Washington State defines impairment as permanent anatomic or functional abnormality or loss of function after maximum medical improvement has been achieved.[77] Workers may be rated with regard to degree of impairment for a PPD award if treatment has been completed and the worker is still able to work, but has suffered a permanent loss of function.[78] Washington State uses two different PPD rating systems, depending on the type of impairment: (1) specified PPD, and (2) unspecified PPD.[77] Awards for specified PPD impairments are listed in state rule, and include amputation, loss of function of extremities, hearing loss, and vision loss. Impairment for loss of function of extremities or partial hearing or vision loss is rated using the American Medical Association (AMA) Guides to the Evaluation of Permanent Impairment, 5th Edition,[79] unless otherwise mandated by L&I. Unspecified PPD impairments include internal injuries, back injuries, mental health conditions, respiratory disorders, and other disorders affecting the internal organs; these are rated using category award schedules that are updated each fiscal year and applied based on injury date.[78] PPD awards are made at claim closure, and may be paid as a lump sum or in monthly installments, depending on the size of the award.[78]

Administrative WC PPD rating data were challenging to summarize. Several impairment rating/award systems were involved. In addition, multiple entries for the same PPD award were often indistinguishable as to whether they represented duplicate entries, multiple/bilateral injuries, pre-existing unpaid impairment based on evaluation, protests, repayments, or other subsequent increases or decreases in the PPD award. We constructed a measure of whole body impairment (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. L&I PPD data contained the following information for each eligible impairment (workers could have multiple impaired body parts): (1) PPD benefit eligibility effective dates (per L&I guidance, only records for the most recent date were used when there were multiple effective dates for the same claim—generally representing updates due to protests/appeals); (2) award amounts for each impaired body part; (3) percent impairment for each impaired body part; and (4) major body part code corresponding to each impaired body part.

We calculated WBI percentage in three main steps. First, we calculated the WBI percentage multiplier for all major body part codes found in the data, using three methods. For impairments listed in the L&I PPD Category Awards list,[78] the multiplier was set to 1.0 (for category awards, percent impairments in the database were equal to WBI percentage). For other impairments, we used the AMA Guides to identify WBI percentage multipliers for each major body part code.[79] When multipliers were not available in the AMA Guides for a specific impairment (e.g., loss of one eye by enucleation), the multiplier was estimated by dividing the award amount listed for a particular impairment in the L&I PPD Awards Schedule by the statutory award amount for 100% impairment, using amounts specific to the fiscal year of each worker's injury date. Fiscal year-specific amounts are available online.[78] The second step was to multiply the resulting WBI percentage multiplier (specific to major body part code) by the percent impairment for each impaired body part, thus assigning an estimated WBI percentage to each impaired body part for each worker. For the 5.0% of claims having a PPD award but missing percent impairment data for an impaired body part, the WBI percentage was estimated by dividing the actual PPD award for a particular impairment by the fiscal year-specific statutory award amount for 100% impairment.[78] Third, for workers with multiple impaired body parts, we retained only the impaired body part with the highest WBI percentage. Although this likely involved some underestimation of WBI, we took a conservative approach and did not sum all WBI percentages for each worker, due to the inability to distinguish duplicate entries or pre-existing injuries from multiple eligible impairments. The resulting estimate can 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. The highest calculated WBI percentage estimate was 49.2% (median 5.0%, mean 6.2%, SD 5.4%). For purposes of comparing workers with a higher degree of impairment to workers with a lower degree of impairment, we cut the estimated WBI percentage at the 80th percentile, thereby comparing workers with an estimated WBI percentage below 10% to workers with an estimated WBI percentage of 10% and above. We then classified degree of permanent impairment into three mutually exclusive groups: (1) no PPD award (i.e., no compensated permanent impairment), (2) a PPD award with WBI <10%, or (3) a PPD award with WBI ≥10%.

Injured body part. Injured body part was categorized as spine/neck, upper extremity, lower extremity, or other/multiple. For workers with a PPD award, body part was based on the impaired body part used for the WBI percentage estimate. For workers with no PPD award, body part was based on Occupational Injury and Illness Classification System (version 1.01) codes present in the WC claims file.

Job characteristics when initially injured. 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—due to small numbers in some sectors—was further collapsed into nine groups: (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). **Hazard group** was based on L&I-assigned employer risk class; 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).[80]

Pre-injury wages. 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.

Urban-rural residence. Urban-rural residence was based on residence county indicated in the WC claims data, and classified using the 6-level 2013 National Center for Health Statistics Urban-Rural Classification Scheme for Counties.[81]

Functional Comorbidity Index (FCI). We obtained professional and facility WC billing data for the first visit or admission for the initial injury, which was used to construct the FCI (details below).[82]

WC-based RTW programs. Stay at Work is a WC-based financial incentive program that took effect in Washington State on June 15, 2011. Under this program, L&I reimburses eligible employers for certain costs of providing temporary light-duty or transitional jobs for specific injured workers, while they recover. Costs eligible for reimbursement can include: up to half of the worker's base wages for up to 66 days (maximum of $10,000 per claim); up to $1,000 per claim for training fees or materials such as tuition, books and supplies; up to $2,500 per claim for equipment or tools; and up to $400 per claim for clothing. Technically, it is the employer who participates in Stay at Work; however, because the employer participates with respect to a specific injured worker, and because all analyses were worker-level, we henceforth refer to worker participation. The **Preferred Worker Program** is another Washington State WC-based financial incentive program. On request, L&I may certify a worker with eligible permanent medical restrictions as a "preferred worker." Employers may then be eligible to receive financial incentives when they hire a certified preferred worker for a medically approved, long-term job. Employer incentives include financial protection against subsequent claims, premium relief, a one-time incentive payment for continuous employment, reimbursement for 50% of base wages, and reimbursement for certain tools, clothing, and equipment that the worker needs to do the job. **Vocational rehabilitation services** are intended to assist eligible injured workers to overcome RTW barriers (e. g., assessment, work hardening, vocational retraining plan with new occupational goal).[83] Some injured workers who can no longer work in their previous occupation may be determined eligible for WC-based **vocational retraining** for a new occupation, subject to L&I approval of a vocational retraining plan. A new retraining option (known as **Option 2**) became available as of January 1, 2008. Option 2 provides self-directed retraining funds as a voluntary alternative to participating in the approved conventional retraining plan. Workers have 15 days after plan approval to decide whether to participate in the approved plan or choose Option 2. When workers choose Option 2, their claim is closed, time-loss benefits end, a vocational award of roughly six to nine months of time-loss benefits is paid, and vocational retraining funds are set aside. The worker can access their vocational retraining funds for tuition, training fees, and certain related expenses, for up to five years. The worker can seek training at any L&I-approved program or course, and the retraining goal can differ from that in the approved retraining plan.

Survey

Survey design and administrative data source. We conducted a representative descriptive cross-sectional survey designed to gather information about the first year of work reintegration for a retrospective cohort of Washington State workers with a work-related permanent impairment and associated PPD award recorded by L&I. The degree of permanent impairment was rated at WC claim closure (see Data definitions section), and the initial sample was identified by L&I staff, who delivered contact information along with administrative WC claims

data to the research team. The survey was conducted about a year after PPD rating and claim closure. Several months before the survey, we obtained L&I administrative data associated with the qualifying closed claim for all potentially eligible workers, including contact information, claim descriptors (e.g., injury date, State Fund or self-insured coverage, claim status), sociodemographic information (e.g., gender, age, county of residence), employment information at time of the pertinent injury (e.g., occupation, industry), vocational rehabilitation involvement, and PPD data (e.g., body part, impairment percentages). For State Fund claims only, we also obtained data regarding total medical costs and total number of compensated days for time lost from work.

Sample inclusion/exclusion criteria. Workers were potentially eligible for this study if they met inclusion criteria by having (1) an accepted Washington State WC claim (either State Fund or self-insured) that (2) closed between January 1, 2018 and April 30, 2018 with (3) an associated PPD award. Prior to delivering contact information and administrative data for potentially eligible workers 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) fatal or total permanent disability claims; (4) residence outside Washington State; (5) L&I employees and other confidentiality exclusions imposed by L&I; and (6) deceased workers. After applying inclusion and exclusion criteria, L&I staff identified 2,541 workers who were potentially eligible for the survey during the specified time period. This served as the initial sample frame. We attempted to interview all eligible workers in this sample, and no probability sampling was conducted. Two additional exclusion criteria could be determined only during eligibility screening by survey interviewers: (1) language or comprehension barrier; and (2) no RTW since the impairment, as determined by a worker's affirmative response to the question, "Have you RTW since the injury that caused your impairment or disability, even if only very briefly?" Although only workers who had RTW were surveyed, eligibility questions were structured to allow for estimation of the percentage of workers with permanent impairment who had not RTW at all since claim closure.

Survey development and survey domains. The worker survey was developed in collaboration with L&I experts and stakeholders, and by consulting the relevant research and grey literature. Where feasible, questions were drawn from previously conducted surveys.[65,84-92] We queried respondents about eight of the 18 conditions from the FCI, which is a validated instrument for predicting functional outcomes in community-based adult populations.[93] We selected the eight conditions (i.e., arthritis, chronic back pain/disease, depression, anxiety, obesity, upper gastrointestinal disease, asthma, diabetes) because they were identified as the most prevalent (at least 5%) among workers with Washington State WC claims for (1) carpal tunnel syndrome, and (2) upper extremity fractures.[94] Survey content was also developed using findings from previous surveys and qualitative interviews of workers who RTW after vocational rehabilitation, with a focus on patterns of employment and RTW interruption, reinjury, and potentially modifiable workplace and WC-based risk factors.[7,28,65,92] Expert consultation was provided by the Survey Research Division of the Social Development Research Group, an interdisciplinary research team based in the University of Washington School of Social Work. Survey questions were finalized after internal testing and timing by Survey Research Division staff.

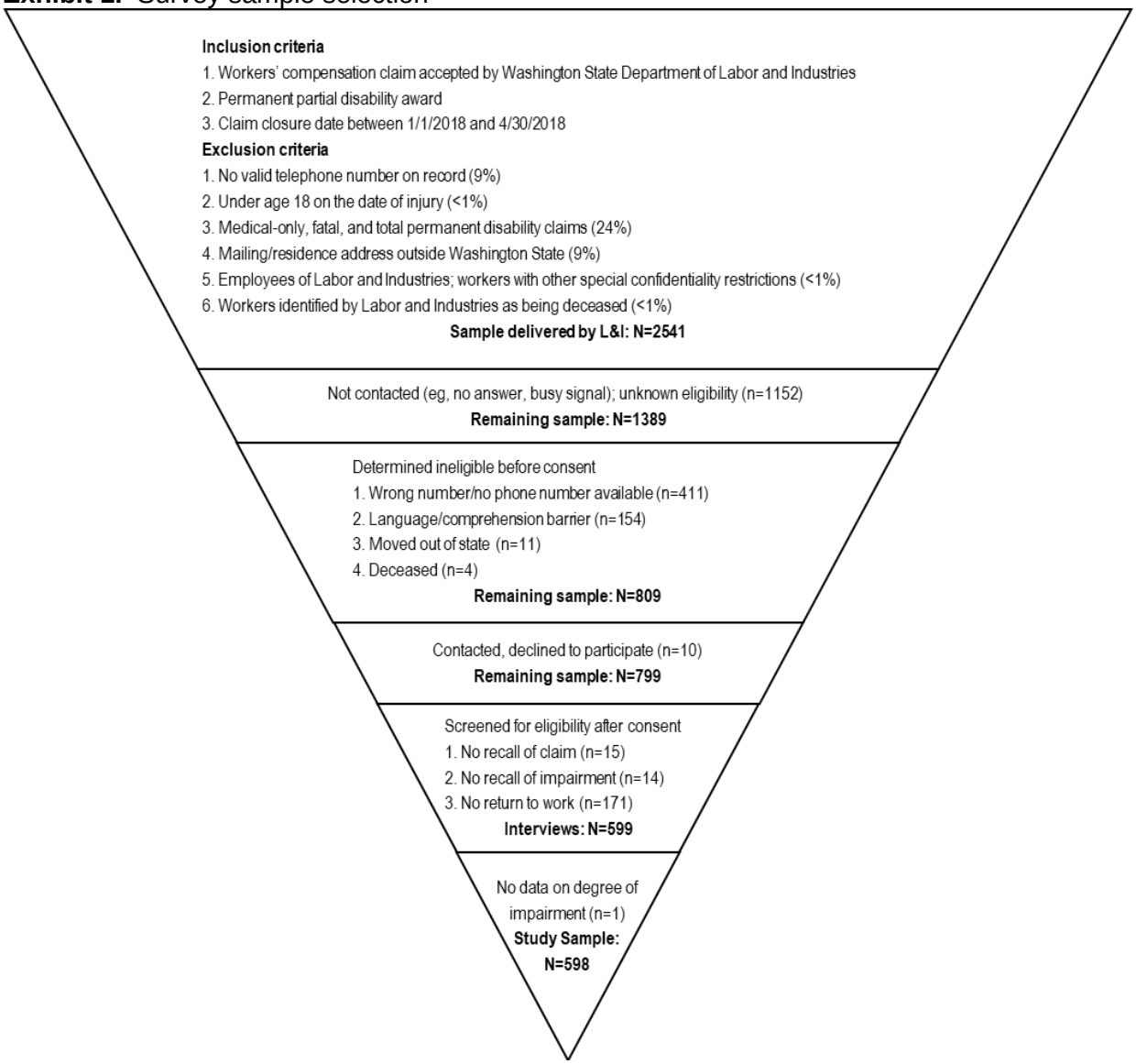
Survey administration and response rate. Trained interviewers conducted live telephone interviews using computer-assisted telephone interviewing technology (i.e., automated dialing, software-managed interview script, responses typed into the computer interface by interviewers). Interviews were conducted from February 6 through April 20, 2019. There were at least 4 to 8 call attempts per worker, which varied by day (weekday/weekend) and time of day. Workers were interviewed about a year (11-15 months) after claim closure (mean: 12.8 months). Interviews averaged 39 minutes each. Advance recruitment letters offered

mechanisms to opt-out or schedule an interview and described the 30 USD gift card for participation, which was provided by mail or email after the interview. Respondents contacted by phone were given the option to reschedule the interview at a convenient time. In total, 599 interviews were conducted (582 complete and 17 partial interviews). Sample exclusions and attrition are depicted in Exhibit 1. The response rate was calculated following recommendations published by the American Association for Public Opinion Research (AAPOR).[95] The overall adjusted response rate was 53.8%, following the standard AAPOR formula for Response Rate 4, selected because it (1) includes partial surveys in the numerator (enough questions were answered that they were usable for many purposes), and (2) includes an adjustment for the estimated proportion of workers with unknown eligibility that were eligible (e), which we calculated using the conservative AAPOR default method (proportion of eligible workers among all workers in the sample for which a definitive determination of status was obtained), resulting in e=0.438 (609 eligible/609 eligible+780 ineligible). The Response Rate 4 formula is: (Complete interviews [n=582] + partial interviews [n=17])/((Complete interviews [n=582] + partial interviews [n=17]) + (Eligible, non-interview [n=10]) + e(Unknown eligibility, non-interview [n=1,152])).[95]

Survey non-response bias assessment. After excluding workers found ineligible during screening, survey respondents (N=599) were compared to nonrespondents (N=1,573) using administrative WC data. On average, respondents were about one year younger when surveyed (49.3 years old; SD 11.6) compared to nonrespondents (50.7 years old; SD 11.6). For both respondents and nonrespondents, 2016 was the median injury year. Respondents did not substantially or significantly differ from nonrespondents with regard to any of the following characteristics: age when injured, State Fund vs. self-insured coverage, whether the qualifying closed claim was their first Washington State WC claim, age at injury, gender, adjusted pre-injury wage, urban-rural residence, whether a vocational rehabilitation plan was completed, and—among State Fund claims only, due to data availability—traumatic injury vs. other injury type, and injury severity (maximum Abbreviated Injury Scale). Though representative, the survey was cross-sectional and relatively small-scale. Recall bias was also a potential threat to the validity of our findings, since workplace exposure and worker outcome data were collected simultaneously. At least three features of this survey sample distinguish it from the larger population of workers with a PPD award. First, by design, all workers included in this survey had RTW at least briefly. This likely impacted worker appraisals of the WC system and RTW programs. In surveys conducted for an evaluation of the Washington State vocational rehabilitation system (2009-2011), RTW status was highly associated with satisfaction ratings.[62] Second, survey respondents reported a high prevalence of union membership (42.2%)—more than double the estimated 19.8% of Washington State employed workers who were union members in 2018, and more than quadruple the estimated 10.5% for the U.S. overall.[96] The high level of union membership may indicate relatively low job precarity among this sample, as well as relatively high potential for union support and representation through the RTW process.[97] We did not have union membership status for survey non-respondents, so we could not be certain whether non-response bias was a factor; however, we did not observe notable differences in the many other characteristics used to assess non-response bias.[3] Speculative mechanisms that might account for overrepresentation of union members in the underlying eligible survey sample, even in the absence of non-response bias, include: (1) if more hazardous types of jobs are more likely to have union representation, union members might more often be injured; (2) union members might feel safer reporting an injury and filing a WC claim; (3) union members might have better access to legal resources, which might facilitate obtaining a PPD award; and (4) union members may be more likely to RTW after a PPD award, which was an eligibility criterion for this survey. Even in the absence of non-response bias with respect to union membership, our survey sample certainly does not reflect the prevalence of union membership in the general workforce. It is possible that the more general workforce might

have less positive appraisals of WC and RTW programs, related to higher job precarity, or to less support or representation in accessing compensation after incurring a work injury. Third, this survey was conducted only in English, which likely resulted in a less diverse set of respondents compared to all workers with a PPD award. We could not test this supposition because the administrative WC data did not include race/ethnicity; however, 80.4% of respondents were non-Latino White. Potential overrepresentation of non-Latino White workers may also be reflective of broader structural issues related to WC coverage and access. Specifically, workers from racialized or otherwise marginalized groups may face larger barriers to accessing WC benefits after experiencing a work-related permanent impairment, due to coverage exclusions for certain types of work (e.g., domestic workers, independent contractors) or other barriers to access (e.g., stigma, fear of retaliation).[98] It is unclear what impact an increased representation of racialized workers or precariously-employed workers might have had on study findings.

Exhibit 1. Survey sample selection



Retrospective cohort

We used administrative WC claims data to construct a retrospective cohort. We used state wage files (i.e., data from mandatory unemployment insurance-related employer tax and wage reports) to measure long-term employment outcomes for up to ten years after first WC claim closure. The eligible cohort included injured workers with an accepted compensable State Fund WC claim that: (1) was their first known WC claim filed in Washington State (i.e., the worker had no prior State Fund or self-insured claim); and (2) closed for the first time during 2009 through 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). Injured workers with self-insured employers were not included in the eligible cohort, due to incomplete vocational rehabilitation and 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. After these exclusions, 4.01% (n=1842) had no state wage data before and after the injury, and were excluded during data analysis; these workers may have been self-employed or working in occupations exempt from unemployment insurance coverage and wage reporting requirements,[99] and therefore it could not be assumed that absence of wages after the injury indicated no RTW. A further 100 workers were excluded due to death on or before the first claim closure date (WC claims for these workers were not classified as fatal claims). The resulting cohort consisted of 43,968 injured workers.

Functional Comorbidity Index (FCI)

The FCI was originally developed as an unweighted index of 18 self-reported chronic conditions,[93] designed to predict functional outcomes in community-based adult populations, rather than the outcomes for which comorbidity indices are typically developed: mortality, hospital length of stay, charges, or costs among inpatient populations.[100-103] Many of the chronic conditions in the FCI are not included in other comorbidity indices; they were selected based on their theorized association with functional status, through a process involving literature review and a series of focus groups conducted among patients and health care professionals.[93] Various International Classification of Diseases (ICD) versions have been used to calculate the FCI based on administrative/billing data in acute, post-acute, outpatient, and WC settings.[94,104-108] Existing ICD diagnosis code lists for the FCI are variable with regard to (1) interpretation of the breadth and focus of each comorbidity category and (2) the specific codes included in each category.

We sought to use the FCI as a covariate for our Aim 2 research, but a comprehensive code list did not yet exist for the ICD-10-CM lexicon. Therefore, in preparation for Aim 2, we developed updated FCI diagnosis code lists based on both ICD-9-CM and ICD-10-CM diagnoses to facilitate (1) measurement continuity across the lexicon change and (2) use of administrative data sets involving both lexicons. We used two internal data sets for development purposes, to assess concordance and identify inconsistencies in coding and code translation: (1) adult inpatients in Washington State, dual-coded by hospital coders in 2014 (N=2,351), and (2) a set of Washington State WC data for allowed work-related conditions (N=6,528). We also used a convenience sample of 7 distinct population-based state hospital discharge databases, representing diverse geographic areas. Hospital discharge data from Arizona, Colorado, Michigan, New Jersey, New York, Utah, and Washington State were obtained from the State Inpatient Databases (SID), Healthcare Cost and Utilization Project (HCUP).[109] SID data for 2015

were available to us, having been purchased for another study (data re-use was approved by HCUP). The ICD-10-CM lexicon took effect on October 1, 2015.[110] The SID diagnosis fields contained diagnoses based on the ICD-9-CM lexicon for the first 3 calendar quarters of 2015; the ICD-10-CM lexicon was used for the fourth calendar quarter of 2015. Inpatients under 18 years old were excluded because the FCI was developed for adult populations.

Our goal during the development process was to optimize concordance between the ICD-9-CM and ICD-10-CM code lists—minimizing discrepancies in capture of individual comorbidities and FCI counts across the two lexicons. We started with published FCI code lists, including the ICD-9-CM code lists developed by Kumar et al. (2016),[104] and the ICD-10-AM code list developed by Gabbe et al. (2013).[111] We also obtained unpublished ICD-9-CM and ICD-10-CM code lists used by Marcum et al. (2018).[94] Where there were discrepancies between these existing lists, we used Groll et al. (2005)[93] to guide decisions based on original intent, scope, and FCI category descriptions. We also reviewed the FCI-related literature (including later articles co-authored by Groll[112-114]) to check for conceptual/definitional drift or refinement. For the stroke category, we relied heavily on the American Heart Association/American Stroke Association expert consensus document.[115] We reviewed Charlson and Elixhauser ICD-9-CM and ICD-10 comorbidity code lists published by Quan et al. (2005),[116] and added codes as indicated. However, the FCI focus on chronic conditions was intentionally maintained; i.e., acute comorbidity codes on the Charlson and Elixhauser lists were not added. During this process, we avoided expanding or modifying category definitions where feasible. Using ICD coding and mapping manuals,[117-119] as well as the American Academy of Professional Coders online code converter,[120] we translated and back-translated all codes between ICD-9-CM and ICD-10-CM to identify potential discrepancies, and made adjustments to ensure concordance across lexicons.

The SID do not contain the type of long-term functional outcomes that the FCI was developed to predict. However, the FCI has already been well-validated in that respect.[93,107,108,111,112] Given the absence of better alternatives, length of stay and discharge disposition were used as proxies for short-term functional status. The primary goal here was to develop diagnosis code lists that could be used across lexicons, and the available shorter-term outcomes served that purpose, despite low explained variance. HCUP calculates and cleans the length of stay uniform variable (LOS), which is generally based on subtracting the admission date from the discharge date. HCUP also calculates and cleans the discharge disposition uniform variable (DISPUNIFORM). We converted this categorical variable to a binary indicator for routine discharge (discharged to home, self-care, or court/law enforcement), vs all other discharges (including transfers to short-term hospitals, skilled nursing facilities, home health care, hospice, discharges against medical advice, and deaths).

Although there was some variation across states in FCI distribution, there was general consistency across ICD lexicon and calendar quarter. As age category increased, there was a nearly monotonic increase in mean FCI. When broken out by state, the general consistency in FCI distribution across ICD lexicon and calendar quarter remained evident, and also remained evident at the individual comorbidity level, with a few minor exceptions. Five of the 18 comorbidities had small (1 to 2 percentage point) discrepancies in prevalence across lexicons. The direction was inconsistent, with angina, depression, and back disease slightly more prevalent under ICD-9-CM, while arthritis and chronic respiratory disease were slightly more prevalent under ICD-10-CM.

Length of stay and discharge disposition outcomes were assessed in separate regression models. Covariates included age, gender, state, ICD lexicon, and FCI/lexicon interaction. To maximize sensitivity, all available diagnosis fields for each hospitalization were used to identify

comorbidities. For regression models with length of stay as the outcome (generalized linear models with gamma family and log link), R^2 went from 0.017 without FCI to 0.023 with FCI included. For logistic regression models with discharge disposition as the outcome, pseudo R^2 went from 0.153 without FCI to 0.167 with FCI included. For both outcomes, the same R^2 values were observed whether or not ICD lexicon-related parameters were included in the models. The FCI/ICD lexicon interaction coefficients were small but statistically significant in both outcome models. Under ICD-9-CM, each additional comorbidity was associated with an 8.9% increase in length of stay and an 18.5% decrease in the odds of a routine discharge, compared to an 8.4% increase and 17.4% decrease, respectively, under ICD-10-CM. The inclusion of lexicon-related parameters had negligible effect on explained variance, and the combined (main effect and interaction) lexicon effect size was small relative to the FCI, on the order of a 0.1% decrease in mean length of stay and a 1.0% decrease in the odds of a routine discharge after the lexicon change.

