An Evaluation of Employer-Reported Data in the Nation's Occupational Injury Surveillance System

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THESIS

Submitted as partial fulfillment of the requirements
for the degree of Doctor of Philosophy in Public Health Sciences
(Environmental and Occupational Health Sciences)
in the Graduate College of the
University of Illinois at Chicago, 2015

Chicago, Illinois

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ACKNOWLEDGEMENTS

I would like to thank Drs. Linda Forst and David Bonauto for their support and encouragement. I would also like to thank Darrin Adams for his assistance with record linkage and for sharing his immense knowledge of the Washington State workers' compensation and unemployment insurance data. I am grateful to Polly Phipps for sharing an interview guide she developed for similar employer interviews. Additionally, there are several individuals to thank for assisting with the employers interviews: Cody Spann, Nicole Reister, Michael Foley, Nanette Yragui, and Whitney Johnson.

SEW

CONTRIBUTION OF AUTHORS

Included in this thesis are three manuscripts: two published and one submitted for publication. For the manuscript presented in Chapter IV (Wuellner, S. E., and D. K. Bonauto. "Injury Classification Agreement in Linked Bureau of Labor Statistics and Workers' Compensation Data." *Am J Ind Med* 57, no. 10 (2014): 1100–9. doi: 10.1002/ajim.22289), I contributed to the study design, conducted the record linkage, led the data analysis and interpretation of results, and was primary author of the manuscript. My coauthor, David Bonauto, contributed to the study design and interpretation of the results, and reviewed drafts of the manuscript in preparation for publication. For the manuscript presented in Chapter V (Wuellner, S. E., and D. K. Bonauto. "Exploring the Relationship between Employer Recordkeeping and Underreporting in the BLS Survey of Occupational Injuries and Illnesses." *Am J Ind Med* 57, no. 10 (2014): 1133–43. doi: 10.1002/ajim.22350), I contributed to the study design, collected the interview data, conducted the analysis, and was the primary author of the manuscript. My coauthor, David Bonauto, contributed to the study design, data collection, and interpretation of the results. He also reviewed drafts of the manuscript in preparation for publication. For the manuscript presented in Chapter VI (Underreporting of workers' compensation claims to the Department of Labor's Survey of Occupational Injuries and Illnesses: Establishment factors; submitted for publication), I have two coauthors. I contributed to the study design, led the data analysis and interpretation of results, and was primary author of the manuscript. Darrin Adams contributed to the study design, conducted the record linkage, contributed to the interpretation of the results, and reviewed drafts of the manuscript. David Bonauto designed the study, contributed to the interpretation of the results, and reviewed drafts of the manuscript.

PREFACE

This research was conducted with restricted access to Bureau of Labor Statistics (BLS) data. The views here do not necessarily reflect the views of the BLS.

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LIST OF ABBREVIATIONS

BLS	Bureau of Labor Statistics
CI	Confidence Interval
CSTE	Council of State and Territorial Epidemiologists
DAFW	Injuries Involving One or More Days away from Work
DJTR	Injuries Involving One or More Days of Job Transfer or Restriction
DLI	[Washington State] Department of Labor and Industries
E-code	External cause-of-injury code
NAICS	North American Industry Classification System
NEISS-WORK	National Electronic Injury Surveillance System-Work Supplement
NHIS	National Health Interview Survey
ODI	OSHA Data Initiative
OIICS	Occupational Injury and Illness Classification Manual
OSHA	Occupational Safety and Health Administration
PR	Prevalence Ratio
RL1	Record Linkage 1
RL2	Record Linkage 2
ROA	Report of Industrial Injury and Occupational Disease (Report of Accident)
SIC	Standard Industrial Classification System
SOII	Survey of Occupational Injuries and Illnesses
SSN	Social Security Number
UBI	[Washington State-assigned] Unified Business Identifier
UI	Unemployment Insurance

SUMMARY

The Bureau of Labor Statistics' (BLS) Survey of Occupational Injuries and Illnesses (SOII) is a key source of occupational injury surveillance data, providing both national and state-level estimates of work-related injuries and illnesses. These estimates are based on employer-reported data, and there is growing evidence that employers underreport injuries in SOII. But there is little consensus about the magnitude by which SOII underestimates the true occurrence of occupational injuries and illnesses and to what degree reporting differs by establishment characteristics. Moreover, little empirical data exist to explain the reasons for underreporting.

By linking SOII injury case data to Washington State workers' compensation claims data using unemployment insurance data to improve the accuracy of the identification of SOII-reportable claims, this study estimated the magnitude of unreported workers' compensation claims. Multivariable regression models were used to estimate prevalence ratios (PR) of unreported workers' compensation claims for establishment characteristics including establishment size and industry. This study also assessed agreement in injury classifications between data sources and the impact of classification differences on case estimates among records reported to multiple data sources. Finally, occupational injury and illness record-keepers from Washington State establishments that participated in the 2008 SOII were interviewed to explore record-keeping and business practices that may explain SOII's incomplete case-capture compared with workers' compensation claims data.