This methodological research provided code lists for the FCI that were used for Aim 2 and that can be used for other studies spanning the ICD lexicon change in 2015, or with data sets that include diagnosis codes from both lexicons. Although there were small discrepancies in prevalence across ICD lexicons for a few individual comorbidities, the FCI demonstrated general stability across lexicons. Although there was a statistically significant structural break at lexicon change, the effect size was quite small, and likely ignorable for most purposes. However, if trend analysis were a specific research focus, it might be advisable to include ICD lexicon-related main effect and interaction terms in statistical models in order to adjust for the small structural break. Given the differences in ICD-10-CM with respect to ICD-9-CM, such as conditions being grouped differently, higher granularity, and nearly five times as many diagnosis codes,[121] it is both fortunate and remarkable that ICD lexicon was not associated with larger discrepancies in FCI. Detailed methods and findings for these analyses, as well as a complete presentation of coding decisions and the resulting code lists, are available in our related publication.[82]

Safety climate

Safety climate is a robust leading indicator of occupational safety outcomes, and was a concept of interest for our Aim 3 research focused on modifiable workplace factors. There was, however, limited research on safety climate among workers who have RTW with a work-related permanent impairment. In preparation for Aim 3, we examined three propositions: (1) a two-level model of safety climate (group-level and organization-level) will provide the best fit to the data; (2) antecedent factors such as safety training, job demands, supervisor and coworker support, and decision latitude will predict safety climate; and (3) previously reported associations between safety climate and outcomes such as reinjury, work-family conflict, job performance, and job security will be observed.

Using our survey data, confirmatory factor analyses were conducted to test the factor structure of the safety climate construct. Correlation analyses were used to examine the criterion-related validity. Consistent with general worker populations, our findings suggest: (1) the two-factor structure of safety climate outperformed the single-factor structure in our population of workers with a permanent impairment; (2) correlations demonstrate that workplace safety training, decision latitude, supervisor support, coworker support, and job demands could predict safety climate; and (3) safety climate may decrease reinjury risk and work-family conflict and may increase job performance and job security. These analyses validated an existing two-factor safety climate scale among workers with permanent impairment who have RTW. Detailed methods and findings for these analyses should be available in a manuscript now under review.

Data analysis

Analyses were conducted using Stata/MP 15.1 for Windows (StataCorp, College Station, TX, USA).[122] Survey measures excluded those who responded, “Don’t know,” or refused to answer, resulting in varying numbers of responses for each question. For many survey questions, responses were collapsed into binary variables or fewer categories for ease of presentation. Additional methodological and analytic details for each aim/sub-study are presented below.

Specific Aim 1

Aim 1: Characterize the first year of labor market participation after claim closure with a PPD award (e.g., work history, job characteristics, comorbidity, pain, reinjury), for permanently impaired workers.

This aim was focused on five domains: (1) worker and injury characteristics; (2) health, function, impairment, and pain; (3) chronic health conditions and their effect on ability to work; (4) workforce reintegration, RTW interruption, and reinjury; and (5) economic outcomes.

Additional methodology specific to Aim 1

This descriptive aim relied on survey data. Response patterns for workers with an estimated WBI percentage below 10% were compared to those for workers with an estimated WBI percentage of 10% and above using unadjusted logistic regression models; robust variance estimates were used to produce 95% confidence intervals (CIs) for crude odds ratios (ORs).

In addition, we used linked survey and administrative data for the subset who were still working when interviewed and responded to all relevant questions (N=442) for an additional analysis focused on nonstandard and precarious employment. We used multivariable logistic regression models to examine associations between both nonstandard employment and precarious employment and outcomes related to worker well-being and sustained employment.

Defining nonstandard and precarious jobs. Employment in a nonstandard job was defined as working in a temporary, part-time, or seasonal employment arrangement instead of a full-time, permanent employment arrangement at the time of the interview. Since the survey was not originally developed to measure precarious employment, we developed an exploratory measure of precarious employment by summing several indicators. We followed recent guidance within the occupational health literature that measurement of precarious employment should occur at the level of the worker-employer relationship.[123] Specifically, we defined precarious employment as a multidimensional measure of jobs characterized by five dimensions: (1) job insecurity, (2) individualized (as opposed to collective) bargaining relations, (3) limited workplace rights and social protection, (4) powerlessness to exercise rights and vulnerability to hazards and (5) low wages and economic deprivation. We identified six indicators suitable for constructing a precarious employment measure, representing four of these five conceptual dimensions. The first precarious employment dimension, job insecurity, was operationalized by two indicators: (1) whether the worker reported being employed in a nonstandard work arrangement (versus a full-time, permanent employment arrangement) and (2) whether the worker strongly or somewhat disagreed (versus somewhat strongly agreed) with the statement, "My job security is good." For the second dimension, bargaining relations were operationalized by the worker's union membership status; a worker reporting no union membership indicated more precarious

employment. For the third dimension, employment that provides limited workplace rights and social protections was operationalized by whether the worker reported having employer-provided health insurance. For the fourth dimension, powerlessness to exercise rights and vulnerability to hazards was operationalized by two indicators: (1) whether the worker indicated not being comfortable reporting either an occupational injury or an unsafe work environment, and (2) the worker's response to validated safety climate instruments developed to measure safety culture at the organizational and supervisory level. For safety climate, workers were considered to be less protected from workplace hazards if their score on either the organizational or supervisory scale was one or more standard deviations below the means for the reference worker population. The reference worker population was based on the safety climate instrument validation study (N=29,179 workers at N=46 companies).[124] We did not include low wages or economic deprivation as an indicator in the precarity score because we were unable to identify suitable measures in the survey. To calculate the precarious employment score, we summed these six binary indicators. Workers with three or more indicators of precarious employment were considered to be employed in a precarious job; workers with fewer than three indicators were considered to be employed in a less precarious job. This cutoff represents greater than one standard deviation above the mean count of precarity indicators in our study sample [mean, (SD): 1.4, (1.2)].

Results and discussion

Of workers contacted and otherwise eligible for the survey, 22.2% (171 of 770) were ineligible specifically because they had not RTW even briefly during the first year after claim closure (Exhibit 1). This likely underestimates the percentage of workers with permanent impairment who had not RTW, because the survey recruitment letters described at least brief RTW as an eligibility criterion, and workers who already knew they were ineligible may not have answered the call. An earlier study, using state wage data (2006 through 2011) for Washington State Fund workers eligible for vocational retraining (not all of whom had permanent impairments), found that roughly 60% did not have any reported wages during the first year after WC claim closure.[63]

Year of injury ranged from 1991 to 2018; 4.5% were injured before 2011. Upper extremity impairment contributed most to the WBI rating for nearly half (48.7%) of the study sample of 598 workers (Exhibit 2). The distributions of sociodemographic characteristics were roughly similar across the two WBI categories (Exhibit 2).

Total days of time-loss compensation and total medical costs for the WC claim that closed with a PPD award were available only for the 62.4% of surveyed workers covered by the State Fund (vs. self-insurance). State Fund workers had 374 mean days of time-loss compensation (SD 598 days); workers with a higher degree of impairment had substantially more time-loss days on average (710 days for workers with ≥10% WBI, vs. 260 days for workers with <10% WBI; mean difference 450 days, 95% CI [259, 642]). Mean total medical costs were 35,077 USD (SD 18,648 USD) for State Fund workers; workers with a higher degree of impairment had substantially higher medical costs on average (67,970 USD for workers with ≥10% WBI, vs. 23,995 USD for workers with <10% WBI; mean difference 43,975 USD, 95% CI [27,515 USD, 60,436 USD]).[3]

Exhibit 2. Worker and injury characteristics for Washington State workers surveyed about a year after workers' compensation claim closure with a PPD award

Characteristic	Data source	N	Overall (N=598)	WBI <10% (N=464)	WBI ≥10% (N=134)
			n (%)	n (%)	n (%)
Gender	Admin	598			
Men			403 (67.4)	306 (66.0)	97 (72.4)
Women			195 (32.6)	158 (34.1)	37 (27.6)
Age at survey	Admin	598			
19-24			15 (2.5)	14 (3.0)	1 (0.8)
25-34			62 (10.4)	50 (10.8)	12 (9.0)
35-44			116 (19.4)	91 (19.6)	25 (18.7)
45-54			165 (27.6)	133 (28.7)	32 (23.9)
55-64			206 (34.5)	149 (32.1)	57 (42.5)
65-73			34 (5.7)	27 (5.8)	7 (5.2)
Educational level	Survey	579			
Not HS graduate/no GED			23 (4.0)	19 (4.2)	4 (3.1)
HS graduate/GED			144 (24.9)	117 (26.0)	27 (20.9)
Some college			297 (51.3)	230 (51.1)	67 (51.9)
College graduate			115 (19.9)	84 (18.7)	31 (24.0)
Pre-tax earnings during past year	Survey	559			
< 20,000 USD			75 (13.4)	53 (12.2)	22 (17.5)
20,000 to < 40,000 USD			124 (22.2)	99 (22.9)	25 (19.8)
40,000 to < 60,000 USD			147 (26.3)	115 (26.6)	32 (25.4)
60,000 to < 80,000 USD			88 (15.7)	73 (16.9)	15 (11.9)
80,000+ USD			125 (22.4)	93 (21.5)	32 (25.4)
Race/ethnicity	Survey	598			
White/Caucasian			467 (78.1)	358 (77.2)	109 (81.3)
Black/African American			20 (3.3)	17 (3.7)	3 (2.2)
Asian			15 (2.5)	10 (2.2)	5 (3.7)
American Indian/Alaska Native			7 (1.2)	7 (1.5)	0 (0.0)
Native Hawaiian/Pacific Islander			9 (1.5)	6 (1.3)	3 (2.2)
Latino (any race)			34 (5.7)	31 (6.7)	3 (2.2)
Multiple			20 (3.3)	16 (3.5)	4 (3.0)
Unknown/vague			26 (4.4)	19 (4.1)	7 (5.2)
Nativity	Survey	579			
Born in U.S.			526 (90.9)	405 (90.0)	121 (93.8)
Born outside U.S.			53 (9.2)	45 (10.0)	8 (6.2)
Urban/rural residence	Admin	590			
Large central metro			122 (20.7)	98 (21.4)	24 (18.1)
Large fringe metro			209 (35.4)	154 (33.7)	55 (41.4)
Medium metro			126 (21.4)	100 (21.9)	26 (19.6)
Small metro			60 (10.2)	44 (9.6)	16 (12.0)
Micropolitan			56 (9.5)	47 (10.3)	9 (6.8)
Noncore			17 (2.9)	14 (3.1)	3 (2.3)
Body part	Admin	598			
Upper extremity			291 (48.7)	245 (52.8)	46 (34.3)
Lower extremity			178 (29.8)	147 (31.7)	31 (23.1)
Spine			95 (15.9)	51 (11.0)	44 (32.8)
Mental health			6 (1.0)	0 (0.0)	6 (4.5)
Other			28 (4.7)	21 (4.5)	7 (5.2)

Admin, administrative workers' compensation data; GED, General Education Diploma; HS, high school; metro, metropolitan; PPD, permanent partial disability; U.S., United States; USD, United States Dollar; WBI, whole body impairment.

Note: Column percentages do not always sum to exactly 100% due to rounding.

Workers with a higher degree of impairment more frequently reported fair to poor health status and work functioning (vs. good to excellent), both at claim closure (retrospectively) and at the time of their interview (Exhibit 3). Notably, 47.5% of those surveyed reported that their permanent impairment made it difficult to get a job, and 58.0% reported that their permanent impairment made it difficult to keep their job. Nearly two-thirds of workers reported moderate to very severe bodily pain during the past four weeks, and 39.9% reported at least some pain interference with work during that timeframe. With a 95% level of confidence, we found that workers with a higher degree of impairment had a higher odds of reporting poorer health status, poorer work-related functional ability, and difficulty getting or keeping a job, relative to workers with a lower degree of impairment. Further, although the 95% CI included the null, the same direction of effect was seen for several other survey questions reported in Exhibit 3, including continuing to experience (1) disability, pain or work limitations; (2) moderate to severe bodily pain, and (3) pain interference with work. Overall, 10.6% (N=61) reported taking chronic opioids (60 or more days in a row over the past year), and only 36.1% of that subset reported that taking opioids helped them work or function at their best (Exhibit 3).

The vast majority of workers surveyed (87.6%) were working for pay when interviewed, and 82.5% reported that their current or most recent job was full-time (Exhibit 4). When asked to estimate the average percent time they had worked over the year since claim closure, respondents reported working 82.2% of full-time (SD 28.1), on average, which could reflect either some delay in RTW after claim closure, and/or gaps in employment. The number of distinct jobs held since claim closure ranged from one to six; 79.0% of workers surveyed had a single job during the past year. We found that workers with a higher degree of impairment had a 70% higher odds of working in a different occupation than when they were injured, relative to workers with a lower degree of impairment (95% CI [1.13, 2.56]). Although the 95% CI included the null, workers with a higher degree of impairment had an estimated 44% higher odds of their first job after claim closure being with a new employer, rather than with the employer where they were injured (95% CI [0.95, 2.19]). Among those working at the time of the interview (N=500), workers with a higher degree of impairment had a 66% higher odds of reporting that their impairment put them at higher risk of losing their job, relative to workers with a lower degree of impairment (95% CI [1.01, 2.71]). During the year since claim closure, 13.4% of workers reported at least one new work injury that involved at least one missed day of work (Exhibit 4).

Workers were asked whether they had been diagnosed with, affected by, or treated for eight specified chronic health conditions, during the year since claim closure. Arthritis (rheumatoid or osteoarthritis) was reported as most prevalent, and diabetes (type I or II) as least prevalent. The self-reported effect of each condition on ability to work in the past year followed roughly the same ordering, except that chronic back pain/disease and depression were most frequently reported as interfering with ability to work, both more so than arthritis. Chronic back pain/disease was reported by 24.1% of the sample (144 of 598). The spine was the main impaired body part for 15.9% of the sample (95 of 598); fully half of that subset (48 of 95) reported chronic back pain/disease (which may have resulted from the primary spine impairment as opposed to representing a distinct comorbidity).[3]

More than a quarter of workers reported working fewer hours and earning less at the time they were interviewed, compared to before the injury, and 28.8% reported often worrying about their total income not being enough to meet expenses. Workers with a higher degree of impairment more frequently reported both working fewer hours and earning less at the time they were interviewed, compared to before the injury (Exhibit 5). Among all workers surveyed, 37.4% reported having no health insurance coverage via their employer, and 9.1% reported having no health insurance coverage at all (Exhibit 5).

Exhibit 3. Health, function, impairment, and pain, as reported by Washington State workers surveyed about a year after workers' compensation claim closure with a PPD award

Survey question	N	Overall (N=598)	WBI <10% (N=464)	WBI ≥10% (N=134)	Crude OR
		n (%)	n (%)	n (%)	(95% CI)
Health status at claim closure	595				
Fair/poor		166 (27.9)	119 (25.8)	47 (35.1)	1.55
Good/very good/excellent		429 (72.1)	342 (74.2)	87 (64.9)	(1.03, 2.34)
Current health status	594				
Fair/poor		165 (27.8)	117 (25.4)	48 (36.1)	1.66
Good/very good/excellent		429 (72.2)	344 (74.6)	85 (63.9)	(1.10, 2.51)
Work function ability at claim closure	592				
Fair/poor		215 (36.3)	153 (33.3)	62 (46.6)	1.75
Good/very good/excellent		377 (63.7)	306 (66.7)	71 (53.4)	(1.18, 2.59)
Current work function ability	590				
Fair/poor		186 (31.5)	131 (28.6)	55 (41.7)	1.78
Good/very good/excellent		404 (68.5)	327 (71.4)	77 (58.3)	(1.19, 2.66)
Still have disability/pain/limitation due to work injury	597				
Yes		553 (92.6)	426 (92.0)	127 (94.8)	1.58
No		44 (7.4)	37 (8.0)	7 (5.2)	(0.69, 3.62)
Impairment/disability/pain	550[a]				
Made it difficult to get a job		261 (47.5)	190 (44.2)	71 (59.2)	1.83
Did not make it difficult to get a job		289 (52.6)	240 (55.8)	49 (40.8)	(1.21, 2.76)
Impairment/disability/pain	590				
Made it difficult to stay at work or keep a job		342 (58.0)	248 (54.0)	94 (71.8)	2.16
Did not make it difficult to stay at work or keep a job		248 (42.0)	211 (46.0)	37 (28.2)	(1.42, 3.30)
Bodily pain in past 4 weeks	594				
Moderate/severe/very severe		389 (65.5)	293 (63.6)	96 (72.2)	1.49
Very mild or no pain		205 (34.5)	168 (36.4)	37 (27.8)	(0.97, 2.27)
Pain interfered with work in past 4 weeks	592				
Somewhat/quite a bit/very much		236 (39.9)	181 (39.3)	55 (42.0)	1.12
Not at all/a little bit		356 (60.1)	280 (60.7)	76 (58.0)	(0.75, 1.66)
Pain in past 4 weeks was impairment-related	536[b]				
Sometimes/always		453 (84.5)	337 (81.6)	116 (94.3)	3.74
Never/almost never		83 (15.5)	76 (18.4)	7 (5.7)	(1.67, 8.34)
Took opioids for pain 60+ days in a row in past year	593				
Yes		63 (10.6)	44 (9.6)	19 (14.3)	1.58
No		530 (89.4)	416 (90.4)	114 (85.7)	(0.88, 2.81)
Opioid medication taken for pain	61[c]				
Helped me work/function at my best		22 (36.1)	14 (32.6)	8 (44.4)	1.66
Had no effect or made work/function more difficult		39 (63.9)	29 (67.4)	10 (55.6)	(0.53, 5.17)

CI, confidence interval; OR, odds ratio; PPD, permanent partial disability; WBI, whole body impairment.

[a] Many workers still working for their pre-injury employer answered this question "Don't Know."

[b] Queried only if reported any pain.

[c] Queried only if reported taking opioids for 60+ days in a row.

Note: In each unadjusted logistic regression model, the independent variable was WBI percentage, comparing responses for workers with higher WBI to those with lower WBI (the reference category). ORs are shown on the row containing the response that was coded as 1; CIs are shown on the row containing the response that was coded as 0. Column percentages do not always sum to exactly 100% due to rounding.

Exhibit 4. Workforce reintegration, RTW interruption, and reinjury, as reported by Washington State workers surveyed about a year after workers' compensation claim closure with a PPD award

Survey question	N	Overall (N=598) n (%)	WBI <10% (N=464) n (%)	WBI ≥10% (N=134) n (%)	Crude OR (95% CI)
Working for pay when interviewed	589				
Currently working		516 (87.6)	402 (87.6)	114 (87.7)	1.01
Not currently working		73 (12.4)	57 (12.4)	16 (12.3)	(0.56, 1.83)
Current/most recent employment type	590				
Full-time traditional		487 (82.5)	381 (83.2)	106 (80.3)	0.82
Part-time, temporary, seasonal, or self-employed		103 (17.5)	77 (16.8)	26 (19.7)	(0.50, 1.35)
Union membership	588				
Currently a union member		250 (42.5)	191 (41.9)	59 (44.7)	1.12
Not currently a union member		338 (57.5)	265 (58.1)	73 (55.3)	(0.76, 1.66)
Industry sector now versus when injured[a]	588				
Industry sector now different than when injured		258 (43.9)	201 (44.1)	57 (43.2)	0.96
Industry sector not different		330 (56.1)	255 (55.9)	75 (56.8)	(0.65, 1.43)
Occupation now versus when injured	588				
Occupation now different than when injured		177 (30.1)	126 (27.5)	51 (39.2)	1.70
Occupation not different		411 (69.9)	332 (72.5)	79 (60.8)	(1.13, 2.56)
Employer for initial RTW versus when injured	591				
Initial RTW with different employer		166 (28.1)	121 (26.4)	45 (34.1)	1.44
Initial RTW with same employer		425 (71.9)	338 (73.6)	87 (65.9)	(0.95, 2.19)
New work injuries[b] since claim closure	590				
One or more new work injuries		79 (13.4)	60 (13.1)	19 (14.5)	1.13
No new work injuries		511 (86.6)	399 (86.9)	112 (85.5)	(0.65, 1.97)
Risk of being reinjured at work due to impairment	569				
At higher risk now compared to before injury		371 (65.2)	285 (64.2)	86 (68.8)	1.23
Not at higher risk now compared to before injury		198 (34.8)	159 (35.8)	39 (31.2)	(0.80, 1.88)
Risk of being reinjured at work due to impairment	561				
At higher risk compared to others doing same job		305 (54.4)	236 (53.9)	69 (56.1)	1.09
Not at higher risk compared to others doing same job		256 (45.6)	202 (46.1)	54 (43.9)	(0.73, 1.64)
Risk of losing current job due to impairment	500[c]				
At higher risk due to impairment		102 (20.4)	72 (18.5)	30 (27.3)	1.66
Not at higher risk due to impairment		398 (79.6)	318 (81.5)	80 (72.7)	(1.01, 2.71)
Will be working in 6 months	567				
Certain		456 (80.4)	355 (80.7)	101 (79.5)	0.93
Uncertain		111 (19.6)	85 (19.3)	26 (20.5)	(0.57, 1.52)

RTW, return(ed) to work; CI, confidence interval; OR, odds ratio; PPD, permanent partial disability; WBI, whole body impairment.

[a] Survey response for industry sector was compared to administrative workers' compensation data for industry sector when injured.

[b] For this question, qualifying work injuries were defined as those resulting in at least one missed day from work.

[c] Queried only if currently working.

Note: In each unadjusted logistic regression model, the independent variable was WBI percentage, comparing responses for workers with higher WBI to those with lower WBI (the reference category). ORs are shown on the row containing the response that was coded as 1; CIs are shown on the row containing the response that was coded as 0. Column percentages do not always sum to exactly 100% due to rounding.

Exhibit 5. Economic outcomes, as reported by Washington State workers surveyed about a year after workers' compensation claim closure with a PPD award

Survey question	N	Overall (N=598) n (%)	WBI <10% (N=464) n (%)	WBI ≥10% (N=134) n (%)	Crude OR (95% CI)
Number of work hours now versus before impairment	580				
Working fewer hours now		171 (29.5)	122 (27.2)	49 (37.4)	1.60
Working the same or more hours now		409 (70.5)	327 (72.8)	82 (62.6)	(1.06, 2.42)
Earnings now versus before impairment	583				
Earning less now		170 (29.2)	122 (27.0)	48 (36.6)	1.56
Earning the same or more now		413 (70.8)	330 (73.0)	83 (63.4)	(1.04, 2.36)
Worry about total income not being enough to meet expenses	579				
Often worry		167 (28.8)	123 (27.3)	44 (34.1)	1.38
Sometimes/never worry		412 (71.2)	327 (72.7)	85 (65.9)	(0.90, 2.09)
Contacted by collection agency in past 3 months	579				
Yes		102 (17.6)	77 (17.1)	25 (19.4)	1.16
No		477 (82.4)	373 (82.9)	104 (80.6)	(0.71, 1.92)
Housing at risk due to underpaid rent/mortgage in past 3 months	582				
Yes		57 (9.8)	43 (9.5)	14 (10.8)	1.15
No		525 (90.2)	409 (90.5)	116 (89.2)	(0.61, 2.17)
Health insurance coverage from employer	580				
No		217 (37.4)	170 (37.8)	47 (36.2)	0.93
Yes		363 (62.6)	280 (62.2)	83 (63.9)	(0.62, 1.40)
Health insurance coverage from any source	581				
No		53 (9.1)	46 (10.2)	7 (5.4)	0.50
Yes		528 (90.9)	405 (89.8)	123 (94.6)	(0.22, 1.14)

CI, confidence interval; OR, odds ratio; PPD, permanent partial disability; WBI, whole body impairment.

Note: In each unadjusted logistic regression model, the independent variable was WBI percentage, comparing responses for workers with higher WBI to those with lower WBI (the reference category). ORs are shown on the row containing the response that was coded as 1; CIs are shown on the row containing the response that was coded as 0. Column percentages do not always sum to exactly 100% due to rounding.

Workers in (1) nonstandard jobs (compared to full-time, permanent jobs) and (2) precarious jobs (compared to less precarious jobs) had higher adjusted odds of low expectations for sustained RTW (respectively, OR: 3.18, p=.002; OR: 3.13, p<.001). Additionally, workers in precarious jobs had higher adjusted odds of reporting fair or poor health (OR: 2.35, p=.011) and unmet need for disability accommodation (OR: 3.90, p<.001).[97]

More than a quarter of surveyed workers (27.8%) reported fair to poor health status at the time they were interviewed. This compares unfavorably with the most recent available Behavioral Risk Factor Surveillance System (2013-2015) estimate of 10.2% among all employed adults [125]. Nearly two-thirds of workers surveyed reported moderate to severe bodily pain during the past four weeks, and the vast majority attributed this pain to the injury that resulted in PPD. Of workers surveyed, 39.9% reported at least some pain interference with work during the same timeframe. Notably, only 36.1% of the subset who had taken chronic opioids during the past year (10.6% of the study sample) reported that taking opioids helped them work or function at their best.

We queried workers regarding the eight chronic health conditions from the FCI[93] that were identified by Marcum et al.[94] as most prevalent among workers with Washington State WC claims. Respondents reported arthritis as the most prevalent of the eight conditions, followed closely by chronic back pain/disease. Chronic back pain/disease and depression were the most frequently reported as interfering with ability to work. With the sole exception of arthritis, the

prevalence of each chronic health condition was higher than in the Marcum et al. study. Two possible reasons may be contributory: (1) Marcum et al. used medical billing diagnoses rather than self-report to identify comorbidities, and diagnosis codes for conditions unrelated to treatment of the work-related injury may not be systematically included on WC medical bills; and (2) the Marcum et al. study included all workers who had any compensated temporary or permanent disability (which could be as temporary as missing four days from work), while our study included only workers with some degree of permanent impairment. The Marcum et al. study found that claimants with multiple chronic comorbidities had higher odds of not working after injury, as well as poorer hours and earnings recovery, compared to those with no chronic comorbidities.[94]

More than a quarter of workers surveyed (and more than a third of those with ≥10% WBI) reported (1) often worrying about their total income not being enough to meet expenses, and (2) working fewer hours and earning less than before they were injured. These findings comport with a Canadian study documenting that about 12% of surveyed workers with permanent impairments (N=494) had poverty-level individual incomes prior to injury, rising to about 27% to 40% after injury (estimate varied by poverty measure).[15]

Of workers surveyed, 9.1% reported having no health insurance, compared to an estimated 7% of the Washington State population, and 9% of the U.S. population (based on 2018 American Community Survey data[126]). Of workers surveyed, 62.6% reported having health insurance via their employer, compared to an estimated 52% of the Washington State population, and 49% of the U.S. population.[126]

The high level of reported union membership may indicate relatively low job precarity among this sample. We found that disabled workers in nonstandard and precarious jobs reported a higher prevalence of challenges—including poor health, financial strain, poor sleep, and limited job accommodations after workforce reintegration—compared to their counterparts with full-time, permanent, and less precarious jobs.[97] Additionally, both nonstandard and precarious jobs were associated with low expectations for sustained RTW.[97] There were no clear patterns in workplace suggestions that emerged relative to current job precarity.

Due to data limitations, our estimated WBI percentages represented a lower bound, based solely on the body part contributing most to WBI, which would have a conservative effect on our ability to detect differences in response patterns associated with degree of impairment. Yet we did find several interesting, if unsurprising, patterns of association with degree of impairment—supporting content validity. As would be expected, workers with a higher degree of impairment (≥10% WBI) had substantially more time-loss days and higher medical costs for the WC claim that closed with a PPD award, on average, compared to workers with a lower degree of impairment (<10% WBI). Workers with a higher degree of impairment more frequently reported working in a different occupation than when they were injured. Workers with a higher degree of impairment more frequently reported fair to poor health status and work functioning (vs. good to excellent), both at claim closure (retrospectively) and at the time of the interview. Workers with a higher degree of impairment more frequently reported that their permanent impairment made it difficult to get a job (59.2%), and nearly three-quarters (71.8%) reported that their permanent impairment made it difficult to keep their job. When asked to compare their current status to pre-injury status, workers with a higher degree of impairment more frequently reported negative outcomes, including: (1) working fewer hours, (2) earning less, and (3) being at higher risk of losing their job due to permanent impairment.

Specific Aim 2

Aim 2: Quantify time-varying risks of RTW interruption and reinjury for permanently impaired workers who have RTW, compare to risks for injured workers without a PPD award, and assess the impact of worker/injury/job characteristics (e.g., age, gender, language, percent/type of permanent impairment, wage level, occupation, industry) on these outcomes. We hypothesize that permanently impaired workers are at higher risk of these outcomes compared to other injured workers, particularly in the first year after RTW.

Sub-study 2.1: Long-term employment patterns

The primary aim of this study was to characterize and quantify long-term employment outcomes, including RTW and subsequent RTW interruption, by degree of permanent impairment. To broadly characterize various attributes of long-term employment patterns, we used several regression approaches designed to model a set of employment metrics that were based on the timing, order, volatility, and prevalence of presence/absence of quarterly wages after WC claim closure. Secondarily, we explored the potential impact of several WC-based RTW programs on employment outcomes.

Additional methodology specific to sub-study 2.1

Employment outcomes. State wage files from the Washington State Employment Security Department were used to construct employment outcomes. These files include quarterly wages for workers covered by unemployment insurance, which excludes self-employment and exempt occupations.[99] These files do not include WC indemnity (wage replacement) payments or disability compensation. For this study, L&I staff used Social Security numbers to link administrative WC claims with quarterly wage data, and transmitted linked data, without identifiers, to our research team. Employment outcomes were measured beginning with the first claim closure quarter and followed for up to 10 years. Wage data were censored on the earliest of three dates: (1) administrative follow-up end date (December 31, 2018), (2) total permanent disability effective date, or (3) date of death. Wages were adjusted to December 2018 dollars using the Consumer Price Index. For construction of employment outcomes, observation for each included worker began with the quarter that the initial claim first closed (Q0). Although injured workers may RTW prior to claim closure, this origin was selected because it represented the most identifiable point at which all included workers would have: attained maximum medical improvement, been deemed able to work, and been rated with respect to degree of permanent impairment (if any). Each quarter was initially classified as having either (1) any wages or (2) no wages. First RTW was defined as the first quarter with any wages. A RTW interruption was defined as a quarter with no wages following a quarter with any wages (i.e., transition from a period of employment to a period of unemployment). For each worker, RTW interruptions were counted and the quarter with the first RTW interruption was identified. For descriptive purposes, a variable was constructed to summarize five specific wage patterns of interest: (1) timely and ongoing RTW, (2) delayed but ongoing RTW, (3) intermittent RTW, (4) RTW termination, and (5) never RTW. For each worker, wage pattern category was assigned based on all observed quarters from Q0 through censoring. These pattern categories were somewhat arbitrary; classifications for individual workers could change with shorter or longer observation periods. Exhibit 6 provides detailed definitions and illustrative examples of each of these wage patterns. Wage pattern examples were selected to demonstrate variation, rather than frequency, and include a selection of patterns exhibited by multiple workers having at least five years of uncensored follow-up after the first claim closure.

Data analysis. To broadly characterize long-term employment patterns, we used four different regression modeling approaches: (1) time to first RTW, (2) time to first RTW interruption, (3) RTW volatility, and (4) employment gaps. Each approach was intended to capture a somewhat different aspect of RTW and employment trajectories. Time to first RTW was analyzed using Cox proportional hazards regression,[127] estimating time from the first claim closure quarter to the first quarter with any wages. In order to include workers who RTW (or were already working) during the same quarter that their initial WC claim first closed, a small arbitrary value (0.001) was added to the time variable for those workers.[128] Time to first RTW interruption was also analyzed using Cox proportional hazards regression, estimating time from the first quarter with any wages to the first quarter with no wages, conditional on having some observed wages (i.e., workers who never RTW were excluded). RTW volatility and employment gaps were analyzed using negative binomial regression with the exposure term (at-risk denominator) measured at the worker level. The outcome for RTW volatility was the count of RTW interruptions, and the exposure was the count of quarters with any wages, conditional on having some observed wages (i.e., workers who never RTW were excluded). The outcome for employment gaps was the count of quarters with no wages, and the exposure was the count of observed calendar quarters. Exhibit 6 summarizes outcome definitions for each of the four regression-modeling approaches and provides measurement examples. Unadjusted Kaplan-Meier survival curves were used to illustrate differences in time to first RTW and time to first RTW interruption, by degree of impairment. Adjusted models for each regression approach included degree of permanent impairment, gender, age, preferred language, residence county, injured body part, FCI, urban-rural residence, injured body part, pre-injury quarterly wages, employer size, industry sector, hazard group, and fixed effects for year of first claim closure (2009 through 2017). Robust variance estimates were used to produce 95% CIs. The amount of missing data was negligible (<1%) for all variables; case-wise deletion was used in regression models. Parallel models were used to explore participation-related outcomes for the three separate analyses of WC-based RTW programs. To explore WC program-related outcomes, we conducted three separate analyses. For the first analysis, comparing employment outcomes for workers who participated in the Stay at Work program to those who did not, we excluded workers who did not have access to this program because their claims were never open (either initially or via reopening) once the Stay at Work program was implemented on June 15, 2011. Subgroup assignments were based on Stay at Work participation at any time during the initial WC claim. For the second analysis, comparing outcomes for workers who completed a vocational retraining plan to those who did not complete their plan, we included workers who: (1) had an approved vocational retraining plan for the initial injury, and (2) did not choose Option 2 in place of the approved conventional retraining plan. For the third analysis, comparing outcomes for workers who chose Option 2 to those who chose a conventional retraining plan (whether completed or not), we included workers who: (1) had an approved vocational retraining plan for the initial injury, and (2) had access to Option 2, which was first offered January 1, 2008. For the latter two analyses, subgroup assignments were based on events occurring prior to the initial WC claim's first claim closure date.

Exhibit 6. Definitions and examples of wage patterns and employment outcomes for regression models

		Employment outcomes for regression models			
Wage pattern category (definition)	Wage pattern examples (0=Q with no wages; 1=Q with any wages[a])	Time to first RTW (N Qs)	Time to first RTW interruption (N Qs)	RTW volatility (N RTW interruptions/N Qs with any wages)	Employment gaps (N Qs with no wages/N Qs observed)
Timely and ongoing RTW (wages in all observed Qs)	11111111111111111111	0.001[b]	>20 (censored)	0/21	0/21 (no pattern variation)
Delayed but ongoing RTW (RTW after Q0; wages in every observed Q after RTW)	00111111111111111111	2	>18 (censored)	0/19	2/21
	00000011111111111111	6	>14 (censored)	0/15	6/21
	00000000000000111111	15	>5 (censored)	0/6	15/21
Intermittent RTW (RTW in any Q, followed by RTW interruption in future Q, followed by RTW in future Q; pattern may repeat)	00000000001100000000	11	2	1/2	19/21
	01011111111111111111	1	1	1/19	2/21
	10000000000001111111	0.001[b]	1	1/8	13/21
	10100000000000000000	0.001[b]	1	2/2	19/21
	10010111111111111111	0.001[b]	1	2/18	3/21
	10111011000000000000	0.001[b]	1	3/7	14/21
	11110001011101000000	0.001[b]	4	4/10	11/21
	11101110110111011101	0.001[b]	3	5/16	5/21
RTW termination (timely RTW; no wages observed after first RTW interruption)	11000000000000000000	0.001[b]	2	1/2	19/21
	11111100000000000000	0.001[b]	6	1/6	15/21
	11111111111111111100	0.001[b]	19	1/19	2/21
Never RTW (no wages in all observed Qs)	00000000000000000000	>20 (censored)	N/A (excluded)	N/A (excluded)	21/21 (no pattern variation)

N/A, not applicable; Q, quarter; Q0, quarter of first claim closure; RTW, return(ed) to work.

[a] Order of presence/absence of any quarterly wages from quarter of first claim closure (Q0) through 5 years of follow-up.

[b] In order to include workers who RTW (or were already working) during the same quarter that their initial workers' compensation claim first closed (Q0), a small arbitrary value (0.001) was added to the time variable for those workers.

Results and discussion

In this retrospective cohort, 73.8% had no PPD award, 19.6% were in the WBI <10% group and 6.6% were in the WBI ≥10% group (Exhibit 7). All characteristics in Exhibit 7 were differentially distributed across these groups, to a statistically significant degree. For example, nearly half (47.8%) of those in the WBI ≥10% group had spine/neck injury compared to about a quarter (26.0%) overall. Compared to the WBI ≥10% group, the WBI <10% group had markedly higher percentages of upper and lower extremity injuries, and markedly lower percentages of spine/neck and other/multiple injuries. Spanish language preference applied to 19.8% of workers in the WBI ≥10% group, but to only 12.0% of workers with no PPD award. Construction/utilities/mining was the most common industry category for the WBI ≥10% group (17.6%), but only accounted for 9.3% of workers with no PPD award.

Nearly 90% of the workers included in each of the vocational rehabilitation program analyses had a permanent impairment (Exhibit 7). Over half (51.5%) of workers with an approved vocational retraining plan selected self-directed retraining funds (Option 2) in place of the conventional retraining plan; 56.7% of the WBI ≥10% group chose Option 2, compared to only 36.6% of those with no PPD award. Of workers with an approved vocational retraining plan (excluding those who chose Option 2), 41.0% completed their plan; 38.2% of the WBI ≥10% group completed their plan, compared to more than half (51.7%) of those with no PPD award.

Exhibit 7. Worker, injury, job, and workers' compensation program participation characteristics, by degree of impairment

Variable	Total (N=43,968) n (%)	No PPD award (n=32,450) n (%)	WBI <10% (n=8,604) n (%)	**WBI ≥10%** (n=2,914) n (%)
Body part				
Spine/neck	11,433 (26.0%)	8,782 (27.1%)	1,259 (14.6%)	1,392 (47.8%)
Upper extremity	14,649 (33.3%)	9,427 (29.1%)	4,541 (52.8%)	681 (23.4%)
Lower extremity	9,785 (22.3%)	6,781 (20.9%)	2,689 (31.3%)	315 (10.8%)
Other/multiple	8,098 (18.4%)	7,457 (23.0%)	115 (1.3%)	526 (18.1%)
Gender				
Male	24,919 (56.7%)	18,102 (55.8%)	5,083 (59.1%)	1,734 (59.5%)
Female	19,048 (43.3%)	14,347 (44.2%)	3,521 (40.9%)	1,180 (40.5%)
Age at first claim closure				
18-24	8,966 (20.4%)	7,789 (24.0%)	991 (11.5%)	186 (6.4%)
25-34	13,274 (30.2%)	10,418 (32.1%)	2,207 (25.7%)	649 (22.3%)
35-44	9,168 (20.9%)	6,346 (19.6%)	2,061 (24.0%)	761 (26.1%)
45-54	7,165 (16.3%)	4,639 (14.3%)	1,804 (21.0%)	722 (24.8%)
55-64	4,406 (10.0%)	2,686 (8.3%)	1,246 (14.5%)	474 (16.3%)
≥65	989 (2.2%)	572 (1.8%)	295 (3.4%)	122 (4.2%)
Preferred language				
English	36,538 (83.1%)	27,572 (85.0%)	6,713 (78.0%)	2,253 (77.3%)
Spanish	6,081 (13.8%)	3,890 (12.0%)	1,614 (18.8%)	577 (19.8%)
Other	1,349 (3.1%)	988 (3.0%)	277 (3.2%)	84 (2.9%)
Urban-rural residence county				
Large central metropolitan	11,589 (26.6%)	8,933 (27.8%)	2,091 (24.5%)	565 (19.5%)
Large fringe metropolitan	12,869 (29.5%)	9,475 (29.5%)	2,516 (29.5%)	878 (30.2%)
Medium metropolitan	8,283 (19.0%)	6,064 (18.9%)	1,614 (18.9%)	605 (20.8%)
Small metropolitan	5,889 (13.5%)	4,059 (12.6%)	1,308 (15.4%)	522 (18.0%)
Micropolitan	3,904 (9.0%)	2,835 (8.8%)	796 (9.3%)	273 (9.4%)
Noncore	1,022 (2.3%)	766 (2.4%)	196 (2.3%)	60 (2.1%)
Employer size				
Small (<50 FTE employees)	19,756 (45.3%)	14,208 (44.0%)	4,107 (48.3%)	1,441 (51.3%)
Large (≥50 FTE employees)	23,850 (54.7%)	18,088 (56.0%)	4,394 (51.7%)	1,368 (48.7%)
Industry sector				
Agriculture, Forestry, Fishing, Hunting	3,047 (6.9%)	2,074 (6.4%)	712 (8.3%)	261 (9.0%)
Construction, Utilities, Mining	4,826 (11.0%)	3,014 (9.3%)	1,300 (15.1%)	512 (17.6%)
Manufacturing	3,156 (7.2%)	2,168 (6.7%)	763 (8.9%)	225 (7.7%)
Retail/Wholesale Trade	7,017 (16.0%)	5,260 (16.2%)	1,338 (15.6%)	419 (14.4%)
Transportation, Warehousing	2,434 (5.5%)	1,911 (5.9%)	377 (4.4%)	146 (5.0%)
Information, Finance, Real Estate, Professional	2,846 (6.5%)	2,058 (6.3%)	604 (7.0%)	184 (6.3%)
Administrative, Support, Other Services	7,814 (17.8%)	5,853 (18.0%)	1,466 (17.0%)	495 (17.0%)
Education, Health Care, Social Services	7,199 (16.4%)	5,628 (17.3%)	1,164 (13.5%)	407 (14.0%)
Arts, Entertainment, Hospitality	5,617 (12.8%)	4,475 (13.8%)	878 (10.2%)	264 (9.1%)
Stay at Work program[a]	(N=31,536)	(n=23,167)	(n=6,173)	(n=2,196)
No participation in Stay at Work	29,734 (94.3%)	22,043 (95.1%)	5,640 (91.4%)	2,051 (93.4%)
Participated in Stay at Work	1,802 (5.7%)	1,124 (4.9%)	533 (8.6%)	145 (6.6%)
Vocational retraining plan[b]	(N=1,319)	(n=143)	(n=608)	(n=568)
Plan not completed	778 (59.0%)	69 (48.3%)	358 (58.9%)	351 (61.8%)
Plan completed	541 (41.0%)	74 (51.7%)	250 (41.1%)	217 (38.2%)
Vocational retraining approach[c]	(N=1,267)	(n=131)	(n=589)	(n=547)
Conventional vocational retraining plan	615 (48.5%)	83 (63.4%)	295 (50.1%)	237 (43.3%)
Option 2: Self-directed retraining funds	652 (51.5%)	48 (36.6%)	294 (49.9%)	310 (56.7%)

Note: All variables in Exhibit 7 were significantly associated with degree of impairment (*P*<.001 for all variables, with exception of *P*=.013 for vocational retraining plan completion).

FTE, full-time equivalent; PPD, permanent partial disability; WBI, whole body impairment.

[a] Inclusion conditional on initial claim being open at some point after the Stay at Work program was implemented (June 15, 2011).

[b] Inclusion conditional on having an approved vocational retraining plan and not having selected Option 2.

[c] Inclusion conditional on having an approved vocational retraining plan (completed or not completed).

The FCI ranged from 0 to 8, with 93.0% having no identified comorbidities; mean values were 0.07 (95% CI: 0.07, 0.08) for the no PPD award group, 0.08 (95% CI: 0.08, 0.09) for the WBI <10% group, and 0.17 (95% CI: 0.15, 0.19) for the WBI ≥10% group. Mean adjusted pre-injury quarterly wages were $6196 (95% CI: $6133, $6260) for the no PPD award group, $7218 (95% CI: $7076, $7360) for the WBI <10% group, and $7149 (95% CI: 6894, $7404) for the WBI ≥10% group. Hazard group ranged from 1 to 9, with a mean of 3.70 (95% CI: 3.67, 3.72) for the no PPD award group, 4.09 (95% CI: 4.04, 4.14) for the WBI <10% group), and 4.35 (95% CI: 4.26, 4.44) for the WBI ≥10% group. Year of first claim closure (2009 through 2017) was fairly evenly distributed across impairment groups.

As shown in Exhibit 8, wage patterns were significantly different by degree of impairment. Based on wage files, 8.98% of the overall cohort—and over a quarter (27.32%) of workers with WBI ≥10%--did not RTW during the observation period. Only 17.78% of workers with WBI ≥10% exhibited timely and ongoing RTW, compared to 34.43% of workers with no PPD award. Less than 1% of this cohort had a subsequent total permanent disability award (pension) or a recorded death during the observation period, and the observation period was roughly similar across all impairment categories. Workers with WBI ≥10% took longer on average to RTW, and then had shorter average times to the first RTW interruption, compared to workers in the other two impairment categories (workers with WBI <10% and workers with no PPD award). The same pattern—poorest outcomes among workers with WBI ≥10%— held for both the frequency of RTW interruptions, and the frequency of quarters with no wages. Up to 15 RTW interruptions were observed over the follow-up period. With the exception of time to first RTW interruption, there were monotonic associations between a higher degree of impairment and poorer employment outcomes.

Exhibit 8. Unadjusted employment outcome summaries, by degree of permanent impairment

	Total (N=43,968)		No PPD award (n=32,450)		WBI <10% (n=8,604)		**WBI ≥10%** (n=2,914)	
Variable	n	%	n	%	n	%	n	%
Wage pattern[a]								
Timely and ongoing RTW	14,349	32.64	11,172	34.43	2,659	30.90	518	17.78
Delayed but ongoing RTW	1,941	4.41	1,200	3.70	485	5.64	256	8.79
Intermittent RTW	12,289	27.95	9,012	27.77	2,391	27.79	886	30.40
RTW termination	11,440	26.02	9,065	27.94	1,917	22.28	458	15.72
Never RTW	3,949	8.98	2,001	6.17	1,152	13.39	796	27.32
Reason for censoring								
Administrative[b]	43,878	99.80	32,398	99.84	8,575	99.66	2,905	99.69
Total permanent disability[c]	50	0.11	35	0.11	14	0.16	1	0.03
Death	40	0.09	17	0.05	15	0.17	8	0.27
Any wages (RTW) in Q0 or Q1[d]	34,969	79.53	27,403	84.45	6,137	71.33	1,429	49.04
Time measured in Qs	Estimate	(95% CI)	Estimate	(95% CI)	Estimate	(95% CI)	Estimate	(95% CI)
Observation time (mean)	22.79	(22.70-22.89)	22.60	(22.49-22.72)	23.38	(23.16-23.60)	23.23	(22.86-23.60)
Time to first RTW								
Median	0.001[e]	(0.001-0.001)	0.001[e]	(0.001-0.001)	0.001[e]	(0.001-0.001)	2	(1-2)
Restricted mean[f]	4.18	(4.08-4.29)	2.96	(2.85-3.06)	6.16	(5.88-6.44)	12.02	(11.40-12.64)
Time to first RTW interruption after first RTW (N=40,019)								
Median	12	(12-12)	12	(12-12)	13	(13-14)	10	(9-11)
Restricted mean[f]	18.02	(17.85-18.19)	17.98	(17.78-18.17)	18.72	(18.33-19.11)	16.14	(15.42-16.86)
N RTW interruptions[g] as a proportion of N Qs with any wages (N=40,019)	0.15	(0.14-0.15)	0.14	(0.14-0.15)	0.15	(0.14-0.15)	0.18	(0.16-0.19)
N Qs with no wages as a proportion of N observed Qs	0.36	(0.35-0.36)	0.33	(0.33-0.33)	0.39	(0.39-0.40)	0.55	(0.53-0.56)

CI, confidence interval; PPD, permanent partial disability; Q, quarter; RTW, return(ed) to work; WBI, whole body impairment.

[a] Wage pattern category definitions are presented in Exhibit 6.

[b] The study observation period ended on December 31, 2018.

[c] Related to a subsequent claim for the same worker.
[d] All included workers were observed for wages during the first claim closure quarter (Q0) and the subsequent quarter (Q1); some workers were censored beginning in quarter 2.
[e] In order to include workers who RTW (or were already working) during the same quarter that their initial workers' compensation claim first closed (Q0), a small arbitrary value (0.001) was added to the time variable for those workers.
[f] The restricted mean was calculated by restriction to the longest follow-up time; it underestimates mean survival time due to censoring.
[g] RTW interruption was defined as a quarter with no wages following a quarter with wages.

We estimated associations between degree of permanent impairment and employment outcomes using four modeling approaches (Exhibit 9). Poorer employment outcomes would be indicated by a hazard ratio <1 for the time to first RTW models, and a hazard ratio or incidence rate ratio >1 for the other three modeling approaches. In adjusted models, workers with WBI ≥10% had substantially and significantly poorer employment outcomes, compared to workers with no PPD award. Compared to workers with no PPD award, workers with WBI ≥10% were 43% less likely to RTW and 15% more likely to have a RTW interruption (instantaneous hazard); they also had an 18% higher rate of RTW interruptions (RTW volatility), and a 65% higher rate of quarters with no wages (employment gaps). However, findings were mixed for workers with WBI <10%. Compared to workers with no PPD award, workers with WBI <10% had significantly poorer outcomes with respect to time to first RTW and employment gaps, but not with respect to first RTW interruption and RTW volatility.

There were also strong associations between most covariates and employment outcomes, though many exhibited smaller effect sizes than those observed for permanent impairment (Exhibit 9). For example, compared to men, women were 3% less likely to RTW and 4% more likely to have a RTW interruption (instantaneous hazard). Women also had a 6% higher rate of quarters with no wages than did men; however, there was little difference in RTW volatility. Older workers generally exhibited poorer employment outcomes compared to younger workers (all four modeling approaches), particularly in the upper age categories. Higher pre-injury wages and a large (versus small) pre-injury employer were associated with better employment outcomes (all four approaches). Compared to a spine/neck injury, the other three body part categories were associated with better (though not always statistically significant) employment outcomes (all four approaches). A higher score on the FCI was significantly associated with poorer employment outcomes for three of the four modeling approaches, but not with time to first RTW. Workers residing in the most rural (noncore) counties had markedly poorer employment outcomes (all four approaches), including a 34% higher rate of RTW interruptions (RTW volatility), compared to workers residing in the most urban county (large central metropolitan).

We estimated associations between participation in each of three WC-based RTW programs and the four employment outcomes (Exhibit 10). Adjusted models included all covariates presented in Exhibit 9 (as well as fixed effects for year of first claim closure), and also included the specified program participation variable. We found that participation in the Stay at Work program was associated with significantly and substantially better employment outcomes (all four modeling approaches), compared to those who did not participate. We also found that completion of a conventional vocational retraining plan was associated with significantly and substantially better employment outcomes (all four approaches), compared to those who did not complete their plan. In contrast, we found that choosing self-directed retraining funds (Option 2) was significantly and substantially associated with poorer employment outcomes, compared to choosing a conventional retraining plan (Exhibit 10).