An estimated 70% of workers' compensation claims were captured in SOII. Claims among state and local government establishments were most likely to be reported. Underreported claims were most prevalent among small education services establishments (PR=2.47, 95% CI: 1.52–4.01) and large construction establishments (PR=2.05, 95% CI: 1.77–2.37), compared to large manufacturing establishments. Injury classification agreement between data sources was greatest for body part and lowest for event or exposure. Agreement on nature of injury varied by condition. Workers'

compensation-assigned injury codes estimated 94% more amputations than SOII-assigned codes while SOII-assigned codes estimated 34% more cases of work-related musculoskeletal disorders. Most of the injury record-keepers interviewed (90%) did not comply with OSHA record-keeping regulations. Record-keeping noncompliance was equally extensive among participants who reported all claims to SOII and among participants who underreported claims. Other factors including using workplace injury data to evaluate supervisors' or SOII respondent's job performance, recording injuries for a worksite that operates multiple shifts, and failing to follow SOII instructions were more common among establishments with unreported workers' compensation claims.

Underreporting of workers' compensation claims to SOII varies by establishment characteristics, obscuring true differences in work injury incidence and hindering the use of SOII to identify and prioritize groups at greatest risk of occupational injury and illness. Business practices that incentivize low injury rates, disorganized record-keeping, and limited communication between BLS and survey respondents are barriers to accurate employer reports of work-related injuries and illnesses. Accounting for classification differences may improve case ascertainment within individual data sources and help align injury and illness estimates derived from different data sources. The accuracy of SOII data may be improved through increased education and outreach with participants to help them understand and comply with the record-keeping requirements. Expanding the SOII to include worker-reported injury data among sampled establishments may provide a more complete picture of workplace injuries. Additional resources would likely be necessary to support enhanced data collection or outreach activities.

I. INTRODUCTION

Surveillance is fundamental to public health practice. Surveillance data should inform the design and evaluation of research, interventions, and public health policy and play a crucial role in prioritizing public health resources. Occupational injury and illness surveillance is no different, guiding efforts to improve worker safety and health. Sources of occupational health surveillance data vary by reporting mechanism, covered workforce, health outcomes captured, timeliness, geography, and data detail. One of the major sources of occupational injury and illness data is the BLS annual survey of establishments, the SOII. With the passage of the Occupational Safety and Health Act (OSHA) in 1970, the US Department of Labor was charged with "[compiling] accurate statistics on work injuries and illnesses."[1] The SOII is central to the Labor Department's approach to fulfilling that requirement. Each year, more than 250,000 establishments from private industry and state and local governments are selected for participation in the SOII. Based on the data submitted by the sampled establishments, BLS publishes national and state-level estimates of occupational injuries and illnesses characterized by industry, occupation, and injury.

Studies have sought to assess the accuracy of the SOII data almost from its inception (Eisenberg and McDonald, 1988, Seligman et al., 1988), and nearly all have concluded that the survey underestimates the true burden of work-related injuries and illnesses (Smith et al., 2005, Leigh et al., 2004, Rosenman et al., 2006, Boden and Ozonoff, 2008). While consensus grows regarding underreporting to SOII, there is less agreement on the magnitude of underreporting and the establishment characteristics associated with underreporting. Moreover, empirical data on the reasons for employer underreporting is sparse.

Workers' compensation claims data offer another avenue for the surveillance of occupational injuries and illnesses. Additionally, the data can also be used to assess the completeness of SOII case

[1] Occupational Safety and Health Act of 1970, 29 U.S.C. § 673 (1970).

capture. The goal of this project was to evaluate employer reporting in SOII compared to workers' compensation in a state with extensive claims data to learn more about the patterns of and reasons behind underreporting in SOII.

Using SOII injury case data linked to Washington State workers' compensation claims, this study estimated the magnitude of unreported workers' compensation claim and establishment characteristics associated with underreporting. This study also assessed agreement in injury classifications between data sources and the impact of classification differences on case estimates among records reported to multiple data sources. Finally, occupational injury and illness record-keepers from Washington State establishments that participated in the 2008 SOII were interviewed to explore record-keeping and business practices that may explain SOII's incomplete case-capture compared with workers' compensation claims data.

II. LITERATURE REVIEW

A. Common Sources Of Occupational Injury Surveillance Data

In general, data sources commonly used for the surveillance of nonfatal occupational injuries and illnesses can be grouped into one of the following types of data systems: Healthcare utilization data, workers' compensation administrative data, population-based survey data, and employer-based survey data. The strengths and limitations of each are highlighted in the descriptions that follow.