Exhibit 9. Unadjusted and adjusted employment outcome regression models, by degree of permanent impairment

Characteristic/Model	Time to first RTW Unadjusted N=43,968 Adjusted N=43,023			Time to first RTW interruption Unadjusted N=40,019 Adjusted N=39,227			RTW volatility Unadjusted N=40,019 Adjusted N=39,227			Employment gaps Unadjusted N=43,968 Adjusted N=43,023		
Unadjusted	HR	(95% CI)	*P*[a]	HR	(95% CI)	*P*[a]	IRR	(95% CI)	*P*[a]	IRR	(95% CI)	*P*[a]
Impairment (Ref: No PPD award)			<.001			<.001			<.001			<.001
WBI <10%	0.82	(0.80-0.83)		0.95	(0.92-0.98)		0.97	(0.93-1.01)		1.19	(1.16-1.22)	
WBI ≥10%	0.57	(0.55-0.59)		1.15	(1.09-1.22)		1.18	(1.10-1.26)		1.65	(1.60-1.69)	
Adjusted	HR	(95% CI)	*P*[a]	HR	(95% CI)	*P*[a]	IRR	(95% CI)	*P*[a]	IRR	(95% CI)	*P*[a]
Impairment (Ref: No PPD award)			<.001			<.001			<.001			<.001
WBI <10%	0.83	(0.82-0.85)		0.98	(0.95-1.02)		1.00	(0.96-1.04)		1.15	(1.12-1.19)	
WBI ≥10%	0.62	(0.60-0.65)		1.15	(1.09-1.22)		1.18	(1.10-1.26)		1.53	(1.47-1.59)	
Female (Ref: Male)	0.97	(0.95-0.98)	<.001	1.04	(1.01-1.07)	.006	1.02	(0.98-1.05)	.350	1.06	(1.03-1.08)	<.001
Age (Ref: 18-24)			<.001			<.001			<.001			<.001
25-34	0.92	(0.90-0.93)		1.04	(1.00-1.07)		1.09	(1.05-1.14)		1.16	(1.12-1.20)	
35-44	0.86	(0.85-0.88)		0.97	(0.93-1.01)		1.03	(0.98-1.08)		1.19	(1.15-1.24)	
45-54	0.81	(0.79-0.83)		0.99	(0.94-1.03)		1.06	(1.01-1.12)		1.31	(1.25-1.37)	
55-64	0.77	(0.75-0.79)		1.21	(1.15-1.27)		1.40	(1.32-1.49)		1.65	(1.55-1.74)	
≥65	0.65	(0.61-0.69)		1.62	(1.49-1.76)		2.12	(1.90-2.37)		2.38	(2.19-2.58)	
Preferred language (Ref: English)			<.001			<.001			<.001			<.001
Spanish	0.94	(0.92-0.96)		0.98	(0.94-1.02)		1.03	(0.98-1.08)		1.10	(1.06-1.13)	
Other	0.97	(0.93-1.00)		0.85	(0.79-0.92)		0.82	(0.75-0.91)		0.99	(0.93-1.05)	
Urban-rural residence county (Ref: Large central metropolitan)			.016			.001			<.001			<.001
Large fringe metropolitan	0.98	(0.97-1.00)		1.03	(0.99-1.06)		1.04	(1.00-1.08)		1.04	(1.01-1.07)	
Medium metropolitan	1.00	(0.99-1.02)		1.05	(1.01-1.09)		1.08	(1.04-1.13)		1.05	(1.02-1.09)	
Small metropolitan	1.00	(0.98-1.02)		1.03	(0.98-1.07)		1.08	(1.02-1.13)		1.00	(0.96-1.04)	
Micropolitan	1.01	(0.99-1.03)		1.03	(0.98-1.08)		1.05	(0.99-1.12)		1.02	(0.97-1.07)	
Noncore	0.95	(0.91-0.99)		1.19	(1.09-1.29)		1.34	(1.22-1.47)		1.21	(1.13-1.29)	
Body part (Ref: Spine/neck)			<.001			.006			.006			<.001
Upper extremity	1.08	(1.06-1.09)		0.97	(0.94-1.00)		0.96	(0.92-1.00)		0.91	(0.88-0.94)	
Lower extremity	1.09	(1.07-1.11)		0.94	(0.90-0.97)		0.93	(0.89-0.97)		0.88	(0.85-0.90)	
Other/multiple	1.03	(1.02-1.05)		0.97	(0.93-1.01)		0.99	(0.95-1.04)		0.95	(0.92-0.98)	
Functional Comorbidity Index	0.98	(0.96-1.00)	.101	1.06	(1.02-1.10)	.003	1.08	(1.03-1.13)	.001	1.05	(1.02-1.08)	.001
Pre-injury wages ($10,000 increments)	1.17	(1.15-1.19)	<.001	0.51	(0.49-0.52)	<.001	0.44	(0.42-0.46)	<.001	0.68	(0.63-0.73)	<.001
Large employer (Ref: Small employer)	1.07	(1.06-1.08)	<.001	0.93	(0.90-0.95)	<.001	0.93	(0.90-0.96)	<.001	0.89	(0.87-0.91)	<.001
Industry sector (Ref: Information, Finance, Real Estate, Professional)			<.001			<.001			<.001			<.001
Agriculture, Forestry, Fishing, Hunting	0.98	(0.95-1.02)		1.18	(1.09-1.27)		1.26	(1.15-1.38)		1.03	(0.96-1.10)	
Construction, Utilities, Mining	0.93	(0.90-0.96)		1.17	(1.10-1.26)		1.22	(1.12-1.32)		1.10	(1.04-1.17)	
Manufacturing	0.98	(0.95-1.01)		1.01	(0.95-1.09)		0.98	(0.90-1.07)		0.98	(0.92-1.04)	
Retail/Wholesale Trade	1.00	(0.97-1.02)		0.92	(0.87-0.98)		0.89	(0.83-0.96)		0.95	(0.90-1.01)	
Transportation, Warehousing	0.96	(0.93-1.00)		1.08	(1.01-1.17)		1.08	(0.99-1.18)		1.07	(1.00-1.14)	
Administrative, Support, Other Services	0.96	(0.94-0.99)		1.01	(0.95-1.07)		1.02	(0.95-1.09)		1.01	(0.95-1.06)	
Education, Health Care, Social Services	1.01	(0.98-1.04)		0.92	(0.87-0.97)		0.89	(0.83-0.96)		0.93	(0.87-0.99)	
Arts, Entertainment, Hospitality	0.98	(0.95-1.01)		0.96	(0.90-1.03)		0.93	(0.86-1.01)		0.99	(0.92-1.05)	
Hazard group	0.99	(0.99-0.99)	<.001	1.01	(1.01-1.02)	<.001	1.01	(1.01-1.02)	.002	1.01	(1.01-1.02)	<.001
Year of first claim closure (Ref: 2009)[b]			<.001			<.001			<.001			<.001

CI, confidence interval; HR, hazard ratio; IRR, Incidence rate ratio; PPD, permanent partial disability; Ref, reference category; RTW, return(ed) to work; WBI, whole body impairment.

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

[b] A fixed effect for each year of first claim closure was also included in all models presented in this table; though statistically significant, these parameters were not of direct interest. For brevity, these parameters were not included in this table.

Exhibit 10. Unadjusted and adjusted employment outcome regression models, by participation in workers' compensation programs

	Time to first RTW			Time to first RTW interruption			RTW volatility			Employment gaps		
Model	N	HR	(95% CI)	N	HR	(95% CI)	N	IRR	(95% CI)	N	IRR	(95% CI)
Stay at Work program[a]												
Unadjusted	31,536	1.13	(1.10-1.15)	28,653	0.75	(0.70-0.81)	28,653	0.74	(0.67-0.81)	31,536	0.75	(0.71-0.80)
Adjusted[b]	30,867	1.12	(1.09-1.14)	28,086	0.86	(0.79-0.92)	28,086	0.84	(0.77-0.92)	30,867	0.80	(0.75-0.86)
Completed vocational retraining plan[c] (Ref: Approved plan not completed)												
Unadjusted	1,319	1.24	(1.09-1.41)	849	0.80	(0.68-0.95)	849	0.78	(0.63-0.97)	1,319	0.87	(0.81-0.93)
Adjusted[b]	1,240	1.30	(1.13-1.49)	798	0.75	(0.63-0.90)	798	0.73	(0.58-0.91)	1,240	0.86	(0.80-0.92)
Option 2: Self-directed retraining funds[d] (Ref: Conventional plan)												
Unadjusted	1,267	0.72	(0.63-0.82)	818	1.47	(1.24-1.74)	818	1.60	(1.29-1.98)	1,267	1.24	(1.16-1.33)
Adjusted[b]	1,207	0.69	(0.60-0.79)	776	1.56	(1.30-1.86)	776	1.70	(1.36-2.13)	1,207	1.27	(1.18-1.36)

Note: All estimates in this table were statistically significant at P<.001, with several exceptions for the vocational retraining plan completion models: (1) Time to first RTW (unadjusted, *P*=.001), (2) Time to first RTW interruption (unadjusted, *P*=.009; adjusted, *P*=.002), and (3) RTW volatility (unadjusted, *P*=.024, adjusted, *P*=.006).

CI, confidence interval; HR, hazard ratio; IRR, incidence rate ratio; Ref, reference category; RTW, return(ed) to work.

[a] Inclusion conditional on initial claim being open at some point after the Stay at Work program was implemented (June 15, 2011).

[b] Adjusted models included the same variables as shown for the adjusted models in Exhibit 9, including degree of impairment.

[c] Inclusion conditional on having an approved vocational retraining plan and not having selected Option 2.

[d] Inclusion conditional on having an approved vocational retraining plan (completed or not completed).

In conclusion, we found that wage patterns and employment outcomes significantly differed by degree of impairment. For the most part, there were monotonic associations between a higher degree of impairment and poorer employment outcomes; however, there was little difference between workers with no PPD and workers with WBI <10% regarding timing or frequency of RTW interruption. Workers with WBI ≥10% took longer on average to RTW, and then had shorter average times to the first RTW interruption, compared to workers in the other two impairment categories. Workers with WBI ≥10% also had the highest frequency of RTW interruptions and the highest frequency of quarters with no wages. A higher risk of reinjury among workers with ≥10% WBI may contribute to their higher risk of RTW interruption. In a previous related study, workers with ≥10% WBI had an estimated 34% higher risk of reinjury, compared to workers with no PPD award, based on adjusted models that accounted for working time at risk.[5]

It is important to note that all workers in this cohort would have been classified as having RTW, had we used cessation of time-loss compensation or WC claim closure as a proxy. Yet 8.98% of the overall cohort, and 27.32% of workers with ≥10% WBI, had no observed wages after claim closure. Although most workers RTW within the same calendar quarter that their claim first closed, many workers experienced lengthy delays before first RTW. The average time from first claim closure to first RTW was more than a year (restricted mean: 4.18 quarters), monotonically increasing with increasing degree of impairment.

Several recent studies have demonstrated the importance of characterizing employment trajectories beyond simply measuring initial RTW, whether that be via measuring time to sustained RTW,[22] or via using sequence and/or cluster analysis to identify specific employment patterns.[129,130] In this cohort, some workers exhibited intermittent RTW patterns over an extended period; for other workers, intermittent RTW patterns eventually stabilized into a longer stretch of either employment or unemployment. By modeling four different employment outcomes in this study (i.e., time to first RTW, time to first RTW interruption, RTW volatility, employment gaps), we were able to broadly characterize various attributes of long-term employment patterns. In adjusted models, workers with WBI ≥10% had substantially and

significantly poorer employment outcomes, compared to workers with no PPD award, for all four modeling approaches. However, findings were mixed for workers with WBI <10%. Compared to workers with no PPD award, workers with WBI <10% had significantly poorer outcomes with respect to time to first RTW and employment gaps, but not with respect to first RTW interruption and RTW volatility. There may be quite different mechanisms of effect for initial RTW versus RTW interruption; RTW may depend on availability of the pre-injury (perhaps modified) job or the ability to be hired into a new job, while RTW interruption may depend more upon workplace conditions that support or interfere with sustained RTW, reinjury incidence, etc. RTW volatility (rate of transitions from periods of employment to periods of unemployment) is related to the intermittent nature of RTW, whether due to employment type (seasonal, temporary), workplace characteristics, or worker/injury characteristics. Strikingly, as many as 15 RTW interruptions for an individual worker were observed over 10 years of follow-up. This observation is even more striking when we consider that these data represented quarterly intervals, and thus RTW interruptions lasting less than a calendar quarter would not have been observed.

We found that participation in the Stay at Work program was associated with significantly and substantially better employment outcomes, compared to outcomes for those who did not participate. Employment outcomes for injured workers participating in WC vocational rehabilitation programs were of particular interest because nearly 90% of these workers had a work-related permanent impairment. Further, choice of Option 2 was more prevalent among workers with permanent impairment; 56.7% of the WBI ≥10% group chose Option 2, compared to only 36.6% of those with no PPD award. Among workers who chose the conventional retraining plan, workers with permanent impairment were less likely to complete their plan; 38.2% of the WBI ≥10% group completed their plan, compared to more than half (51.7%) of those with no PPD award. Consistent with findings from an earlier evaluation,[63] completion of a conventional vocational retraining plan was associated with significantly and substantially better employment outcomes, compared to outcomes for those who did not complete their plan. In contrast, we found that choosing self-directed retraining funds (Option 2) was significantly and substantially associated with poorer employment outcomes, compared to choosing a conventional retraining plan (whether completed or not). In an earlier related study,[5] we found a higher risk of reinjury among injured workers who: (1) did not complete their approved vocational retraining plan, compared to those who did; and (2) chose Option 2, compared to those who chose a conventional retraining plan (the Stay at Work program was not assessed).

These program-related findings are descriptive and exploratory, and, at least in part, they likely reflect selection effects into each of these programs (whether by WC staff, employers, or workers themselves). However, these findings merit further inquiry into the underlying mechanisms, especially as these programs operate at the WC system level and thus could have important impacts on the health and safety of large numbers of workers. Every year, roughly 300,000 U.S. workers experience serious work injuries that result in permanent impairment and a PPD award,[131] yet there has been little systematic research regarding the impact of WC-based programs on long-term employment outcomes for these workers. In a California study, researchers found that RTW programs led to significant reductions in the duration of work-injury absences, and that most of that impact was driven by a large improvement in RTW for injured workers with permanent impairments.[66] Previous research documenting WC benefit inadequacy demonstrates the importance of promoting good employment outcomes to minimize workers' economic losses. In a Wisconsin study of injured workers (1989-1990), WC benefits for workers with PPD awards were estimated to cover 83% of 10-year after-tax projected losses for men, and 63% for women.[18] In a more recent New Mexico study linking WC claims (1994-2000) to federal tax data, WC benefits for workers with PPD awards were estimated to cover 35% of 10-year after-tax losses for men, and 28% for women.[17]

While our regression models were not specifically designed to assess other covariates, most had strong associations with employment outcomes, and the observed associations may provide exploratory fodder for further research. A higher score on the FCI was significantly associated with poorer employment outcomes for three of the four modeling approaches but was not associated with time to first RTW. This suggests that, for workers with comorbidities, sustained RTW is more challenging than initial RTW. Other research has found that injured workers with multiple chronic comorbidities had significantly higher odds of not working post injury and poorer hours and earnings recovery (using state wage data) compared to those with no chronic comorbidities.[94] Using data from the Health and Retirement Study, researchers found that workers with multimorbidity had a higher risk of transitioning to partial retirement and to full retirement, when compared to workers without chronic conditions or to those who had just one comorbidity.[132] Our findings that women, compared to men, had delayed RTW followed by quicker RTW interruption, along with more quarters with no wages, generally comport with other studies showing women at higher risk for RTW interruption[22] and economic losses[17,18] after work injury. Our findings that older workers generally exhibited poorer employment outcomes compared to younger workers, particularly in the upper age categories, comport with other studies showing older age as a risk factor for both RTW interruption[22] and early retirement after work injury.[23,133] Higher pre-injury wages were associated with better employment outcomes. Other studies have documented that workers with low income prior to a work injury are particularly likely to exit the labor force early,[23] are more vulnerable to poverty,[15] and face a substantially greater risk of being unable to escape poverty after work-related permanent impairment.[15]

Sub-study 2.2: Estimating time to reinjury

Injured workers may face delayed RTW or may RTW part-time or intermittently. A calendar timescale may overestimate time at risk (via the assumption of full employment during that time, or the assumption that the amount of calendar time spent working is comparable across groups), yielding underestimated reinjury rates and biased comparisons between groups having differential RTW patterns. In particular, calendar time might differentially overestimate time at risk for workers with permanent impairment, which would lead to underestimated reinjury risk estimates. In addressing this issue, state wage files—constructed from mandatory unemployment insurance-related employer tax and wage reports—provide an efficient but underused approach to identifying RTW patterns. To facilitate more accurate estimates of reinjury risk, we used state wage data to identify periods of employment and unemployment. The aims of this study were to: (1) estimate reinjury risk for workers by degree of permanent impairment; (2) estimate variation in reinjury risk by other worker, injury, and job characteristics, and by time since injury; and (3) assess whether choice of timescale (at-risk denominator) substantially affects reinjury risk estimates. We hypothesized that workers with work-related permanent impairment would be at elevated risk of reinjury compared to other injured workers, particularly in the first year after RTW. Secondarily, we explored program-related outcomes for injured workers participating in vocational rehabilitation, many of whom have a work-related permanent impairment.

Additional methodology specific to sub-study 2.2

Reinjury outcomes. After the eligible cohort was identified, further administrative data were obtained from L&I for these workers. These data included all WC claims (State Fund and self-insured) with injury dates after the initial injury date, through the end of 2018, regardless of

claim status (e.g., medical-only, fatal, total permanent disability). The operational definition of reinjury included both reopened claims (likely reflecting initial injury aggravation, exacerbation or recurrence) and new claims (likely reflecting new injuries).[134,135] This allowed for observation of reinjury outcomes for one to 19 years after the initial injury, depending on year of injury.

Time at risk. 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.[99] For this study, L&I staff used Social Security numbers to link administrative WC claims with quarterly wage data, and then transmitted linked data, without identifiers, to our research team. Wages were adjusted to December 2018 dollars using the Consumer Price Index. For comparison purposes, three at-risk timescales were used to measure time from initial injury to the first reinjury or censoring: (1) calendar quarters (i.e., observed calendar time, regardless of wages/hours worked); (2) any-wage quarters (i.e., excluding quarters with no wages, when presumably not at risk for work injury); and (3) FTE quarters (i.e., cumulative work hours divided by 520—approximating quarters of full-time work). The latter two timescales used work-status measures (wages or hours) rather than calendar time to measure time at risk and were not necessarily synchronous with calendar time. 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. Data were censored on the earliest of three dates: (1) administrative follow-up end date (December 31, 2018), (2) total permanent disability effective date, or (3) date of death.

Data analysis. The amount of missing data was negligible (<1%) for all variables. We therefore used the subset of cases with complete data for all variables (retaining N=43,114 injured workers, or 97.8% of the eligible sample of 44,068 injured workers) for all analyses. This also ensured that comparisons across the three timescales would be based on the same sample (wages and hours were not always missing synchronously). Unadjusted Kaplan-Meier survival curves were used to illustrate differences in the proportions of injured workers not reinjured, by degree of impairment and timescale. Survival functions were used to quantify the proportions of injured workers not reinjured for each timescale. Data presentation via Kaplan-Meier curves and survival function tables was limited to 60 quarters for all three timescales, because so few workers (<30) remained at risk beyond that point. Rates of first reinjury per 100 worker-years were calculated by degree of impairment, using each of the three timescales. Reinjury rates were also calculated for each two-quarter interval after initial injury, to assess rate variation over time. Unadjusted and adjusted Cox proportional hazard regression models were used to estimate reinjury risk by degree of permanent impairment; separate models were run using each of the three timescales. Adjusted models included degree of permanent impairment, gender, age, preferred language, residence county, injured body part, FCI, urban-rural residence, injured body part, pre-injury quarterly wages, employer size, industry sector, and hazard group, and were fully stratified by year of injury (2003 to 2017 for this sample). Robust variance estimates were used to produce 95% CIs. Parallel models were used to explore program-related outcomes for two subsets of injured workers participating in vocational rehabilitation. The first set of models estimated reinjury risk for injured workers who completed a vocational retraining plan versus those who did not complete their plan, among the subset of workers who: (1) had an approved vocational retraining plan for the initial injury, and (2) did not choose self-directed retraining funds (known as Option 2) in place of the approved conventional retraining plan (N=1,242). The second set of models estimated reinjury risk for injured workers selecting Option 2 versus a conventional retraining plan, among the subset of workers who: (1) had an

approved vocational retraining plan for the initial injury, and (2) had access to Option 2, which was first offered January 1, 2008 (N=1,209). For these analyses, subgroup assignments were based on events occurring prior to the first claim closure date for the initial WC claim. To our knowledge, reinjury outcomes have not previously been assessed for either scenario. However, completion of an L&I-approved vocational rehabilitation training plan by an eligible injured worker is associated with faster RTW and better long-term employment outcomes, compared with workers who do not complete their plan.[63,65]

Results and discussion

Unadjusted Kaplan-Meier survival curves were used to assess the proportion of injured workers not reinjured over time, by degree of impairment and for each timescale (figures available in our related publication).[5] When using the calendar timescale, workers with no PPD award appeared slightly more likely to be reinjured. In contrast, when using timescales based on wages or hours worked, degree of impairment sorted out in the hypothesized manner, i.e., workers with a higher degree of impairment were more likely to be reinjured. Comparing survival functions by timescale provides a direct assessment of the difference between using calendar time versus more accurate measures of time at risk. Based on survival functions (Exhibit 11), 16% of all workers in our sample were reinjured within four FTE quarters (i.e., one year of full-time work) after initial injury, whereas it took an estimated eight calendar quarters (i.e., two calendar years) for the same percentage to be reinjured. At 15 years (60 quarters) of follow-up, fewer than half were estimated to be reinjured when using the calendar timescale, whereas nearly 70% were estimated to be reinjured when using the FTE timescale.

Exhibit 11. Survival function (proportion of injured workers not reinjured), by timescale

Quarter	Calendar quarters			Quarters with any wages			FTE quarters (hours worked/520)		
	N at risk	Survival function	95% CI	N at risk	Survival function	95% CI	N at risk	Survival function	95% CI
0	43,114	1.00		43,114	1.00	-	43,114	1.00	
1	42,733	0.97	0.97-0.98	41,060	0.96	0.96-0.96	36,165	0.95	0.95-0.95
4	40,232	0.91	0.91-0.92	33,704	0.88	0.88-0.88	27,283	0.84	0.84-0.84
8	35,590	0.85	0.84-0.85	25,123	0.78	0.78-0.79	18,915	0.74	0.73-0.74
12	30,161	0.79	0.79-0.80	18,272	0.71	0.71-0.72	13,114	0.66	0.66-0.67
24	17,080	0.69	0.69-0.70	6,450	0.57	0.57-0.58	4,299	0.52	0.52-0.53
36	6,930	0.63	0.63-0.64	1,332	0.49	0.48-0.50	1,008	0.45	0.44-0.46
48	576	0.59	0.58-0.60	38	0.44	0.42-0.46	146	0.38	0.37-0.40
60	12	0.56	0.54-0.58	1	0.41	0.36-0.47	28	0.34	0.30-0.37

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

Using any of the three timescales, rates of first reinjury per 100 worker-years were highest in the first two quarters after initial injury (Exhibit 12). These elevated reinjury rates (nearly double the long-term rates shown in Exhibit 13) gradually decreased, and then leveled off after about four years. Estimated time from initial injury to first reinjury at the 25th percentile, and rate of first reinjury per 100 worker-years are presented in Exhibit 13, by degree of impairment and timescale. (The 25th percentile was used because the median was not observed for calendar quarters, i.e., <50% of injured workers were reinjured during follow-up.) When using the calendar timescale, we found that workers with the highest degree of impairment had the

longest estimated time to reinjury and the lowest overall reinjury rate. On the other hand, using timescales based on wages or hours worked generated findings in accord with our hypothesis that, when accounting for work-time at risk, higher degrees of impairment would be associated with shorter times to reinjury and higher overall reinjury rates.

Exhibit 12. Time-varying rate of first reinjury per 100 worker-years during the first five years (20 quarters) after initial injury, by timescale (FTE, full-time equivalent; Q, quarter)

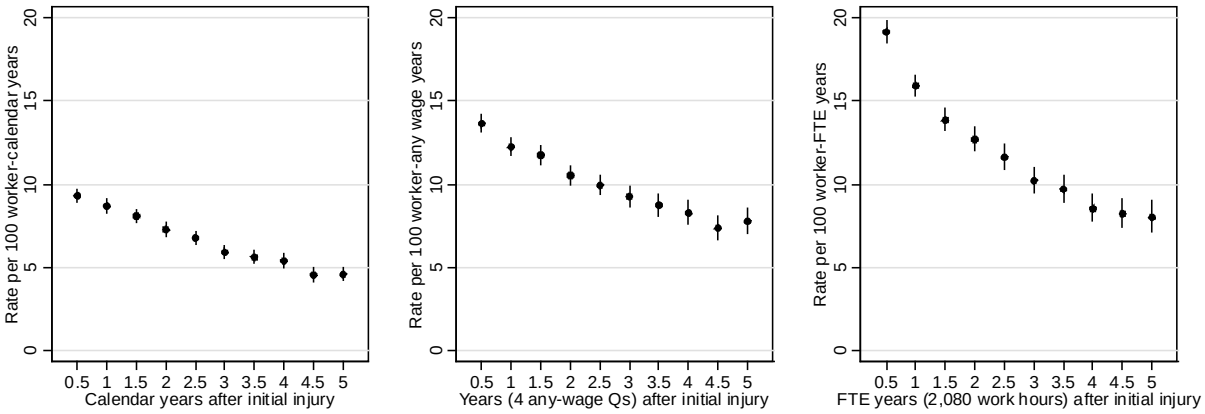


Exhibit 13. Time from initial injury to first reinjury, and rate of first reinjury per 100 worker-years, by degree of impairment and timescale

		Calendar quarters		Quarters with any wages		FTE quarters (hours worked/520)	
Impairment	N	P25 (95% CI)	Rate (95% CI)	P25 (95% CI)	Rate (95% CI)	P25 (95% CI)	Rate (95% CI)
Overall	43,114	17 (16-17)	5.9 (5.8-6.0)	10 (10-11)	10.0 (9.9-10.2)	7.4 (7.2-7.6)	12.5 (12.3-12.7)
No PPD	31,912	16 (15-16)	6.1 (6.0-6.3)	11 (10-11)	9.8 (9.6-10.0)	7.7 (7.5-8.0)	12.2 (12.0-12.5)
WBI <10%	8,404	17 (16-18)	5.5 (5.3-5.7)	10 (10-11)	10.1 (9.7-10.4)	7.2 (6.8-7.6)	12.4 (12.0-12.9)
WBI ≥10%	2,798	21 (19-23)	4.9 (4.6-5.2)	8 (8-9)	12.7 (11.9-13.5)	5.0 (4.6-5.6)	16.8 (15.7-17.9)

Note: The 25th percentile was used for this table because the median was not observed for calendar quarters (i.e., <50% of injured workers were reinjured during follow-up).

CI, confidence interval; FTE, full-time equivalent; P25, 25th percentile; PPD, permanent partial disability; WBI, whole body impairment.

For each timescale in turn, we used unadjusted and adjusted regression models to estimate reinjury risk by degree of permanent impairment (Exhibit 14). In unadjusted models, when using the calendar timescale, both subgroups of workers with PPD awards (WBI <10% and WBI ≥10%) were estimated to have a lower reinjury risk than workers without a PPD award. After adjusting for covariates, reinjury risk no longer appeared to differ across the three groups. However, a very different picture emerged when using timescales based on any-wage or FTE quarters. Those models, whether unadjusted or adjusted, evidenced a significant monotonic trend of increasing reinjury risk as degree of impairment increased. Covariate adjustment was not enough to reveal this pattern—adjustment for time at risk via timescale choice was more important. Similarly, choice of timescale markedly affected other subgroup comparisons of reinjury risk, including those based on the FCI, age, and pre-injury wages.

Exhibit 14. Unadjusted and adjusted regression models of reinjury risk, by timescale (N=43,114)

Characteristic/Model	Calendar quarters			Quarters with any wages			FTE quarters (hours worked/520)		
Unadjusted	HR	95% CI	*P*[a]	HR	95% CI	*P*[a]	HR	95% CI	*P*[a]
Impairment (Ref: No PPD award)			.001			<.001			<.001
WBI <10%	0.95	0.91-0.99		1.05	1.01-1.09		1.05	1.01-1.10	
WBI ≥10%	0.90	0.84-0.96		1.29	1.21-1.38		1.37	1.28-1.47	
Adjusted	HR	95% CI	*P*[a]	HR	95% CI	*P*[a]	HR	95% CI	*P*[a]
Impairment (Ref: No PPD award)			.947			<.001			<.001
WBI <10%	1.00	0.95-1.05		1.06	1.01-1.11		1.08	1.03-1.13	
WBI ≥10%	1.00	0.92-1.06		1.26	1.18-1.36		1.34	1.25-1.44	
Body part (Ref: Spine/neck)			.423			.005			.004
Upper extremity	0.99	0.94-1.03		0.94	0.90-0.98		0.94	0.89-0.98	
Lower extremity	0.97	0.92-1.02		0.92	0.87-0.97		0.92	0.87-0.96	
Other/multiple	0.96	0.91-1.01		0.95	0.90-1.00		0.95	0.90-1.00	
Functional Comorbidity Index	0.93	0.88-0.99	.017	0.97	0.92-1.03	.364	0.98	0.92-1.04	.405
Female (Ref: Male)	0.85	0.82-0.89	<.001	0.84	0.81-0.88	<.001	0.91	0.87-0.94	<.001
Age (Ref: 18-24)			<.001			<.001			.004
25-34	0.93	0.88-0.97		1.02	0.97-1.06		1.01	0.97-1.06	
35-44	0.95	0.91-1.01		1.09	1.03-1.15		1.09	1.04-1.16	
45-54	0.88	0.83-0.93		1.04	0.98-1.10		1.04	0.98-1.11	
55-64	0.74	0.68-0.80		0.95	0.88-1.02		1.00	0.93-1.08	
≥65	0.45	0.38-0.54		0.70	0.59-0.83		0.87	0.73-1.04	
Preferred language (Ref: English)			<.001			<.001			<.001
Spanish	1.14	1.08-1.20		1.19	1.12-1.25		1.11	1.05-1.17	
Other	0.81	0.73-0.91		0.80	0.71-0.90		0.74	0.66-0.83	
Urban-rural residence county (Ref: Large central metropolitan)			.025			<.001			<.001
Large fringe metropolitan	1.06	1.01-1.11		1.09	1.04-1.14		1.10	1.05-1.15	
Medium metropolitan	1.05	1.00-1.11		1.07	1.01-1.12		1.08	1.03-1.14	
Small metropolitan	1.01	0.95-1.07		1.00	0.94-1.06		1.02	0.96-1.08	
Micropolitan	0.99	0.92-1.06		0.98	0.92-1.05		0.99	0.92-1.06	
Noncore	0.93	0.82-1.05		1.00	0.89-1.14		1.04	0.92-1.19	
Pre-injury wages ($10,000 increments)	1.05	1.03-1.08	<.001	0.82	0.80-0.85	<.001	0.69	0.67-0.72	<.001
Large employer (Ref: Small employer)	1.22	1.17-1.26	<.001	1.16	1.12-1.21	<.001	1.13	1.09-1.17	<.001
Industry sector (Ref: Information, Finance, Real Estate, Professional)			<.001			<.001			<.001
Agriculture, Forestry, Fishing, Hunting	1.18	1.06-1.31		1.21	1.09-1.35		1.20	1.08-1.34	
Construction, Utilities, Mining	1.08	0.98-1.19		1.14	1.04-1.26		1.22	1.11-1.34	
Manufacturing	1.34	1.22-1.47		1.33	1.21-1.46		1.28	1.17-1.41	
Retail/Wholesale Trade	1.13	1.04-1.23		1.11	1.02-1.21		1.09	1.00-1.19	
Transportation, Warehousing	1.24	1.12-1.38		1.30	1.18-1.44		1.28	1.15-1.42	
Administrative, Support, Other Services	1.15	1.06-1.25		1.20	1.11-1.30		1.22	1.12-1.32	
Education, Health Care, Social Services	1.27	1.17-1.38		1.25	1.15-1.36		1.24	1.14-1.35	
Arts, Entertainment, Hospitality	1.13	1.03-1.24		1.13	1.03-1.24		1.17	1.06-1.28	
Hazard group	1.03	1.02-1.04		1.04	1.03-1.05		1.04	1.03-1.05	

Note: In addition to covariates shown, models were fully stratified by year of initial injury (baseline hazard unique to each year).
CI, confidence interval; FTE, full-time equivalent; HR, hazard ratio; PPD, permanent partial disability; Ref, reference category; WBI, whole body impairment.
[a]*P* value on referent line reflects joint test for set of categories within variable

We used the regression models described previously to estimate associations between two aspects of vocational rehabilitation program participation and reinjury risk. Adjusted models included all covariates presented in Exhibit 14, as well as the specified vocational rehabilitation variable (Exhibit 15). We found that workers who completed a vocational retraining plan were significantly and substantially less likely to be reinjured, compared to those who did not

complete their plan (Exhibit 15). In addition, we found that workers who chose self-directed retraining funds (Option 2) were significantly and substantially more likely to be reinjured, compared to those who chose a conventional retraining plan (Exhibit 15). Although all three timescales resulted in the same direction of effect for both vocational factors, the adjusted models resulted in statistically significant associations when using timescales based on any-wage or FTE quarters, but not when using calendar time. Estimated effect sizes were largest when using the FTE quarters timescale.

Exhibit 15. Unadjusted and adjusted regression models of reinjury risk for injured workers participating in vocational rehabilitation, by timescale

	Calendar quarters			Quarters with any wages			FTE quarters (hours worked/520)		
Subset/Model	HR	95% CI	*P*	HR	95% CI	*P*	HR	95% CI	*P*
Completed vocational retraining plan (Ref: Approved plan not completed)									
Unadjusted (N=1,242[a])	0.77	0.62-0.97	.026	0.72	0.58-0.90	.004	0.68	0.55-0.86	.001
Adjusted[b] (N=1,242[a])	0.83	0.65-1.06	.134	0.72	0.56-0.92	.009	0.68	0.53-0.88	.003
Option 2: Self-directed retraining funds (Ref: Conventional vocational retraining plan)									
Unadjusted (N=1,209[c])	1.29	1.03-1.62	.026	1.45	1.16-1.82	.001	1.58	1.26-1.98	<.001
Adjusted[b] (N=1,209[c])	1.23	0.95-1.59	.116	1.50	1.15-1.95	.003	1.66	1.27-2.17	<.001

CI, confidence interval; FTE, full-time equivalent; HR, hazard ratio; Ref, reference category.

[a]Conditional on having an approved vocational retraining plan and not having selected Option 2.

[b]Adjusted models included the same variables as shown for the adjusted models in Exhibit 14.

[c]Conditional on having an approved vocational retraining plan (completed or not completed) and availability of Option 2 before first claim closure.

In this study, we demonstrated the importance of using a timescale that reflects work-time at risk (versus calendar time) when estimating reinjury risk, which is particularly important for workers who work less than full-time or have employment interruptions, and when comparing groups of workers with differential employment patterns. We found that choice of timescale markedly affected rate estimation, even for our full cohort of injured workers. Overall reinjury rates nearly doubled when using hours worked (12.5 per 100 worker-years) compared to using calendar time (5.9 per 100 worker-years). Using any-wage quarters gave an intermediate estimate that was more similar to hours worked than to calendar time (10.0 per 100 worker-years); using any-wage quarters may be a reasonable alternative to using hours worked, depending on characteristics of a particular state's wage files.

In contrast to regression models based on calendar time, regression models based on any-wage or FTE quarters evidenced a significant monotonic trend of increased reinjury risk as degree of impairment increased. Covariate adjustment was not enough to reveal this pattern—adjustment for time at risk via timescale choice was more important. In line with our hypothesis, workers with ≥10% WBI (compared to workers with no PPD award) had an estimated 34% higher risk of reinjury when using hours worked; no difference was detected when using calendar time. This stands in contrast to a study by Gotz et al. (2000),[36] who found that Wisconsin workers with a PPD award were less likely to be reinjured compared to other Wisconsin workers, even after excluding quarters with no wages from the denominator (comparable to our any-wage quarter timescale). The reason for the difference in findings is unclear. Although Gotz et al. did not distinguish subgroups based on degree of impairment, this would not account for the difference, as we observed increased reinjury risk among workers with any degree of permanent impairment. One notable difference was that Gotz et al. excluded

aggravations of the initial injury (reopened WC claims), focusing instead on unrelated new WC claims; however, compared to workers with an injury involving only temporary disability, workers with permanent impairment may be more likely to have aggravations/exacerbations of their existing injury, rather than an unrelated new injury.

Our finding of elevated reinjury risk among workers with permanent impairment comports with findings from a related survey, which revealed that more than half of respondents thought their permanent impairment put them at higher risk of being reinjured at work, compared to pre-injury (65.2%), or compared to coworkers in the same job (54.4%).[3] The importance of our findings regarding elevated reinjury risk extends beyond workers who have filed WC claims; functional limitations are highly prevalent in the workplace, affecting as many as 22% of employed U.S. workers.[20]

In addition to permanent impairment, findings related to several other subgroup comparisons reinforce the importance of timescale choice. For example, when using calendar time, there appeared to be a monotonic trend of lower reinjury risk with increasing age, compared to ages 18-24, but this changed using other timescales. Of particular note, reinjury risk for older workers was markedly underestimated using either calendar time or any-wage quarters. This may be due to the much higher prevalence of part-time work in this age group.[136] In another example, having more comorbidities (as measured by the FCI), was significantly associated with lower reinjury risk when using a calendar timescale; however, this association was no longer substantial nor significant when using any-wage or FTE quarters. In a study of injured workers in Colorado, Schwatka et al. (2018)[34] found that certain comorbidities were associated with lower odds of a future WC claim, possibly because they did not control for amount of work-time at risk during the follow-up period.

Reinjury outcomes for injured workers participating in WC vocational rehabilitation programs were of particular interest because nearly 90% of these workers had a work-related permanent impairment. We found that workers who completed their approved vocational retraining plan were significantly and substantially less likely to be reinjured, compared to those who did not complete their plan. In addition, we found that workers who chose self-directed retraining funds (Option 2) were significantly and substantially more likely to be reinjured, compared to those who chose a conventional retraining plan. These findings merit further inquiry to understand the underlying mechanisms, especially as these programs operate at the WC system level and thus could have important impacts on the health and safety of a large number of workers.

Another important finding relates to the variation in reinjury risk over time. Using any of the three timescales, rates of first reinjury per 100 worker-years were highest in the first two quarters after initial injury—nearly double the longer-term rates. Reinjury rates gradually decreased over time since initial injury, and then leveled off after about four years. These findings identify the first six months after RTW as a particularly important window of opportunity for prevention efforts, but it is also important to note that elevated risk persists for years. In accord with our findings, Lipscomb et al. (2008)[32] found that carpenters with back injuries remained at elevated reinjury risk for over three years after their initial injury.

Strengths of both sub-studies conducted for Aim 2 included the large cohort, and identification of the first-known WC claim filed in Washington State. Assembling the cohort based on the first-known WC claim allowed for definitive identification of the PPD rating with the initial injury; for subsequent claims, the PPD rating can reflect adjustment of a rating from a prior injury that caused permanent impairment—a circumstance that would not be clearly distinguishable using the available WC claims data. The absence of private WC insurers in Washington State, one of

only four such states, facilitates population-based research.[76,137] In addition, access to state wage files enabled us to avoid conflating the end of time loss compensation with actual RTW, thereby avoiding an inherent limitation of reinjury studies that rely solely on WC claims data and do not measure employment directly.[22,27,29,30] Though common practice, using the end of time loss compensation as a proxy for RTW leads to underestimation of time lost from work,[138] as well as to underestimation of reinjury rates via inflated at-risk denominators. State wage files are an efficient but underused approach for identifying RTW patterns.[139] In a unique back reinjury study, person-hours of work based on union carpenter work records were used to measure time at risk, but this approach is not feasible for statewide or cross-sector studies.[32] Using wage files, we were able to measure time worked (and thus reinjury rates) even while the initial WC claim was open, and irrespective of time loss payments.

These sub-studies also had several limitations. First, identification of reinjury relied on reopening or filing a WC claim, and many work-related injuries are not reported to WC, particularly among workers 65 and older.[140-142] 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;[143] as such, our reinjury estimates are likely to be conservative. Second, the accuracy of the hours-worked data in the wage files is unclear. Fortunately, use of any-wage quarters resulted in estimates closer to those using hours worked than those using calendar quarters, and may be a reasonable alternative when hours worked are unavailable or data quality is suspect. Third, state wage files do not capture earnings for workers who are self-employed or work in exempt occupations.[99] 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.[144] Such differential inclusion in wage files may have affected our reinjury estimates for permanent impairment and age subgroups, to an unknown degree. Finally, all covariates were also based on administrative data, and thus have measurement limitations (e.g., the WBI variable was essentially a lower bound estimate,[3] and the FCI was almost certainly underestimated, because diagnoses unrelated to the WC injury may not be reported to WC for billing purposes[82]).

Specific Aim 3

Aim 3: Prioritize modifiable workplace and WC-based contextual factors (e.g., job accommodation, safety climate, job strain, supervisor/coworker support) for future intervention development by testing associations with RTW interruption and reinjury among permanently impaired workers who did RTW.

Sub-study 3.1: Workplace organizational and psychosocial factors

The aim of this sub-study was to identify potentially modifiable workplace organizational and psychosocial factors associated with RTW interruption and/or reinjury, among workers who had RTW at least briefly after a work-related injury that resulted in permanent impairment. We interviewed injured workers regarding their exposure to a number of workplace factors that we hypothesized would be associated with RTW interruption and/or reinjury, and that might be modifiable via workplace or WC system-level interventions designed to support safe and sustained RTW. We assessed associations between (1) worker-reported exposure to each workplace factor and (2) RTW interruption and reinjury outcomes. For each workplace factor, we also assessed effect modification by degree of permanent impairment.

Additional methodology specific to sub-study 3.1

Worker outcomes. RTW interruption was defined as no longer working when interviewed. Reinjury was defined as any work injury that resulted in at least one missed day of work. Worker outcomes, RTW interruption and reinjury, were ascertained via self-report, specifically with respect to the worker's current job when interviewed, or—if no longer working, when interviewed—with respect to their most recent job. We focused on the current/most recent job in order to assess the most proximate workplace factors, and to minimize recall barriers. Workers who had more than one current/most recent job were asked to answer all outcome and workplace questions with respect to the job they considered to be their primary job. For descriptive purposes, the subset of workers who were no longer working were asked, "What is the primary reason you are no longer working at this job?" Several response categories were pre-specified, but workers could also respond "other reason" and provide a brief alternative response.

Selection and measurement of workplace factors. Based on prior research and stakeholder input, the following set of workplace factors was identified as potentially important: job accommodations, employer/health care provider communication, safety training, presence of a health and safety committee, comfort reporting an unsafe work situation, safety climate, stigmatization, job strain, social support (supervisor, coworker, and combined), and ability to take time off work for personal/family matters. All workplace factors were ascertained via self-report. Survey questions were drawn from existing instruments or previous surveys, where feasible.[3] A brief summary of relevant literature and the measurement approach for this study are provided below for each workplace factor.

There is substantial evidence that job accommodation facilitates RTW,[48,66,145-147] and is economically advantageous.[148] In a study of 40 self-insured California employers, job accommodation was associated with significant reductions in both time loss duration and sustained RTW; reductions were particularly large for workers with a permanent disability.[66] Job accommodation reduced the number of subsequent work absences among Canadian workers with permanent impairments by about 12% to 14%.[149] We used a two-part question to assess job accommodation. First, workers were asked whether the worker or employer had made changes to the job, work environment, or work hours, to help them RTW. If the answer was no, workers were asked whether any such changes were needed to help them work at their best. These two questions were recoded into one three-category variable (needed and provided, needed but not provided, not needed).

There is substantial evidence that adequate employer/health care provider communication facilitates RTW,[48,146] and is economically advantageous.[148] We assessed employer/health care provider communication using a binary choice question: "During the past year, did you feel there was adequate communication between your health care provider(s) and your employer(s) to assist you in staying at work?"

Some evidence suggests that adequate safety training protects against injury.[150,151] Health and safety committee presence may reduce injury rates, but evidence is mixed, and committee effectiveness may be more important.[152] In a Canadian survey, worker empowerment (including comfort reporting unsafe work situations) was found protective against injury.[153] We used three binary choice questions to assess these aspects of the safety environment: (1) "In your current/most recent job, did you receive adequate training to perform your job safely?" (2) "Is there a Health and Safety Committee at your current/most recent workplace?" and (3) "If you

were aware of an unsafe situation at work, would you be comfortable reporting it to your supervisor or employer?"

Safety climate has been found protective with respect to safety behavior and safety outcomes, including injury.[49,57,154,155] Safety climate is also associated with lower turnover, mediated by job satisfaction,[56] as well as with worker well-being and productivity.[156] We assessed safety climate at both the organization level (top management) and group level (direct supervisor), using the validated Safety Climate Short Scales.[124] To be scored, workers must have responded to at least three of the four items per scale.

The workplace stigmatization studies we identified were conceptual or qualitative, but suggested that experiencing stigma could be associated with worker health and well-being,[157] underemployment,[158] and connection with work.[53] One study found that nonsexual workplace harassment was associated with increased likelihood of occupational injury.[159] For our study, workers were first asked, "Are any of your supervisors aware of your work-related impairment or disability?" If yes, they were asked about agreement with the statement "Supervisors think less of me because of my work-related disability or impairment." Agreement was classified as presence of stigmatization; disagreement or supervisors being unaware was classified as absence of stigmatization. The same set of questions was asked with respect to coworkers.

Lower job strain is associated with decreased injury risk,[35,47,160] RTW,[147,161,162] and less workplace absence.[51] We used the validated Work History Questionnaire (WHQ) to assess job strain.[163] High job strain was defined as scoring above the sample median (6) on job demands (two items), in conjunction with scoring below the sample median (7) on decision latitude (two items).

Workplace social support is associated with decreased injury risk,[47,160,164,165] RTW,[147,162] sustained RTW,[50,166,167] and less workplace absence.[51] Among Massachusetts workers with permanent impairments who RTW after WC-related vocational rehabilitation, supportive workplace relationships—and specifically worker-supervisor relationships—contributed to sustained RTW.[7,92] A related concept, better treatment by management and coworkers, predicted lower turnover intention and higher job satisfaction.[12] We used two WHQ items to assess supervisor support, coworker support, and the combined social support concept.[163] We conducted sensitivity analyses using eight social support items from the validated Job Content Questionnaire (JCQ)—four items each for supervisor support and coworker support.[163,168]

Work-family interference has been identified as a reinjury risk factor.[49] Further, a study of Canadian workers with permanent impairments found that disability management strategies that include flexible schedules may be especially effective in reducing reinjury.[149] We asked a work-family interference question ("How difficult is it to take time off during your work to take care of personal or family matters?") from the Quality of Worklife module developed for the 2002 General Social Survey,[169] using a scale from 1 (not at all difficult) to 5 (extremely difficult).

Data analysis. Missing data was negligible. We excluded the 15 cases (2.6% of the 582 completed interviews) with missing data for either outcome or for any of the 10 covariates, which allowed us to assess the association of each workplace factor with each outcome, using the same sample. However, workplace factor questions had varying numbers of "don't know" or "declined to answer" responses, and some questions were not applicable to certain workers; thus, the number of included cases varied by workplace factor. To simplify interpretation of results, coding of all workplace factor variables was aligned so that higher values always referred to the condition hypothesized to be more desirable. Workplace factors that were

measured as scales used several different ranges and scoring methods, and some involved multiple items. To enhance comparability of effect sizes, we standardized scale scores to have a mean of zero and a standard deviation of one. We presented means for the original variables to enable comparison to other published data but used standardized scores in logistic regression models. Bivariate associations between each outcome and the workplace factors and covariates were tested using Pearson's chi-squared test (binary or categorical variables), Wilcoxon rank-sum (Mann-Whitney) test (ordinal variables), or unequal variances *t*-test (ordinal scales or continuous variables). Logistic regression models were used to estimate associations between each workplace factor and each outcome in turn, controlling for gender, age, educational level, nativity, WBI category, State Fund vs. self-insured WC coverage, union membership, employer size, industry sector, and years in the same job. We also tested for interactions between each workplace factor and WBI category. Level of significance was set at $P<0.05$.

Results and discussion

Of 567 workers interviewed, 70 (12.35%) were no longer working in their most recent job when interviewed (RTW interruption), and 70 (12.35%) had been reinjured in their current/most recent job. Despite prevalence similarity, there was little overlap between groups—only five workers (0.88%) reported both outcomes. Injury year ranged from 1991 to 2018; 3.70% were injured before 2010. Years from injury to interview ranged from 1.10 to 27.33, with a mean of 3.45 (SD 2.60), and median of 2.55. Among the 70 workers no longer working in their most recent job, the most frequently reported reason for RTW interruption was impairment, disability, and/or pain from the previous work injury (28.57%; n=20). Other reasons included (in descending frequency): retired (27.14%; n=19); laid off or on work furlough (18.57%; n=13); some other health condition or injury (17.14%; n=12); something about the most recent job/workplace made it hard to keep working (14.29%; n=10); logistical barriers such as transportation, childcare, or family needs (7.14%; n=5); or got a new job, but not yet working (2.86%; n=2). These categories were not mutually exclusive; there were 81 responses from 70 workers. There were few significant or substantial associations between covariates and either outcome. The most striking (and predictable) association was that nearly a third of workers 65 and older were no longer working when interviewed, compared to less than a sixth of workers in all other age categories. At the time of interview, 42.50% of respondents reported being a union member. Union membership was significantly associated with less RTW interruption but was also strongly associated with reinjury; 18.26% of union members reported reinjury, compared to 7.98% of other workers ($P<0.0005$). Time spent working in the same job averaged 9.19 years (SD 10.39). This did not differ significantly by RTW interruption status (mean difference: -0.99; 95% CI: -3.95, 1.97), but did differ by reinjury status. Workers who were reinjured during the past year in their current/most recent job had been working in the same job an average of 12.65 years (SD 10.73), compared to 8.70 years (SD 10.26) for those not reinjured (mean difference: -3.95; 95% CI: -6.65, -1.24).[58]

With two exceptions, the direction of each unadjusted bivariate association between binary/categorical workplace factors and the two outcomes was as hypothesized. Both exceptions—neither statistically significant—involved the reinjury outcome: (1) adequate employer/health care provider communication, and (2) stigmatized for PPD by coworkers. The prevalence of the more desirable condition was above 70% for all workplace factors; over 95% were comfortable reporting an unsafe situation at work. In every case, the direction of each unadjusted bivariate association between ordinal/continuous workplace factors and the two outcomes was as hypothesized. Notably, findings based on the JCQ versions of these three

variables were substantially similar to those for the WHQ versions (see data in Supplementary Table S1, in our related publication).[58]

Exhibit 16 presents the results of the basic regression models for each outcome. Each of these models included all covariates but excluded the workplace factors of interest. Results were generally in line with unadjusted associations: (1) workers ages 65 and older had over three times the odds of RTW interruption, compared to workers ages 18 to 34; and (2) union members had nearly three times the odds of reinjury, compared to other workers.