1. Healthcare utilization data

Hospital discharge, emergency department, trauma registry, and ambulatory surgery data are a few examples of healthcare utilization data. Case-level data are often readily available for surveillance activities (with appropriate data-use agreements to protect patient confidentiality), although the type of records available varies by state. Hospital discharge data are available in a majority of states while emergency department data are available in approximately half (Centers for Disease Control and Prevention, 2008). Few healthcare databases contain a variable for "work-related"; the most common means of determining work-relatedness of the condition is whether the payer (or expected payer) is listed as workers' compensation, or through external cause-of-injury codes (E-codes). As an indicator of a work-related injury or illness, these fields are imperfect. While workers' compensation covers a large portion of the workforce, injuries among the self-employed would not be captured by the payer field. Also, care for cumulative trauma injuries or occupational illnesses, which are often difficult to connect to work and are subject to special stipulations for workers' compensation benefit eligibility, is frequently paid for outside of the workers' compensation system (Spieler and Burton, 2012). Case-capture rates vary by condition, with better capture for acute traumatic injuries. Missing and inaccurate E-codes often limit their utility in surveillance (Centers for Disease Control and Prevention, 2008, Hunt et al., 2007). Trauma registries include specific information on work-relatedness,

but are restricted in scope compared to other data sources (Sears et al., 2011). In general, healthcare utilization databases that have been used, to date, capture only the most severe health outcomes. Also, important covariates on employer (like industry and company size) and worker characteristics (like occupation and tenure) often are not captured (Taylor and Frey, 2013). With the requirement of establishing an electronic health record in order to receive federal insurance reimbursement under the Patient Accountability and Affordable Care Act, there are efforts underway to add industry and occupation to the electronic health record (Institute of Medicine, 2011). This may improve occupational health surveillance in the future.

2. **Workers' compensation administrative data**

Workers' compensation data are available in most states and can provide detailed information on outcomes and costs (Utterback et al., 2012). Extensive information on injuries by industry available in some workers' compensation systems has proven useful for surveillance (Bonauto et al., 2006). However, there are several limitations to using workers' compensation data for occupational health surveillance. States' workers' compensation data do not extend to the entire working population. Self-employed workers do not carry workers' compensation insurance and workers with insurance provided through other workers' compensation systems (e.g., federal workers' compensation insurance system, Longshore and Harbor Workers' Compensation Act) are not included in the data. System differences, including benefit adequacy, covered conditions, and filing deadlines and processes can be reflected in the data, influencing both the number and type of conditions that result in accepted claims (Boden and Ruser, 2003). Also, the detail of the information available for surveillance is not uniform across states. These state differences prohibit the creation of a national estimate based on aggregated state level workers' compensation data. Finally, there is evidence of underreporting in workers' compensation claims data that differs systematically by worker, injury, and industry characteristics (Centers for Disease and Prevention, 2010, Biddle et al., 1998, Silverstein et al., 1997,

Rosenman et al., 2000, Shannon and Lowe, 2002). Both employers and workers face disincentives to file workers' compensation claims. Employers benefit from low claim rates that keep their insurance premiums to a minimum, and workers may not file because they are unaware of the benefits awarded through the program (Fan et al., 2006), perceive the filing process to be overly extensive (Strunin and Boden, 2004), or fear retaliation by their employer (Lipscomb et al., 2012).

3. **Population-based survey data**

Population-based surveys are another source of occupational injury data. Although none focuses specifically on occupational health and safety, some include questions on work injuries and illnesses. The Behavioral Risk Factor Surveillance System can be used to calculate state estimates of work-related injuries by industry and occupation among states that include the relevant questions (Anderson et al., 2014). The National Health Interview Study (NHIS) also includes questions on injuries sustained at work and is designed to produce national estimates (Luckhaupt and Sestito, 2013). Neither survey estimates both state and national occurrence of work-related injuries and illnesses. There are strengths of population surveys not shared by other sources of occupational health data. First, all workers, regardless of workers' compensation coverage, are included in the surveys. Second, many barriers to reporting are absent, thereby reducing the underreporting believed to exist in other data sources. The limitations of household surveys include recall bias, proxy respondents, and small numbers of work injuries. Respondents are more likely to forget minor injuries, instead reporting only the more severe cases. The NHIS collects data on injuries among all household members based on the responses of one respondent whose knowledge of work-related injuries suffered by other household members may be incomplete. Finally, the small numbers of work injuries and the limited detail on self-reported industry, occupation, and other relevant work characteristics prevent the publication of detailed estimates.

4. **Employer-reported data**

Employer-maintained injury and illness records, required by OSHA, offer yet another source of occupational injury data.