Exhibit 16. Logistic regression results for the two basic outcome models: whether no longer working at interview (RTW interruption), and whether reinjured in the current/most recent job (N=567)

Characteristic	RTW interrupted			Reinjured		
	OR	95% CI	*P*	OR	95% CI	*P*
Gender			0.30			0.95
Male	ref			ref		
Female	1.38	0.75, 2.56		0.98	0.54, 1.78	
Age when interviewed			0.04			0.30
18-34	ref			ref		
35-44	0.62	0.22, 1.77		0.99	0.38, 2.59	
45-54	0.91	0.36, 2.28		0.98	0.38, 2.55	
55-64	1.15	0.46, 2.83		0.83	0.32, 2.14	
65+	3.26	1.05, 10.15		2.78	0.74, 10.41	
Educational level			0.61			0.09
<High school graduation	ref			ref		
High school graduation or GED	0.52	0.16, 1.68		3.33	0.41, 27.06	
Some college	0.50	0.17, 1.52		1.81	0.22, 14.85	
College graduation	0.43	0.13, 1.50		1.38	0.15, 12.67	
Born in U.S.			0.15			0.43
No	ref			ref		
Yes	0.54	0.23, 1.24		1.55	0.52, 4.59	
Whole body impairment			0.91			0.69
<10%	ref			ref		
≥10%	1.03	0.58, 1.86		1.13	0.62, 2.09	
Workers' compensation coverage			0.53			0.69
State Fund	ref			ref		
Self-insured	0.82	0.44, 1.53		0.89	0.50, 1.59	
Union member			0.14			0.001
No	ref			ref		
Yes	0.60	0.30, 1.18		2.81	1.52, 5.19	
Large employer			0.16			0.76
No	ref			ref		
Yes	1.48	0.86, 2.55		1.09	0.62, 1.91	
Industry sector			0.35			0.39
Construction/utilities/mining/agriculture/forestry	ref			ref		
Manufacturing	0.35	0.11, 1.09		1.78	0.66, 4.81	
Retail/wholesale trade	0.84	0.31, 2.30		1.69	0.50, 5.66	
Transportation/warehousing	1.00	0.39, 2.55		1.44	0.52, 4.03	
Finance/insurance/real estate/professional/technical	1.00	0.32, 3.10		3.75	1.13, 12.40	
Administrative services/public services	1.17	0.49, 2.77		2.20	0.87, 5.57	
Education/health care/social services	0.50	0.18, 1.41		1.27	0.44, 3.73	
Arts/entertainment/hospitality	0.50	0.13, 1.95		2.92	0.82, 10.33	
Years in same job	1.01	0.98, 1.04	0.59	1.01	0.98, 1.04	0.45

CI, confidence interval; OR, odds ratio; RTW, return to work.

Exhibit 17 presents results of the adjusted logistic regression models for each outcome, assessing each workplace factor in turn. Each of these models included all covariates, along with one of the workplace factors of interest. With two exceptions, the direction of association was as hypothesized, i.e., the presence of the hypothetically more protective condition of each workplace factor was at least suggestive of a lower odds of both RTW interruption and reinjury. As was the case for the unadjusted bivariate associations, both exceptions involved the reinjury outcome, and neither was statistically significant: (1) adequate employer/health care provider communication, and (2) not stigmatized for PPD by coworkers. Despite alignment with the hypothesized direction of association, two of the workplace factors—provision of needed job accommodations and adequate safety training—were not significantly associated with either outcome. Exhibit 18 depicts the statistically significant associations presented in Exhibit 17.

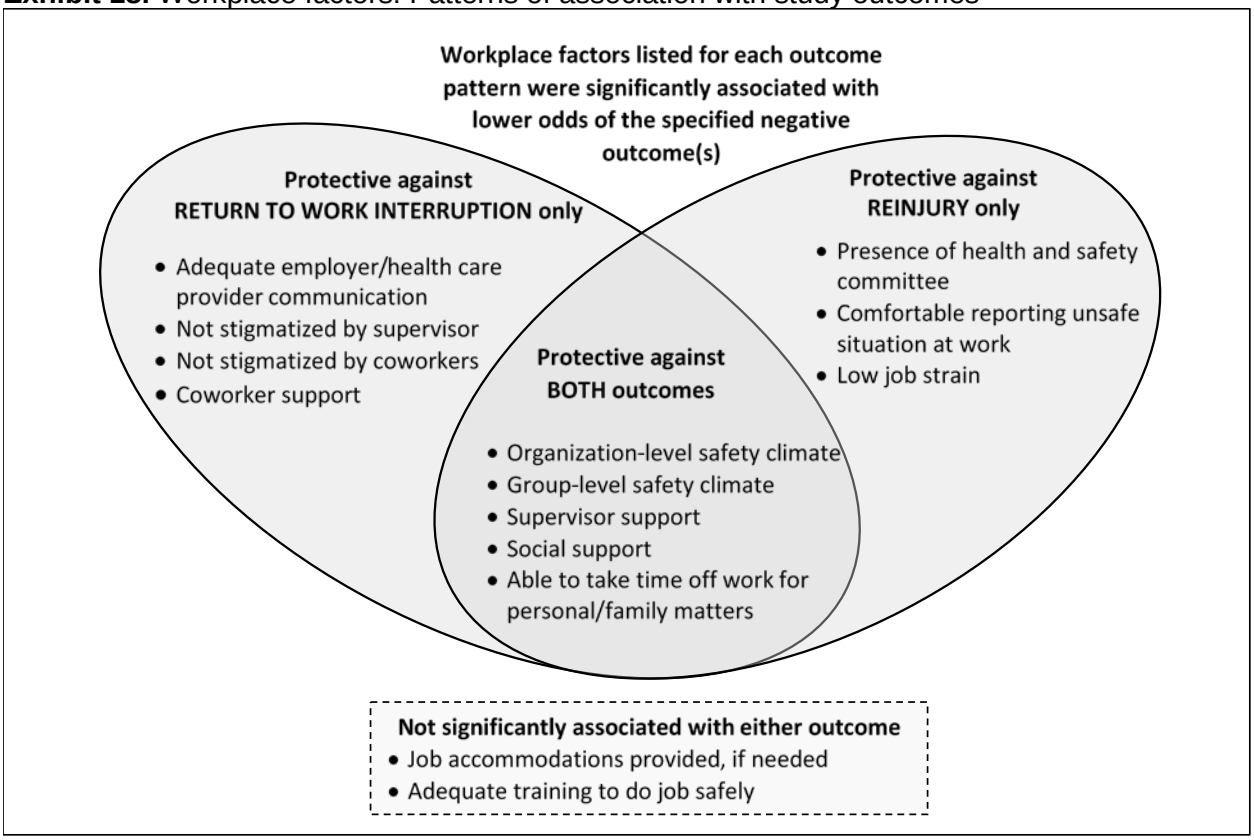
Odds ratios for the binary variables in Exhibit 17 represent effect sizes based on presence or absence of the hypothetically more protective condition, while odds ratios for the standardized variables represent effect sizes based on one standard deviation of difference; hence effect sizes cannot be directly compared across variable type. With respect to RTW interruption, absence of stigmatization by supervisors or by coworkers had the largest effect sizes among binary variables. Supervisor support had the largest effect size among standardized variables; social support was a close second, driven by the supervisor support component. With respect to reinjury, comfort reporting an unsafe work situation had the largest effect size among binary variables. Organization-level safety climate had the largest effect size among standardized variables, nearly matched by group-level safety climate and supervisor support (again, social support closely followed supervisor support).

Exhibit 17. Logistic regression results, adding each workplace factor in turn to the two basic outcome models: whether no longer working at interview (RTW interruption), and whether reinjured in the current/most recent job (N=567)

Workplace factor	Variable type	N	RTW interrupted			Reinjured		
			OR	95% CI	*P*	OR	95% CI	*P*
Job accommodations	Categorical	558						
Needed but not provided			ref	ref	ref	ref	ref	ref
Needed and provided			0.74	0.36, 1.50	0.40	0.64	0.29, 1.38	0.26
Not needed			0.46	0.21, 1.02	0.06	0.44	0.20, 0.96	0.04
Adequate employer/health care provider communication	Binary	484	0.35	0.19, 0.64	0.001	1.12	0.57, 2.22	0.74
Adequate training to do job safely	Binary	561	0.56	0.27, 1.15	0.11	0.60	0.28, 1.26	0.18
Presence of health and safety committee	Binary	525	0.85	0.42, 1.73	0.66	0.46	0.23, 0.95	0.04
Comfortable reporting unsafe situation at work	Binary	565	0.38	0.13, 1.07	0.07	0.29	0.11, 0.77	0.01
Not stigmatized for PPD by supervisor	Binary	565	0.25	0.13, 0.49	<0.001	0.49	0.24, 1.04	0.06
Not stigmatized for PPD by coworkers	Binary	567	0.26	0.12, 0.58	0.001	1.51	0.54, 4.22	0.43
Low job strain	Binary	544	0.68	0.34, 1.40	0.30	0.49	0.24, 0.98	0.04
Organization-level safety climate	Standardized	546	0.64	0.51, 0.81	<0.001	0.64	0.50, 0.82	<0.001
Group-level safety climate	Standardized	551	0.56	0.45, 0.71	<0.001	0.69	0.54, 0.89	0.004
Supervisor support	Standardized	551	0.50	0.40, 0.63	<0.001	0.68	0.53, 0.86	0.001
Coworker support	Standardized	546	0.70	0.55, 0.90	0.006	0.92	0.71, 1.19	0.51
Social support	Standardized	541	0.53	0.41, 0.67	<0.001	0.73	0.56, 0.94	0.02
Able to take time off work for personal/family matters	Standardized	559	0.75	0.57, 0.97	0.03	0.79	0.62, 0.99	0.046

CI, confidence interval; OR, odds ratio; PPD, permanent partial disability; RTW, return to work.

Exhibit 18. Workplace factors: Patterns of association with study outcomes



Testing for interactions between each workplace factor and degree of impairment revealed no notable or statistically significant findings and no consistent direction of association; therefore, the interaction term was dropped from all regression models. Data for the WHQ versions of the social support, supervisor support, and coworker support variables are reported in Exhibit 17. Findings based on the JCQ versions of these three variables were substantially similar (see data in Supplementary Table S2, in our related publication).[58]

In summary, (1) lower reported levels of safety climate, supervisor support, and ability to take time off work for personal/family matters were significantly associated with both RTW interruption and reinjury; (2) Inadequate employer/health care provider communication, perceived stigmatization from supervisors and/or coworkers, and lower levels of coworker support were significantly associated with RTW interruption but not with reinjury; (3) Discomfort with reporting an unsafe situation at work, absence of a health and safety committee, and higher job strain were significantly associated with reinjury, but not with RTW interruption; (4) Inadequate safety training and lack of needed job accommodations were not significantly associated with either outcome. Despite null findings, we are not suggesting that job accommodation and adequate safety training are unimportant. As described earlier, there is strong evidence for the importance of job accommodations, but they may be most important for initial RTW. All workers interviewed for our study had RTW, and only 13% had not obtained needed job accommodations.

To effectively promote safe and sustained RTW, our findings support expanding the focus of prevention efforts to include organizational and psychosocial factors, such as safety climate,

supervisor support, and flexible time off work. Factors we found protective for either negative outcome may be as important as those that were protective for both, depending on workplace characteristics and WC system goals. The lack of interaction between any of these workplace factors and degree of impairment suggests that these findings may be generalizable to all workers, and further, that workplace interventions based on these findings may be useful for both primary and secondary prevention.

The most frequently reported reason for RTW interruption was impairment, disability, and/or pain from the previous work injury. Workers ages 65 and older (compared to ages 18 to 34) had over three times the odds of RTW interruption. Early retirement due to a work injury is associated with more severe injuries, as well as with potentially modifiable factors, such as a less supportive workplace.[133]

Supervisor support and coworker support had differing associations with outcomes; thus, consolidating the two as social support—as is often done—may result in less informative findings. Using only a single item for each construct resulted in decidedly similar findings compared to using four items, which should facilitate inclusion of both constructs in future surveys.

The prevalence of the more desirable condition was above 70% for all workplace factors in this study, and over 95% were comfortable reporting an unsafe situation at work. This may have implications for interpretation of our findings, as these factors can interact in complex ways. For example, in a Canadian study, workers who reported no supervisor support in conjunction with any type of occupational health and safety vulnerability (including discomfort reporting unsafe conditions) were significantly more likely to experience workplace injuries.[170]

Numerous studies have supported the need for research-driven prevention programs designed to reduce reinjury risk and sustain RTW.[2,7,22,27-29,32,42,43,52,54,92,171] Our study provides evidence to support prioritizing several modifiable organizational and psychosocial factors for future intervention development. Systemic support from WC agencies/insurers may be needed to develop and test efficient large-scale WC system-level interventions (e.g., management training, educational campaigns, subsidies/incentives), and encourage uptake. Individual employers, particularly small employers, may not have the resources or motivation to implement interventions targeting these workplace factors. However, it may be feasible to develop and offer trainings to educate employers about key workplace organizational and psychosocial factors, perhaps in-hand with financial support for supervisor training or structural changes. Supervisor training programs can improve safety climate and confidence managing successful RTW.[43,172] Further, systematic reviews have documented that interventions designed to promote workplace social support, job control, and job demands can positively impact absenteeism, productivity and financial outcomes.[173,174] As a WC system-level example, *Stay at Work* is an L&I program designed to reduce temporary total disability. Employers are reimbursed for certain costs of offering light-duty jobs to injured workers (e.g., wage subsidies, training, tools). Since 2012, more than 4,500 employers have used this program to assist more than 20,000 injured workers. Potential savings are not trivial—L&I estimated saving $700 million in work disability and medical costs from *Stay at Work* and other RTW initiatives.[175]

Sub-study 3.2: Workers' suggestions for workplace improvements

This sub-study used data from open-ended questions contained in the survey to: (1) explore workplace factors identified by workers themselves as important levers for change, some of

which may previously have been unrecognized; and (2) summarize workers' suggestions for workplace improvements to promote sustained RTW and prevent reinjury.

Additional methodology specific to sub-study 3.2

We used qualitative content analysis methods to inductively code responses to the open-ended telephone survey question, "If you could suggest one change to the structure, environment, or culture of your current (or most recent) workplace that would help (or would have helped) you to continue working or prevent reinjury, what would it be?" Response options included: open-ended narrative, no change needed, don't know, or refused. Trained interviewers recorded workers' narrative responses verbatim or in summary. The 581 interviews that included any response to this question were included in this study. All 17 partial interviews were excluded because they all terminated before this question was asked, and 1 of the 582 completed interviews was excluded because the respondent declined to answer this particular question.

Following a content analysis approach,[176] and with the assistance of Dedoose[177] qualitative software, two coders began the code development process by independently coding one-third of the responses. Codes were developed inductively, rather than by approaching these data with a priori frameworks. Where responses naturally aligned with workplace factors previously identified (e.g., safety climate, social support, job strain, safety training, job accommodations), we used the same terminology as in our previous related study on modifiable workplace factors.[58] As responses were often detailed and multifaceted, each person's response could be assigned more than one code. We then compared our code assignments and came to consensus on an initial coding scheme and codebook. The remaining responses were independently coded using this schema, discordant codes between coders were reviewed, and consensus on final codes was reached. Codes were further grouped into themes for improved interpretability where appropriate, and frequencies of codes and themes were tabulated. Codes and themes were named to describe the workplace feature being addressed and were assigned whether workers described that feature as being present, lacking, or needing change. A variable was constructed to represent the general response options for this question, after coding and some reclassification based on coded text: (1) no change needed, (2) codable response, (3) vague/unclear response, or (4) don't know/no suggestions.

We used a closed-ended question about job satisfaction to put response option patterns into context, and to assess our assumption that job satisfaction might be related to the propensity to offer suggestions for workplace improvement (vs. simply reporting that no change was needed). Workers were asked to rate job satisfaction ("overall, how satisfied are you with your current/most recent job?") on a 4-point scale from very dissatisfied to very satisfied. Trends in the likelihood of responding "no change needed" (recoded as a binary variable), by level of job satisfaction, were tested using a nonparametric test for trend.[178] Among the 581 included respondents, 577 answered the job satisfaction question (there were four "don't know" responses).

Results and discussion

Overall, 32.5% of respondents (N=581) reported that no change was needed to their workplace to promote sustained RTW or prevent reinjury, while 47.7% provided codable narrative comments or suggestions. Only 5.3% provided narrative comments or suggestions that were too vague or unclear to code, and 14.5% responded that they didn't know or did not have suggestions to make. Most respondents (84.2%) were satisfied with their job (Exhibit 19), and there was a strong association between higher job satisfaction and reporting that no workplace

change was needed (*P*<.0005). Only 8.8% of workers who were very dissatisfied with their job responded that no change was needed, compared to 42.7% of workers who were very satisfied.

Exhibit 19. Response option frequencies for open-ended question: If you could suggest one change to the structure, environment, or culture of your current (or most recent) workplace that would help (or would have helped) you to continue working or prevent reinjury, what would it be?

Job satisfaction	N*	No change needed		Codable response		Vague/unclear response		Don't know/ no suggestions	
		n	Row %	n	Row %	n	Row %	n	Row %
Overall	581	189	32.5	277	47.7	31	5.3	84	14.5
Very satisfied	281	120	42.7	114	40.6	11	3.9	36	12.8
Somewhat satisfied	205	57	27.8	101	49.3	12	5.9	35	17.1
Somewhat dissatisfied	57	8	14.0	40	70.2	3	5.3	6	10.5
Very dissatisfied	34	3	8.8	20	58.8	4	11.8	7	20.6

*Note: Job satisfaction categories sum to N=577 because four respondents responded "don't know" to that question.

Codable narrative responses, provided by 277 respondents, were coded into 18 distinct themes (Exhibit 20). For ease of presentation, we grouped these 18 themes into six major themes (Exhibit 20). Of the numerous constructive suggestions for workplace improvements, some were very specific (e.g., de-icing sidewalks), while others could apply to many/most workplaces (e.g., better communication). For each major theme (presented in descending frequency order below), we describe constituent themes in detail. Percentages reported below are the percentage of 277 respondents mentioning the theme, unless otherwise stated, and do not sum to 100%; many responses involved multiple coded themes and themes were not mutually exclusive.

Work organization/arrangements/conditions. Grouped together, the five coded themes in this major theme were mentioned by 37.3% of respondents (n=103). Adequate staffing/appropriate task distribution was the most frequent theme in this category, mentioned by 16.2% of respondents (n=45). Many workers mentioned that their workplaces were understaffed or could be staffed in safer ways, such as having more people on the same shift (the night shift was specifically mentioned by several). Workers described the drivers of understaffing in their workplaces, such as poor management, turnover, unscheduled work absences (sick calls), and lack of backup staff/scheduling. They also described the negative consequences of understaffing on their well-being, including heavy workload, unwanted overtime, and increased injury risk. Understaffing was described as both a cause and effect of high turnover. Increased teamwork was recommended by several workers, but also described as being impeded by low staffing levels. One worker explicitly stated that better staffing would have prevented their own injury. Improving task distribution (e.g., better delegation) was recommended, but often in vague terms. Job rotation was suggested by two workers. The ergonomics/rest breaks theme was mentioned by 10.5% of respondents (n=29). Workers mentioned the importance of a variety of supports that would be helpful to them, including comfortable/ergonomic keyboards, chairs, and other furniture, less repetitive work and postures (e.g., less sitting, less standing, less bending, less lifting), and more rest breaks. The job strain/job demands/job control theme was mentioned by 6.1% of respondents (n=17). Workers mentioned overwork, high pressure, and stress, and suggested slowing the pace and/or reducing job demands (mental and physical). Most workers focused on job strain or job demands. Job control was a focus for only three workers, all of whom described their ability—because they were in charge—to adjust work to their needs as a positive existing aspect of their workplace. This points to challenges for workers who cannot

adjust their work to their needs. The work scheduling theme was mentioned by 4.7% of respondents (n=13). This theme was defined to include practices related to work schedules and hours/days worked (vs. staffing/task distribution). Suggestions included wanting at least two days off in a row, more than two days off per week (e.g., working four 10-hour shifts), more stable/consistent schedules to enable planning, and more flexibility in time off for other needs. Some identified longer days and/or more hours as an improvement, while some suggested shorter days and/or fewer hours. The better wages/employment arrangements theme was mentioned by 4.0% of respondents (n=11). Most (n=9) focused on better pay. Some suggested improvements in employment or payment arrangements; e.g., one worker suggested changing pay arrangements from commission to hourly. Another wanted to be paid on the books instead of in cash, out of concern for how cash payments might affect handling of a work injury.

Safety and safety climate. The four coded themes in this major theme were mentioned by 35.4% of respondents (n=98). The safety precautions/safer workplace theme was mentioned by 18.1% of respondents (n=50). Many workers reported that various aspects of their workplace could be safer, and mentioned specific areas needing improvement, such as unsafe equipment (including dangerous equipment related to their injury that was either not addressed or addressed reactively), trip hazards, and lack of proper tools or personal protective equipment. Several workers described the need for management to make safety and safety programs an organizational priority, and to include a safety program in the budget. Workers also suggested better safety enforcement and following the law [regarding safety practices]. The safety climate theme was mentioned by 14.1% of respondents (n=39). There was considerable overlap with the previous theme; however, comments coded to this theme were focused on perceived attitudes and culture with regard to safety. The need to "put safety first" was frequently mentioned, and several workers specifically mentioned safety culture as being important. A number of workers described finances as being more important to management than worker safety, and some described pressure by management to do unsafe work. Others suggested that management place a more constant and meaningful focus on safety and safety awareness in the workplace, ensure better two-way communication about safety practices and hazards, and develop better accountability systems to ensure safety. The safety training theme was mentioned by 5.4% of respondents (n=15). Workers suggested safety classes and/or coaching in safe lifting/carrying, safe use of equipment, use of personal protective equipment, injury prevention, and hearing loss prevention. Some workers suggested that safety training be made ongoing, rather than being a one-time event. One worker suggested that the existing—very general—safety training needed to be tailored to specific departments. The equipment theme was mentioned by 4.7% of respondents (n=13). Suggestions for equipment varied from very general (e.g., more automation, more technology) to very specific (e.g., install an elevator). Most suggestions focused on equipment intended to improve safety or ergonomics (e.g., cart pullers, lifts to reach high shelves, patient lifts, building stairs vs. relying on ladders, updating drivers' seats), while a few focused on equipment to improve worker health/fitness (e.g., treadmills). Some were simple and likely inexpensive to implement (e.g., adding rubber feet to ladders).

Social support, communication, respect. The four coded themes in this major theme were mentioned by 20.6% of respondents (n=57). The social support theme was mentioned by 12.3% of respondents (n=34), with nearly three quarters of those (n=25) specifically mentioning support from supervisors/management. Social support was often described in general terms, but more specific suggestions included management training regarding interpersonal skills, being more responsive to employee needs and suggestions, and changing the work culture to promote teamwork. When describing social support, workers used terms such as supportive, caring, empathy, listening, sympathetic, acknowledge, understanding, compassion, welcoming, work together, common goals, respond, and helping. The absence of social support was

described as being “like a sweatshop,” “a situation where management doesn't respond to employees,” or “treating people like robots.” Some workers did commend or suggest coworker support specifically, describing the importance of coworkers being willing to help each other, and having a feeling of community. The better communication theme was mentioned by 5.8% of respondents (n=16). Most workers mentioned better communication very generally; however, communication was often mentioned in conjunction with other coded themes, such as safety climate, safety training, or social support. The fair/humane treatment theme was mentioned by 3.6% of respondents (n=10). This theme was dominated by descriptions of negative treatment by supervisors/management, generally attributed to a worker being injured, reporting an injury, or returning to work with an injury/permanent impairment. Workers described the presence of and/or the need to eliminate: harassment, bullying, oppression, intimidation, retaliation for reporting unsafe conditions or the injury itself, and discriminatory treatment after RTW (e.g., preventing return to the pre-injury job, changing shift assignment, termination). One respondent attributed her inability to get help from coworkers to gender discrimination. Another worker described needing to take anxiety medication to deal with being “afraid of the poor treatment I was going to endure for the eight hours I was to be there.” The value workers over costs theme was mentioned by 3.2% of respondents (n=9). Costs were described in terms of company profit, top management bonuses, or WC costs. Phraseology was often striking, for example: “management only cares about the money, not its employees”; “the concern is the bottom dollar, not…the safety and health of the employees”; “it’s a very numbers driven place, so it`s more about [selling the product] than about the employee”; “we are treated like a liability, not employees”; and “a bonus should not be attached to an employee's health and well-being” [based on not reporting injuries].”

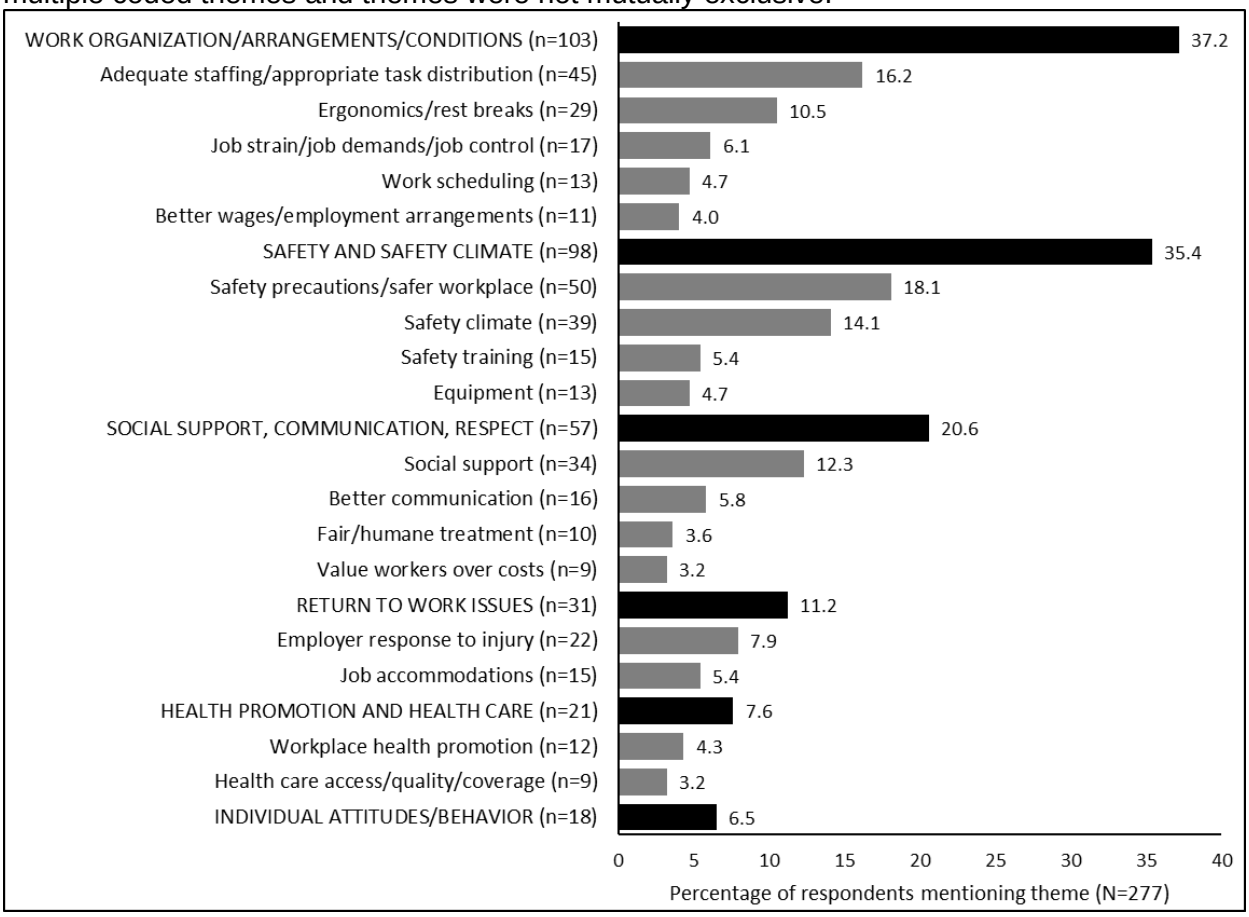
RTW issues. The two coded themes in this major theme were mentioned by 11.2% of respondents (n=31). The employer response to injury theme was mentioned by 7.9% of respondents (n=22). Many workers focused on the lack of acknowledgment of the injury by management/supervisors after RTW, including inadequate levels of accommodation, follow-up, empathy, and/or support. Several workers described terminations or harassment following RTW that they attributed as reactions to their injury/permanent impairment. Workers recommended that employers/supervisors be better educated about the WC agency, be better trained to facilitate and support safe RTW, and provide more information to injured workers about available options. The job accommodations theme was mentioned by 5.4% of respondents (n=15), and was defined to include any type of job modifications that were suggested with respect to accommodating injured workers in general or related to the respondent’s injury or permanent impairment. Worker suggestions included: provide chairs, stools, or desks needed to alleviate discomfort or prevent aggravation; allow more opportunity to change body position (e.g., less sitting, less repetitive motion); minimize or facilitate assistance with difficult physical tasks (e.g., lifting, reaching, bending); move the worker into a job more suited to accommodating the injury (e.g., light duty, office work); and offer flexibility in work hours to accommodate recovery and physical therapy appointments.

Health promotion and health care. The two coded themes in this major theme were mentioned by 7.6% of respondents (n=21). The workplace health promotion theme was mentioned by 4.3% of respondents (n=12). Workers suggested employer encouragement of warm-up, stretching, strength, fitness, and wellness activities, either at the workplace (before or during work, though one worker emphasized these be voluntary), or via incentives to engage in such activities outside work (e.g., discounts for gym memberships). The health care theme was mentioned by 3.2% of respondents (n=9) and was defined to include issues related to health care access, quality, and insurance/WC coverage. Suggestions ranged from general (e.g., better health care) to specific (e.g., cover my surgery, cover a specific medication). Workers

mentioned wanting coverage (or more coverage) for physical therapy, physical rehabilitation, therapeutic massage, preventive/regular health care, and mental health services. One worker suggested adding in-house occupational health services.

Individual attitudes/behavior. This theme/major theme was mentioned by 6.5% of respondents (n=18) and was defined to include comments about attitudes or behaviors of the respondent and/or other workers, without reference to ways the employer, supervisor, or workplace could influence these attitudes/behaviors. Suggestions included: being in good physical shape, paying attention to detail and to the environment, being cautious, slowing down, following workplace protocols, eating healthy food, and being more considerate about things that could cause injury.

Exhibit 20. Worker-suggested workplace improvements (N=277). Coded themes (sentence case and grey bars) are grouped in descending frequency within their respective major themes (uppercase and black bars). Percentages do not sum to 100%; many responses involved multiple coded themes and themes were not mutually exclusive.



In summary, narrative comments and suggested improvements from 277 respondents most frequently fell into the major theme of work organization/arrangements/conditions (37.2%), closely followed by the major theme of safety and safety climate (35.4%). Major themes were used as a post hoc presentation tool and major theme frequencies were thus somewhat artificial; different grouping choices would affect both the percentages and rankings of major themes. However, similar emphases were also evident at the theme level. The most frequently

mentioned theme was safety precautions/safer workplace (18.1%), followed by adequate staffing/appropriate task distribution (16.2%), and then by safety climate (14.1%). The focus on safety-related issues comports with previously published data from the same survey, which revealed that more than half of respondents thought their permanent impairment put them at higher risk of being reinjured at work, compared to pre-injury (65.2%), or compared to coworkers in the same job (54.4%).[3] The focus on safety-related issues also aligns with findings from a large retrospective cohort of injured workers with WC claims linked to wage data, in which workers with work-related permanent impairments had significantly higher reinjury risk compared to workers without permanent impairments—a risk differential that increased as degree of permanent impairment increased.[4]

In sub-study 3.1, which relied on validated instruments and closed-ended survey questions,[58] we found evidence for the association of several modifiable workplace factors with sustained RTW and/or reinjury—factors which also emerged in this study in the context of worker-suggested improvements. In the earlier study, for example, social support (particularly from supervisors), absence of stigmatization, safety climate, low job strain, ability to take time off work for personal or family matters, and comfort reporting unsafe work situations all had substantial and significant associations with safe and/or sustained RTW.[58] In this sub-study, open-ended narrative responses identified all of these factors as potential targets for improvement. Given that this sample was limited to workers who had RTW with a work-related permanent impairment, it was somewhat surprising that RTW issues (e.g., employer response to their injury, job accommodations) were raised by only 11.2% of respondents. On the other hand, this may in part reflect the benefits of negotiated work arrangements experienced by the over 40% of respondents who were union members. In our earlier related study, lack of needed job accommodations was reported by only 13% of respondents, and that lack was not significantly associated with RTW interruption or reinjury.[58] In contrast, other studies have found substantial evidence that job accommodation facilitates sustained RTW.[48,66,145-147,149]

There are promising interventions for modifiable workplace factors such as job strain, safety climate, and social support. For example, supervisor training programs can improve safety climate and confidence managing successful RTW.[43,172] Further, systematic reviews have documented that interventions designed to promote workplace social support, job control, and job demands can positively impact absenteeism, productivity and financial outcomes.[173,174] However, intervention research is relatively sparse for factors such as flexible scheduling and work-life balance. Findings from this study and from our related studies would suggest taking a closer look at developing and evaluating potential interventions for these factors. Improvements in many of these workplace factors could potentially improve worker well-being regardless of whether their disability or permanent impairment was caused by work. Functional limitations are prevalent in the workplace,[179] and many workers do not choose to disclose their disability or impairment to supervisors and/or coworkers.[3,180] Workplace-level interventions, vs. individually-tailored interventions, may positively impact more workers without requiring disclosure.[44] Moreover, workplace-level improvements in these factors may benefit all workers, whether they have a disability or not.[58] Individual employers, particularly small employers, may not have the resources or motivation to implement interventions targeting these workplace factors. However, at the WC system level, it may be feasible to develop and offer trainings to educate employers about key workplace organizational and psychosocial factors, perhaps in-hand with financial support for supervisor training or structural changes. Systemic programmatic or policy support from WC agencies/insurers may be needed to develop and test efficient large-scale interventions, and encourage uptake.

Improving staffing levels was a frequent suggestion, albeit a rather difficult intervention target for employers or the WC system, given profit incentives and market forces. However, some intervention targets would seem to require minimal costs, and to be potentially beneficial regardless of the specific employment scenario. For example, better communication—and more specifically, listening to workers—was embedded within many coded themes, and was mentioned in a number of different contexts (e.g., respect, safety climate, RTW issues). Many workers reported that they were not listened to, or that their input was not sought or considered valuable. Anecdotally, many of the injured workers participating in this survey wanted to talk for much longer than the interview time we had proposed, expressing their desire to be heard. Workers often linked workplace communication deficiencies to preventable deficiencies in safety practices, safety climate, and RTW practices. Research supports the importance of employer/worker dialog to foster safety climate and safer workplaces,[56] as well as active and strategic RTW communication as an effective practice to foster early and sustained RTW.[181] Workers also linked workplace communication deficiencies to a general lack of respect, aura of distrust, and/or being treated by management as less than human. This phenomenon has been described as the "discourse of abuse," emanating from the prevalent underlying assumption that injured workers may be taking advantage of the system.[182] This assumption persists despite overwhelming evidence of systematic shifting of the economic burden of work-related injury/illness away from the WC system and employers and onto other health/disability insurance, the social safety net, and workers themselves.[72]

Nearly a third of respondents reported that no change was needed to their workplace, which was strongly associated with higher job satisfaction. The vast majority (84.2%) of respondents in our sample reported being somewhat to very satisfied with their job. This was also reflected in many narrative comments about a positive workplace factor being both important and present in their workplace. In other words, many workers responded to the request for suggested improvements by giving advice for improving other workplaces based on their own positive experience, rather suggesting improvement of their own workplace. The high prevalence of union membership in this sample may or may not have affected these findings. In a construction industry study, union membership was found to be associated with better worker-reported safety climate.[183] The high level of union membership may also indicate relatively low job precarity among this sample.[97]

Sub-study 3.3: Workers' appraisal/suggestions for WC improvements

This sub-study relied on open-ended questions from the survey. Aims included summarizing: (1) workers' appraisal of several Washington State WC-based RTW programs, including Stay at Work (employer reimbursement for light-duty job arrangements), Preferred Worker (employer incentives for hiring workers with permanent impairments), and vocational rehabilitation; and (2) workers' suggestions for WC system and vocational rehabilitation program improvements to promote safe and sustained RTW.

Additional methodology specific to sub-study 3.3

This sub-study included the 582 survey respondents with completed interviews. Respondents were asked whether participation in specified WC-based RTW programs helped them RTW and/or stay at work. Workers were asked whether they had participated in the Stay at Work program during the past year. If they had, they were asked: (1) "Do you think the Stay at Work program helped you RTW?" and (2) "Do you think the Stay at Work program helped you stay at work?" These questions were asked in the same manner for the Preferred Worker Program.

Workers were also asked, “Did you participate in vocational rehabilitation related to the injury that caused your impairment?” Workers who reported participating were then asked the two program appraisal questions described above. We tabulated responses for all respondents who completed interviews, and for two additional subsets of interest: (1) workers who had a vocational retraining plan, and (2) workers who RTW in an occupation aligned with the vocational retraining plan’s goal occupation.

Suggestions for program and system improvements were solicited using open-ended questions. We used qualitative content analysis methods, as described for sub-study 3.2, to inductively code responses to two open-ended telephone survey questions: “If you could suggest one change to the WC system that would help you to continue working or prevent reinjury, what would it be?,” followed by “If you could suggest one change to the vocational rehabilitation system that would help you to continue working or prevent reinjury, what would it be?” Response options included: open-ended narrative, no change needed, don’t know, or refused. Trained interviewers recorded workers’ narrative responses verbatim or in summary. Codes were subsequently grouped into themes as described for sub-study 3.2.

Results and discussion

Workers participating in the three WC programs were asked whether each program helped them (1) RTW, and (2) stay at work. Although the numbers of workers eligible to appraise each program were small, responses were generally favorable (Exhibit 21). With respect to vocational rehabilitation, there were increasingly positive ratings for both measures among three ordered subsets of workers: (1) those who received any vocational rehabilitation services, (2) those for whom a vocational retraining plan was developed, and (3) those who RTW in an occupation aligned with their vocational retraining goal occupation. Among workers in the latter group, a striking 96.2% (all but one worker) reported that the vocational rehabilitation program had helped them RTW.

Exhibit 21. Worker appraisal of workers’ compensation-based RTW programs

Program/subset	N	Program helped me return to work (vs. No/Don’t Know)		Program helped me stay at work (vs. No/Don’t Know)	
		n	%	n	%
Stay at Work[a]	26	16	61.5%	19	73.1%
Preferred Worker[b]	22	12	54.6%	11	50.0%
Vocational rehabilitation,[c] if received any vocational services	120	75	62.5%	62	51.7%
Vocational rehabilitation,[c] if vocational retraining plan was developed	61	47	77.1%	38	62.3%
Vocational rehabilitation,[c] if RTW in an occupation aligned with retraining goal	26	25	96.2%	20	76.9%

[a] Reimbursement to employers for offering light-duty job arrangements.
[b] Incentives to employers for hiring workers with permanent impairments.
[c] Services intended to assist injured workers to overcome RTW barriers (e.g., assessment, work hardening, vocational retraining plan with new occupational goal).

Overall, 28.0% of respondents reported that no change was needed to the WC system to promote sustained RTW or prevent reinjury, while 57.6% (N=335) provided codable narrative comments or suggestions (Exhibit 22). Only 4.1% provided narrative comments or suggestions that were too vague or unclear to code, and 10.3% responded that they didn’t know or did not have suggestions to make. There were 120 respondents who had received some vocational rehabilitation services, and who were thus asked the ensuing comparable question focused on

the vocational rehabilitation system. Of these 120 respondents, 46.7% (N=56) provided codable narrative comments or suggestions. Of the 120, 35.8% reported that no change was needed to the vocational rehabilitation system; this percentage rose to 41.0% among the subset for whom a vocational retraining plan was developed, and further rose to 50.0% among those who RTW in an occupation aligned with their vocational retraining goal occupation.

Exhibit 22. Response option frequencies for two open-ended questions: If you could suggest one change to the [workers' compensation/vocational rehabilitation] system that would help you to continue working or prevent reinjury, what would it be?

Question/subset	Total*	No change needed		Codable response		Vague/unclear response		Don't know/ no suggestions	
	N	n	Row %	n	Row %	n	Row %	n	Row %
Workers' compensation system	582	163	28.0	335	57.6	24	4.1	60	10.3
Vocational rehabilitation system, if received any vocational services	120	43	35.8	56	46.7	9	7.5	12	10.0
Vocational rehabilitation system, if vocational retraining plan developed	61	25	41.0	27	44.3	4	6.6	5	8.2
Vocational rehabilitation system, if RTW in occupation aligned with retraining goal	26	13	50.0	8	30.8	2	7.7	3	11.5

For ease of presentation, coded themes for each of the two questions were grouped into six major themes (Exhibits 23 and 24). The same set of six major themes was used to organize response themes for both questions, though the rank ordering of major themes, response theme content, and frequency of themes within those major themes varied across the two questions. Some major themes only included one coded theme (varying by question). Respondents offered numerous constructive suggestions for system improvements. Some were very specific (e.g., hiring more in-house vs. subcontracting vocational rehabilitation counselors), while others were very general or high-level (e.g., "overhaul the system"). For each major theme, we describe constituent themes in detail. Percentages reported below reflect the prevalence of themes and major themes (i.e., for the WC system question, the percentage of 335 respondents mentioning the theme; for the vocational rehabilitation system question, the percentage of 56 respondents). Theme percentages do not sum to 100%; many responses involved multiple coded themes and themes were not mutually exclusive.

Efficiency, access, services. With respect to the WC system question, the 13 coded themes in this major theme were mentioned by 59.7% of respondents (n=200). Notably, reduce delays/simplify process/improve efficiency was by far the most frequent of all coded themes, mentioned by 34.9% of respondents (n=117). Of those 117, 38.5% (n=45) specifically mentioned delays with the health care authorization process, e.g., approvals for surgery or imaging. Numerous workers emphasized the need to reduce delays and speed up the process in general terms, and often linked those issues to delayed recovery and/or delayed RTW, e.g., "had I had the care I needed in a timely manner, my recovery would have been a lot faster"; "if injuries were treated in a timely manner, people would not suffer as much"; "every minute counts when injured…the faster medical help is received, the faster pain is relieved and the healing process can begin"; and "speed it up so people can get back to work faster." Some

suggested incorporating deadlines for WC response times, and for health care providers to complete paperwork. Numerous workers also emphasized the need to simplify the process and make it less confusing, including making it easier to open a claim, navigate the system, file an appeal, and reopen a closed claim. To that end, workers suggested “less paperwork,” “less red tape,” “less bureaucracy,” and “not having to jump through so many hoops.” The theme of better/faster compensation was mentioned by 8.1% of respondents (n=27). This included higher compensation levels for temporary wage replacement and permanent disability, as well as improving and accelerating payment processes. Workers reported intense financial stress, e.g., “I was constantly stressed out about money and how I was to support my family”; “I almost lost my house”; “I had to get food stamps”; “I'll have to work past retirement”; “I spent my 401K making up for lost wages”; and “often times I would receive my checks several days late, not being able to pay my rent and other bills on time.”

The theme of employer/WC should follow health care recommendations was mentioned by 6.3% of respondents to the WC system question (n=21), which most often was described as WC disagreeing with or not authorizing a recommended surgical or imaging procedure, sometimes one recommended by several health care providers. Several workers described hiring attorneys specifically to resolve this situation. In other cases, this was described as WC mandating certain health care protocols that delayed what the worker perceived as necessary care, e.g., requiring physical therapy prior to imaging/surgery. Workers also expressed frustration with conflicts of opinion between their own health care provider and the Independent Medical Examination (IME) physician. Although not specific to the WC system, workers mentioned also wanting their employers to follow their health care provider’s recommendations in terms of RTW timing. The theme of don't fight legitimate WC claims was mentioned by 6.0% of respondents (n=20), who generally described an oppositional process, using phrases such as “fight tooth and nail,” “combative experience,” “such a battle,” and often linked this process to unnecessary recovery delays and economic hardship, e.g., “I had to spend thousands of dollars to get what I deserved”; “they make it a combative experience, delaying recovery”; “they make it so difficult to reopen a claim, that is what I am fighting with right now”; “everything has been a fight from day one.” One worker explained, “initially they declined my claim; by declining it, it caused a long appeal process and multiple visits to different medical providers to justify the treatment—it should have been a six-month process, which turned into a three-year process, and in those entire three years I remained injured.” The theme of don't close WC claim too soon was mentioned by 4.8% of respondents (n=16), which was often described as cutting off access to ongoing or future medical treatment for the work injury (e.g., physical therapy to enable sustained RTW, pain injections, surgery). Workers described hiring attorneys specifically to reopen their claim due to medical needs. Several workers pointed out that when the claim is closed immediately upon RTW, exacerbations or other unforeseen issues can require reopening, and suggested that WC claims be kept open for some period of time after initial RTW.

The theme of more knowledgeable/skilled claim managers was mentioned by 3.9% of respondents to the WC system question (n=13), which most often was described as having a claim manager who was new to the job, or uninformed about procedures, about the specific claim, or about health/injury. One worker remarked that their self-insured employer’s third party administrator was in a different state and seemed unfamiliar with Washington State laws. Workers suggested additional training for claim managers, and one suggested a focus on understanding job descriptions (with respect to RTW). Other less-frequently coded themes included: (1) reduce eligibility/participation barriers for RTW/vocational programs (n=8; e.g., “I could have used vocational training,” “making the programs easier to get into”); (2) improve staff continuity (n=6; e.g., fewer claim managers involved with a claim, fewer transitions, more

transparent hand-offs and vacation coverage); (3) WC staff should better understand/investigate workplace/job (n=6; e.g., understanding the injured worker's job description, investigating the injury/work situation, expecting the employer to obey the law as much as the employee); (4) more flexibility for special circumstances/needs (n=5; e.g., adjust for pre-existing conditions, tailor RTW expectations to individual differences); (5) improve WC staffing/hire more claim managers (n=3; e.g., "hire more people," "overwhelmed case workers"); (6) follow up after WC claim closure (n=2; e.g., provide longer-term follow-up care, with options if still having problems); and (7) reduce subcontracting to vocational rehabilitation counselors (n=1; i.e., hire in-house).

With respect to the vocational rehabilitation question, the nine coded themes within the efficiency, access, services major theme were together mentioned by 41.1% of vocational rehabilitation participants (n=23); this major theme was a close second in frequency to the vocational retraining plan major theme, which is described further below (42.9%, n=24). The theme of more knowledgeable/skilled vocational rehabilitation counselors was mentioned by 12.5% of vocational rehabilitation participants (n=7). Some workers pointed to their vocational rehabilitation counselors' inadequate knowledge of or research into the job demand and earning potential of new occupations, and wanted them to be better prepared to identify new occupations that would fit the injured worker's specific situation and interests. Several workers commented that their vocational rehabilitation counselor "didn't really know her job," "did not fill out forms right," "was not well informed about the classes," and/or was not very effective. One worker suggested that WC screen vocational rehabilitation counselors before referring injured workers to them. The theme of reduce eligibility/participation barriers for vocational retraining was mentioned by 8.9% of vocational rehabilitation participants (n=5). Workers described various issues with access to vocational retraining, including eligibility and service-related barriers, and two workers described having a retraining plan developed that was later removed as an option. Notably, the coded theme of reduce delays/simplify process/improve efficiency was mentioned by only 7.1% of vocational rehabilitation participants, in contrast to the 34.9% of respondents overall who mentioned this theme with respect to the WC system. Counts and percentages for the remaining themes are reported in Exhibit 24; comments and suggestions within these themes were very similar to those made in response to the WC system question, except that the focus was naturally on the vocational rehabilitation system.

Social/navigational support, communication, respect. With respect to the WC system question, the five coded themes in this major theme were mentioned by 34.6% of respondents (n=116). Better communication was suggested by 12.8% of respondents (n=43); comments in this theme were often very vague or general, but often included aspects such as responsiveness, style, and tone. Most workers focused on improving the communication by WC or the third-party administrator with injured workers, but five (11.6%) focused on communication between WC and employers, and six (14.0%) focused on communication between WC and health care providers. Three workers (7.0%) suggested specific communication mechanisms, which were focused on preferring in-person or phone communication over email, and any of these mechanisms over letters. Beyond the general communication theme, 7.2% of respondents (n=24) mentioned the more specific provide more/clearer information about process theme. The social/navigational support theme was mentioned by 10.4% of respondents (n=35), with nearly half of those (n=17) specifically mentioning support from an attorney, advocate, or RTW coordinator as an alternative to inadequate support from the WC system/claim manager. The need for navigational/social support was often suggested in the context of describing negative aspects of the WC system/process, e.g., "confusing system," "entire process was hell," "no one on my side," "the system is a racket," "it's a long and hellish process," "WC was not helpful in any regard." The fair/humane treatment theme was mentioned

by 7.8% of respondents (n=26). This theme was dominated by descriptions of unfair or otherwise negative treatment by the WC system generally or claim managers more specifically. Multiple workers described, often in strikingly similar terms, feeling "harassed," "threatened," "shamed," or "bullied" to RTW too soon, being treated as "numbers" rather than as people, or being "treated like criminals." Systemic distrust and suspicion of injured workers was frequently mentioned, e.g., WC "treats everyone like they are going to abuse the system," "we`re treated like we`re faking it," "they treated me like I was not honest." One worker theorized that "the people that work in that system for too long, they lose their compassion for injured people and jump to the conclusion that people are lying." Several workers described feeling blamed for having been injured. Workers noted that "WC is designed to be confrontational," and that WC is "a combative experience delaying recovery." Another worker suggested that WC should "not write us off. They send you a check, they're done, even if you're not done and still hurting and not able to work." The value workers over costs theme was mentioned by 3.0% of respondents (n=10). Workers described WC as a "safety net" that they paid into (unique to Washington State), but which then didn't adequately value their needs once injured, e.g., "we pay into the system and they do everything in their power not to pay out"; "L&I is like all insurance companies, they don't want to payout." Several workers suggested that WC refocus on workers' needs over employers' needs or "bottom line."

With respect to the vocational rehabilitation question, the four coded themes within this major theme were together mentioned by 21.4% of vocational rehabilitation participants (n=12). Theme counts and percentages are reported in Exhibit 24. Comments and suggestions were very similar to those made in response to the WC system question, except that the focus for improvements in social/navigational support and communication was naturally on the vocational rehabilitation counselor. Specifically, many workers suggested they wanted closer interactions with their vocational rehabilitation counselor, or that the vocational rehabilitation counselor should prioritize listening to and understanding injured workers.

Law/system change. With respect to the WC system question, 17.6% of respondents (n=59) made comments or suggestions assigned to the law/system change major theme, which contained three coded themes: (1) improve rating/IME system (n=34), (2) improve self-insurer/third party administrator system (n=11), and (3) system overhaul or other law/policy change (n=19). The latter category included both very specific suggestions (e.g., start a safety panel, claims should automatically stay open for one year after RTW) and very high-level suggestions (e.g., complete overhaul, get rid of WC completely, replace WC with socialized medical system). With respect to the vocational rehabilitation question, only one vocational rehabilitation participant (1.8%) made a comment assigned to this major theme; the comment—that the system needs to change to actually help people—was quite general in nature, but also evocative.

Physical rehabilitation/health care. With respect to the WC system question, the physical rehabilitation/health care theme/major theme was mentioned by 11.3% of respondents (n=38). The majority of those (n=21) made comments/suggestions related to better quality health care, including: facilitate referrals to appropriate and competent physicians/surgeons/physical therapists, specifically those who understand the WC system; ensure better assessment/evaluation before starting treatment; decrease reliance on protocols (tailor treatment to individual worker); provide more support with medical mishaps/mistakes; and provide a more comprehensive approach to health care. One worker suggested that WC should drop providers who "treat patients like garbage." Workers also frequently suggested improved/expanded WC coverage of certain treatments, such as physical therapy, chiropractic care, Pilates, counseling, and a less restrictive medication formulary (n=12). Five workers

recommended better access to providers, describing issues such as few providers accepting WC, tight provider schedules, or not being offered any choice of providers. Two workers mentioned the need to provide/continue regular health insurance in addition to WC coverage, to facilitate routine and preventive health care.

With respect to the vocational rehabilitation question, the physical rehabilitation/health care theme/major theme was mentioned by 8.9% of vocational rehabilitation participants (n=5). Most suggestions were focused on better access to or quality of physical rehabilitation; one worker emphasized the lack of and need for mental health care and emotional support during vocational rehabilitation.

RTW issues. With respect to the WC system question, the theme/major theme of RTW issues was mentioned by 9.3% of respondents (n=31). Comments were focused on not forcing RTW too soon (i.e., before adequate recovery), and/or on support for job re-entry (e.g., assistance with job search, assistance with finding an appropriate job with adequate pay). One worker succinctly expressed a recurrent sentiment as: “Provide help for injured workers to get a job. Don`t leave them hanging.”

With respect to the vocational rehabilitation system question, the RTW issues theme/major theme was mentioned by 14.3% of vocational rehabilitation participants (n=8). As for the WC system question, comments were focused on timing of and support for RTW; the majority of suggestions related to wanting the system to focus on identifying/facilitating a (physically appropriate) RTW job more comparable to the pre-injury job, in terms of pay level or fit with interest/experience.

Vocational retraining plan. With respect to the WC system question, three respondents (0.9%) suggested more worker choice/input to the vocational training plan (no other themes emerged within this major theme). In contrast, when vocational rehabilitation participants were questioned specifically with respect to the vocational rehabilitation system, vocational retraining plan was the most frequent major theme; grouped together, the two coded themes within this major theme were mentioned by 42.9% of vocational rehabilitation participants (n=24): (1) more worker choice/input to the vocational retraining plan (n=19), and (2) higher quality/longer duration vocational retraining plans (n=6). Notably, more worker choice/input to the vocational retraining plan was by far the most frequent of all coded themes, mentioned by 33.9% of vocational rehabilitation participants.

Exhibit 23. Workers' compensation system suggestions (N=335). Coded themes (sentence case and grey bars) are grouped in descending frequency within their respective major themes (uppercase and black bars). Some major themes represented only one coded theme, and thus are not followed by grey bars. Percentages do not sum to 100%; many responses involved multiple coded themes and themes were not mutually exclusive. (IME, Independent Medical Examination; RTW, return to work; voc, vocational; WC, workers' compensation)

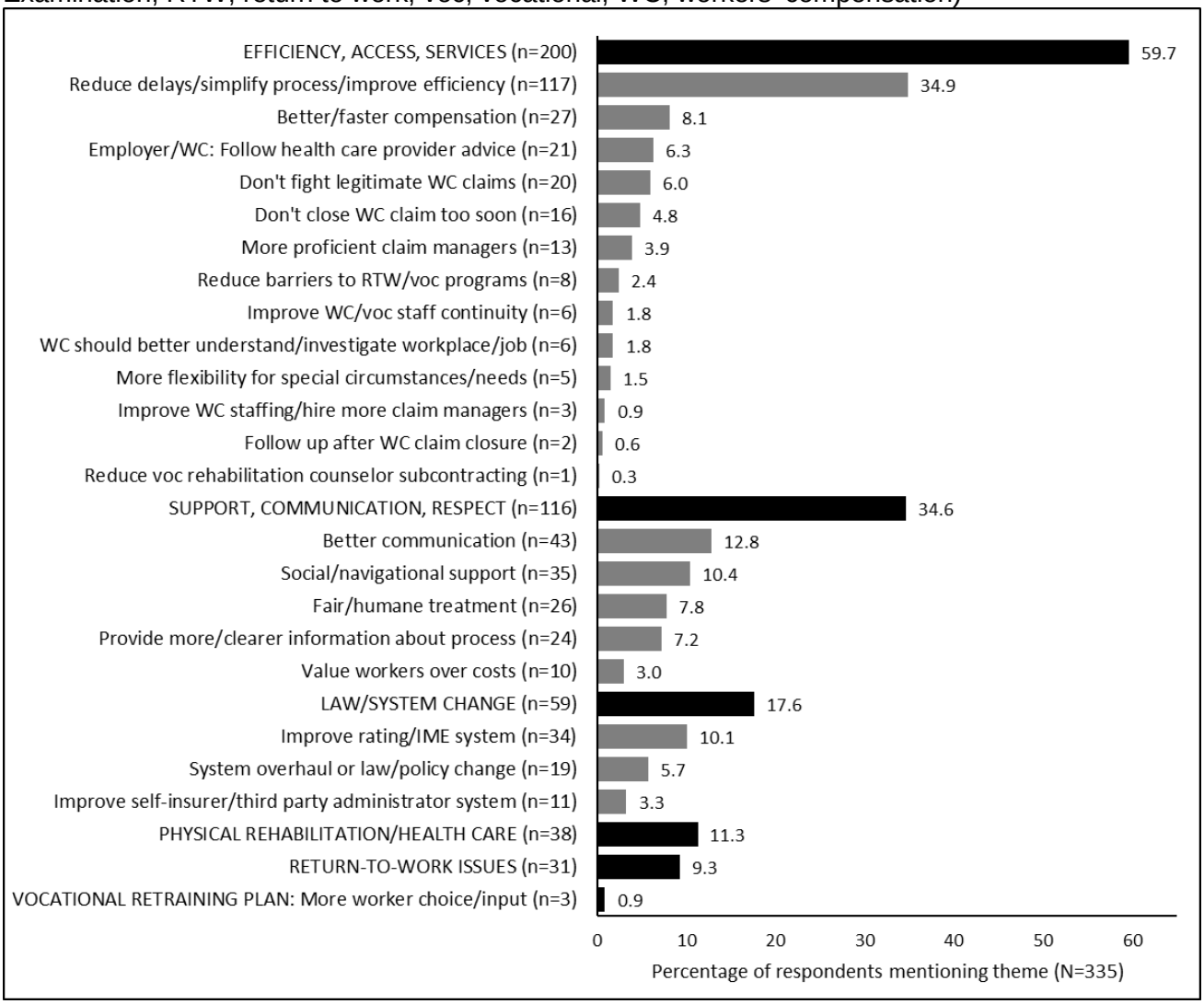
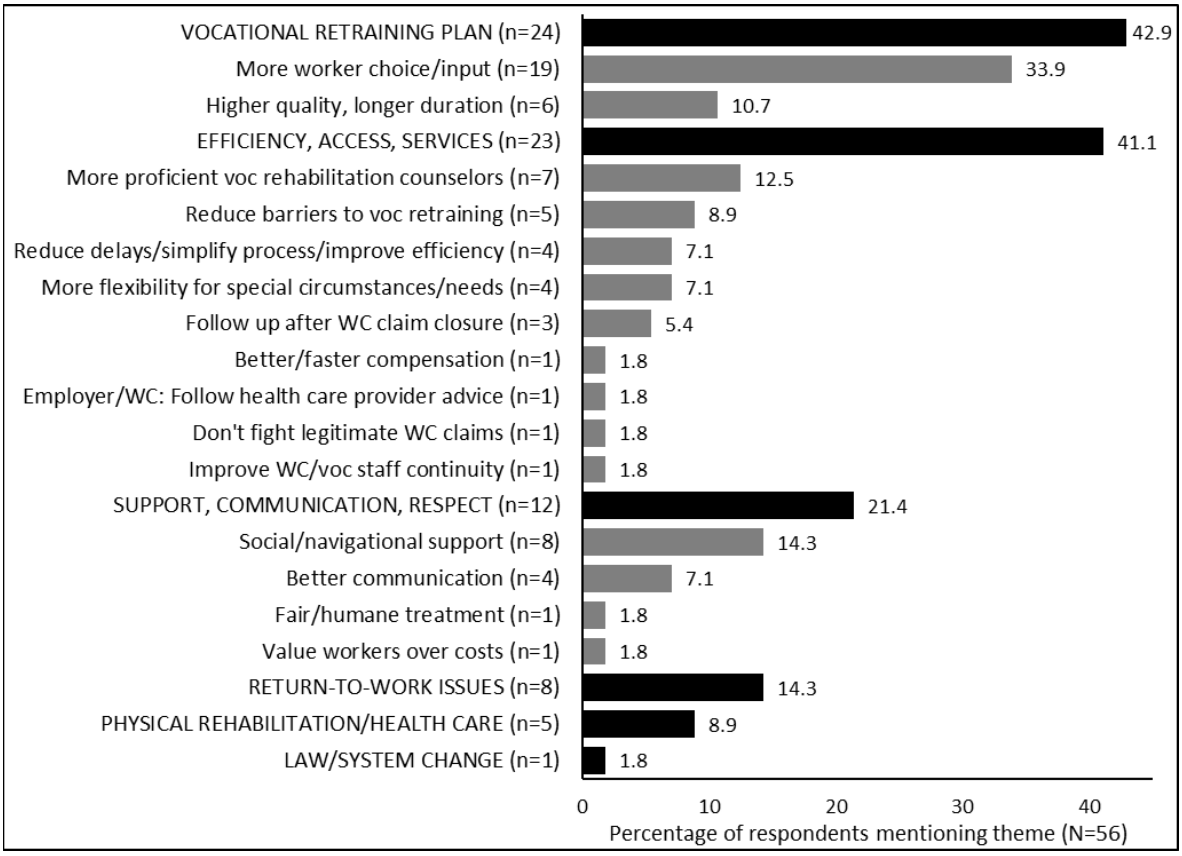


Exhibit 24. Vocational rehabilitation system suggestions (N=56). Coded themes (sentence case and grey bars) are grouped in descending frequency within their respective major themes (uppercase and black bars). Some major themes represented only one coded theme, and thus are not followed by grey bars. Percentages do not sum to 100%; many responses involved multiple coded themes and themes were not mutually exclusive. (voc, vocational; WC, workers' compensation)



This study provides important new information regarding injured workers' appraisals of and suggestions to improve WC-based RTW programs and the WC system as a whole. The majority of workers appraised RTW programs favorably; for example, 62.5% of vocational rehabilitation participants reported that vocational rehabilitation helped them RTW, and 51.7% reported that it helped them stay at work. Relatively few respondents had participated in each of the three WC RTW programs (i.e., Stay at Work, Preferred Worker, vocational rehabilitation), and we were unable to assess outcomes beyond self-reported appraisals. However, in related studies using administrative data, we found that participation in the Stay at Work program was associated with significantly and substantially better employment outcomes, compared to those who did not participate.[4] We also found that completion of a vocational retraining plan, compared to those who did not complete their plan, was associated with significantly and substantially better employment outcomes,[4] and with lower reinjury rates.[5]

Although most respondents reported positive impacts from WC-based RTW program participation, many workers suggested improvements. Overall, 28.0% of 582 respondents reported that no change was needed to the WC system, while 57.6% (N=335) provided suggestions or critiques. Among 120 vocational rehabilitation participants, 35.8% reported that

no change was needed to vocational rehabilitation, while 46.7% (N=56) provided critiques/suggestions. Respondents offered numerous constructive suggestions for system improvements. Some were very specific, while others were very general or high-level. Some suggestions were unique, while others were offered by many workers. With respect to the WC system overall, the most frequent theme—mentioned by 34.9%—was reduce delays/simplify process/improve efficiency in the WC system. With respect to vocational rehabilitation, the most frequent theme—mentioned by 33.9%—was more worker choice/input into the vocational retraining plan. This echoes the most frequent suggestion from workers participating in an earlier evaluation of the vocational rehabilitation program in Washington State (i.e., there should be more training choices, more worker input into the retraining goal, and/or a better fit of the retraining goal with the workers' experience and abilities).[62] Similar issues have been reported in other jurisdictions.

Many of the themes discussed by respondents related to the more general concept of administrative burden. Administrative burden has been described as consisting of three categories of costs experienced by individuals interacting with government systems: (1) learning costs (e.g., investigating eligibility and filing processes), (2) compliance costs (e.g., burdensome paperwork), and (3) psychological costs (e.g., stress or stigma experienced while interacting with the system).[70,71] Despite numerous studies highlighting system deficiencies and onerous administrative burdens imposed on workers by the WC system, which can interfere with successful physical, mental, and economic recovery, these issues remain prevalent and persistent.[2,60,62,64,157,184-186] With regard to WC, administrative burden can serve the systemic purpose of limiting the costs to employers that are assessed via WC insurance premiums, while focusing public attention on excluding ineligible workers from compensation (versus inclusively identifying eligible workers for compensation).[70] Administrative burden is one of the mechanisms through which much of the economic burden of WC is diverted from employers to workers and their families, to other health care and disability insurers, and to the social safety net.[72] Administrative burden also has the potential to directly and negatively affect the health of injured workers via the accumulated stress induced by its psychological costs—a potential outcome at odds with the goal of promoting safe and sustained RTW.[70] Workers' suggestions and critiques often related directly to one or more of the three categories of administrative burden. For example, the provide more/clearer information about process theme addresses learning costs, the reduce delays/simplify process/improve efficiency theme addresses compliance costs, and the fair/humane treatment theme addresses psychological costs. Notably, workers often directly linked the administrative burdens they described to negative impacts on health or recovery time.

On the other hand, many worker suggestions were not directly related to administrative burden. For example, many workers suggested improvements in health care quality or in the type of health care they received, beyond WC system-regulated access or coverage issues. Yet, even in those cases, workers often suggested ways that the WC system could act to improve the situation, e.g., doing better screening or not making referrals to health care providers, independent medical examiners, or vocational rehabilitation counselors who provide low-quality services. A few additional areas merit discussion based on current trends relevant to WC research and system change:

1. Several workers suggested that WC cover mental health services or counseling to assist with stress, transitions, and recovery related to having a permanent injury. This aligns with growing research attention on the downstream mental health impacts of work-related injury—impacts which may in part be direct health impacts of the injury, but may also be preventable sequelae of WC-related administrative burdens and their psychological

costs,[73,187-189] or of post-injury economic burdens, which were described by survey respondents with alarming frequency and stress.[3,4,72]

2. A large number of workers (N=45) emphasized the need for easier and earlier access to specific procedures, particularly imaging and surgery. Workers reported experiences with protocol mandates or long delays in the health care authorization process that they perceived to be both unnecessary and responsible for delays in recovery and RTW. Some workers commented that mandating physical therapy before approving other interventions also did them physical harm. These mandates and approval delays were generally attributed to WC system delays, rules, or inattention, or in some cases to poor communication between WC and providers. L&I has issued a number of guidelines intended to encourage or mandate best practices in clinical care (e.g., lumbar fusion, advanced imaging, pain treatment), and there is evidence—at least for certain guidelines—of resulting population-level improvements.[190-193] However, the purpose of and rationale for such guidelines may not be transparent to workers, or workers may be hearing disparate opinions from their health care providers. It is possible that making pertinent guideline rationale more directly and transparently available to affected injured workers might help to reduce demand for treatments or procedures that are not evidence-based. On the other hand, though guidelines may be beneficial on average, a recurrent comment was that the system needed to be more personalized and take individual worker circumstances into better account.

3. More than a few workers commented that the permanent impairment rating system needs improvement or overhaul. Several specifically suggested that chronic pain should be considered when rating impairment/disability. This suggestion resonates with a recent paper describing the historical origins of excluding pain from compensation, and concluding that the resulting WC systems fail to address certain harms and may contribute to perceptions of injustice and adverse health outcomes.[194]

The findings of this study suggest that, although the majority of workers appraised WC-based RTW programs favorably, there is also substantial room for improvement in workers' experience with the WC system. In addition, injured workers' feedback may reflect opportunities to reduce administrative burden and to improve health and RTW outcomes. Even if these findings sometimes reflected misperceptions rather than system inadequacies, or might be attributable to factors beyond the purview of the WC system, such perceptions could be expected to interfere with worker satisfaction, the recovery process, and RTW outcomes.[64,69] For example, in a Washington State study focused on satisfaction with health care related to the workplace injury, injured workers who reported less-favorable treatment experience had 3.5 times the odds (95% CI: 1.20, 10.95) of being on long-term time-loss compensation for work disability (6 or 12 months after filing a claim), compared to workers whose treatment experience was more positive.[69] Thus, the identification and implementation of system improvements that address injured workers' perceptions hold potential to improve both satisfaction and RTW outcomes.

Many of the suggestions made by injured workers aligned with system factors that have either an existing evidence base or inherent cost incentives supporting attention for quality improvement, such as reducing administrative burden, improving efficiency, supporting best practices in clinical care, etc. Others, particularly novel suggestions, may warrant further research. L&I has several standing stakeholder committees that include labor representatives, but the route for individual injured workers to provide input for system improvement is not obvious. Amplifying workers' voices during intervention design, implementation, and evaluation is crucial.[182,195]

There has been limited research specific to injured workers' satisfaction with the WC system or WC-based RTW programs. Surveys of injured worker satisfaction conducted in Washington State and California focused on WC-related health care, rather than on the WC system itself.[69,196] Notable exceptions include an evaluation of the Vocational Improvement Program in Washington State,[62,63] a set of qualitative studies conducted in Ontario [2,60,64] and the evaluation of New Zealand's vocational rehabilitation system (covering both occupational and non-occupational injuries)[61] that together offer an unusual in-depth window into workers' experiences and assessments. These studies elucidate numerous challenges and barriers to meeting injured workers' needs and goals within WC and vocational rehabilitation systems, such as time constraints, conflicting values and priorities, power imbalances, restrictive rules and system-driven expectations, the lack of outcome-based evidence regarding particular interventions, and barriers to meaningful and effective claimant involvement in goal setting and decision-making. Despite jurisdictionally widespread quality improvement efforts, there remains a great deal of room for vocational rehabilitation and WC system improvement internationally.[59,64,67,184,186] This study adds to the existing literature by presenting potential improvements suggested by a large number of workers, organized by theme.

Conclusions

A substantial number of injured workers return to the workplace with lingering or permanent disability. Our research described the long-term challenges related to health limitations, chronic pain, reinjury, barriers to sustained RTW, and ongoing economic impacts faced by injured workers with permanent impairments. Many of these challenges were exacerbated for injured workers with a higher degree of impairment.

It has been well-documented that many injured workers never RTW, and that those who do often face delayed, temporary, and/or intermittent RTW, as well as higher risk of reinjury. However, accurately estimating time to RTW and to reinjury has been problematic. Our use of state wage data linked to WC claims facilitated measurement of long-term employment patterns, yielding more accurate reinjury estimates than when using proxies that overestimate successful RTW, such as the end of time loss compensation or WC claim closure. We demonstrated how choice of timescale substantially affects reinjury estimates and comparisons between groups with differential RTW patterns. Overall reinjury rates nearly doubled when using hours worked, compared to using calendar time. Using hours worked, workers with ≥10% WBI had a 34% higher risk of reinjury, relative to workers with no PPD award; no such difference was detected using calendar time. Choice of timescale also had substantial impact on comparisons by age category and by number of comorbidities.

Our findings identified the first six months after RTW as a particularly important window of opportunity for prevention efforts, though elevated reinjury risk persisted for about four years. While workers with permanent impairments were observed to be at substantially higher risk of poorer employment outcomes compared to other workers, our findings suggest that WC-based vocational rehabilitation and RTW programs may be useful in promoting better employment outcomes. Most injured workers with permanent impairments reported positive impacts from participating in WC-based RTW programs. Many workers also suggested improvements in these programs, and our findings suggest that there is substantial room for improvement in workers' experience of the WC system. Reduce delays/simplify process/improve efficiency was the most frequent theme with respect to the WC system overall—mentioned by 34.9% of respondents. More worker choice/input into the vocational retraining plan was the most frequent theme with respect to vocational rehabilitation—mentioned by 33.9% of vocational rehabilitation

participants. Injured workers' feedback may reflect opportunities to reduce administrative burden and improve worker health and economic outcomes.

This research also provides evidence that several potentially modifiable workplace factors are associated with safe and sustained RTW among injured workers with work-related permanent impairment. The lack of interaction between any of these workplace factors and degree of impairment suggests that these findings may be generalizable to all workers, and further suggests that workplace interventions based on these findings might be useful for both primary and secondary prevention. In this research, workers themselves suggested a number of workplace improvements that could potentially support safe and sustained RTW. Modifiable workplace factors that frequently emerged included (but were not limited to): safety, safety climate, adequate staffing, ergonomics, rest breaks, job strain, predictability and flexibility in work scheduling practices, employer response to injury, social support, communication, and respect. In addition to corroborating the importance of the workplace factors covered by pre-specified survey questions, the open-ended questions we included gave voice to workers with respect to the factors they considered most important to their well-being. Our findings suggest that policies and interventions targeting these factors at the workplace, WC system, and/or population level may promote safe and sustained RTW.

By focusing on RTW interruption and reinjury for workers with permanent impairment—topics which have received little attention but which affect the productivity and economic interests of large numbers of workers and employers—this study contributes to a more complete description of the long-term burden of worker injury. Conducting a worker survey enabled the characterization of work reintegration and reinjury during the year following WC claim closure—a time period which is typically opaque for studies relying solely on WC administrative data. Our inclusion of workers with any type and degree of permanent partial impairment enhances generalizability to a broad range of injuries and conditions, and indications of non-response bias were negligible. A key strength of the survey was that the use of open-ended questions allowed us to present potential WC system improvements from the standpoint of the worker.[182] Many studies, including most of our own related studies, focus on more easily available administrative outcomes (e.g., reinjury via WC claim filing, and work disability via duration of compensated time loss or administrative wage files). Administrative outcomes are generally framed from the standpoint of impact on WC system and employer costs, though they may also benefit workers. Even when fielding worker surveys, the topics covered by survey instruments and closed-ended questions generally focus on existing frameworks, which may serve to prioritize WC system and employer perspectives over those of workers; workers' primary concerns may lie elsewhere. In this study, we did not use a priori frameworks when coding responses to the open-ended questions; rather, we allowed workers' own priorities for workplace and WC system improvement and insights into potential levers for change to emerge from the data. Finally, the survey involved a large population-based sample, larger than typical for qualitative research, and the non-response assessment revealed no consequential bias.

During the course of this research project, we conducted two methodological studies in order to advance existing research methods, and to ensure their applicability to our research. First, our study validated the use of an existing two-factor safety climate scale among workers with a history of work-related permanent impairment. Second, we produced and published a new set of compatible ICD-9-CM and ICD-10-CM code lists for the FCI. These code lists can be used for studies spanning the ICD lexicon change in 2015, or with data sets that include diagnosis codes from both lexicons. These methodological contributions advance the field of occupational health services research, and health services research more generally.

The recognition that employment is a critical social determinant of health[197,198] was a primary motivator of this research project. Sustained RTW after occupational injury or illness is important for workers' health and economic stability, as well as for workplace productivity. Although primary prevention is key, efforts to sustain RTW and prevent reinjury may reduce the considerable health, economic, and social burden of occupational injury/illness.[29,72,199] The development of workplace and WC system interventions that promote sustained RTW and reduce reinjury for workers with permanent impairments should be prioritized as an important public health and societal goal.

Publications

1. Sears JM, Edmonds AT, MacEachen E, Fulton-Kehoe D: [2021] Appraisal of Washington State Workers' Compensation-Based Return-To-Work Programs and Suggested System Improvements: A Survey of Workers With Permanent Impairments. American Journal of Industrial Medicine 64(11):924-940. PubMed Central PMCID: PMC8500921.

2. Sears JM, Edmonds AT, MacEachen E, Fulton-Kehoe D: [2021] Workplace Improvements to Support Safe and Sustained Return to Work: Suggestions From a Survey of Workers With Permanent Impairments. American Journal of Industrial Medicine 64(9):731-743. PubMed Central PMCID: PMC8362688.

3. Edmonds AT, Sears JM, O'Connor A, Peckham T: [2021] The Role of Nonstandard and Precarious Jobs in the Well-Being of Disabled Workers During Workforce Reintegration. American Journal of Industrial Medicine 64(8):667-679. PubMed Central PMCID: PMC8336416.

4. Sears JM, Schulman BA, Fulton-Kehoe D, Hogg-Johnson S: [2021] Workplace Organizational and Psychosocial Factors Associated With Return-to-Work Interruption and Reinjury Among Workers With Permanent Impairment. Annals of Work Exposures and Health 65(5):566-580. PubMed Central PMCID: PMC8329963.

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6. Sears JM, Schulman BA, Fulton-Kehoe D, Hogg-Johnson S: [2021] Estimating Time to Reinjury Among Washington State Injured Workers by Degree of Permanent Impairment: Using State Wage Data to Adjust for Time at Risk. American Journal of Industrial Medicine 64(1):13-25. PubMed Central PMCID: PMC7768893.

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Inclusion Enrollment Report(s)

Two Inclusion Enrollment Reports have been included in one pdf file:

- Part A: Survey (race/ethnicity data were available from survey questions)
- Part B: Cohort (no race/ethnicity data were available in the existing workers' compensation data)

Inclusion of Gender and Minority Study Subjects

The distribution of subjects included in this study reflected the demographics of the underlying population. This project relied on existing workers' compensation data, and neither recruited nor excluded any sex/gender or racial/ethnic group. There were no subject selection criteria related to selection of sex/gender or racial/ethnic group members. The workers' compensation claims data used for this study did not include any information on race or ethnicity.

Inclusion of Children

Children under 18 years old were excluded from this study because the number of severely injured or permanently impaired employed children under 18 years of age is so small that meaningful statistical analyses could not be conducted. According to the Washington State Department of Labor and Industries, children under 18 years old rarely or never receive services through their vocational rehabilitation program for injured workers.

Materials Available for Other Investigators

None. This project relied primarily on existing state workers' compensation and wage data. The terms of our data sharing and confidentiality agreements with the State of Washington prohibit use or release of identified or de-identified data for any purposes not specifically described in the agreements, and require returning or destroying all data created in whole or in part using agency records at the conclusion of the agreement. Therefore, we are unable to share the data for other research projects.

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