The OSHA collects data from employers to calculate establishment-specific injury rates and identify establishments for consultation and enforcement activities (Occupational Safety and Health Administration). But the population of establishments covered by the OSHA data initiative (ODI) is very limited and includes only high-hazard industries with forty or more employees outside of the construction industry. The data are not representative of all establishments, and neither state nor national estimates have been published based on ODI data. Given the explicit use of the data in identifying establishments for OSHA inspections, underreporting in the ODI is a nontrivial concern.

The BLS provides another source of occupational health statistics through the SOII, which is an annual sample of approximately 275,000 establishments. It employs a set of uniform case definitions, OSHA recordable cases (US Department of Labor, 2012a). Reliance on the OSHA case definition has both benefits and drawbacks. The survey data are comparable within and across industries as well as other establishment, worker, and injury characteristics. But changes in the OSHA record-keeping criteria dramatically impact reporting, obscuring true trends in injury rates (Friedman and Forst, 2007). Similar to workers' compensation systems, SOII does not include every worker in the country. The self-employed and federal workers are two notable groups excluded from the survey.

Another limitation of SOII is its reliance on employer-reported data. Azaroff et al. (Azaroff et al., 2002) describes "filters" present throughout multiple reporting processes that may impede the reporting of a work-related condition. For a case to be included in SOII, the worker must report the injury to the supervisor, the supervisor must be aware of the medical treatment provided or work absence, the supervisor must record the case on the OSHA log and then pass the log data on to BLS. There are numerous reasons an employer may report fewer cases than occurred: the employer may not

be aware of the case; the employer may not believe that the case meets the inclusion criteria based on the information available; or the employer may choose not to report a case to benefit the business—or to avoid harming the business (Wuellner and Bonauto, 2014, Phipps and Moore, 2010). Some healthcare workers feel pressured to provide medical treatment so as to avoid the OSHA recordability criteria (US Government Accountability Office, 2009). Workers face several disincentives to reporting a work injury to their employer, including: fear of appearing weak or being labeled as a complainer; fear of being reassigned to an undesirable job; fear of jeopardizing coworkers' safety incentive awards; and fear of being disciplined or fired (Moore et al., 2013, Lipscomb et al., 2012, Pransky et al., 1999). In some cases, workers are uncertain that the injury was caused by work, and whether the severity of the injury is sufficient to merit reporting (Tucker et al., 2014, Pransky et al., 1999, Boden et al., 2014). Many of the barriers that impact SOII reporting are present in other data sources including workers' compensation and medical records data.

Like every other data source, SOII is flawed. It is also, however, the only surveillance system that annually publishes state and national estimates of occupational injuries and illnesses with detailed information on industry, occupation, injury type, and other worker and establishment characteristics.

B. History of the Department of Labor's Occupational Injury Surveillance and Its Critics

As a key source of occupational injury and illness data, the accuracy of BLS injury estimates has been in question almost as long as the agency has been collecting the data. In 1926, BLS began collecting work-injury data for manufacturing industries through annual surveys of employers and state-based records. The agency's data collection efforts expanded and evolved over the next four decades, collecting data from employers who volunteered to provide information on work injuries. Surveillance activities were strengthened by the passage of the Occupational Safety and Health Act in 1970, which required employers to maintain injury and illness records and to provide the Department of Labor with

periodic reports based on the records.[2] Additionally, the Occupational Safety and Health Act mandated that the Department of Labor systematically collect and analyze occupational safety and health statistics. Tasked with the responsibility of implementing the surveillance program, the BLS began publishing occupational injury and illness numbers and rates for the private sector in 1973 (Drudi, 1997). In 1976, BLS added case information via the Supplementary Data System, based on workers' compensation data. The surveillance system drew criticism on three fronts: (1) the Supplementary Data System failed to capture details relevant to understanding and preventing workplace injuries, (2) differences in state workers' compensation systems impeded state comparisons and the compilation of national estimates, and (3) injuries collected from the annual survey were underreported (National Research Council Panel on Occupational Safety and Health Statistics, 1987). Based on recommendations from the National Research Council, BLS overhauled the system in 1992 to collect detailed worker and incident information on nonfatal injuries involving days of missed work (Abraham et al., 1996).

The issue of underreporting was not solved by the redesign of the annual survey and, based in part on a 2008 congressional hearing, there was renewed pressure on BLS to investigate the topic and its impact on the national occupational surveillance data (US House of Representatives, 2008). The BLS expanded the scope of SOII to include state and local governments in all participating states starting in 2008, but acknowledges that the current SOII does not capture all of the country's work-related injuries and illnesses, specifically missing injuries among workers not included in the annual survey (federal workers, the self-employed, household workers, and employees of small agricultural establishments), and most illnesses, particularly those with long latencies (Ruser, 2008).

Several approaches have been used to shed light on reporting and the accuracy of published estimates: audits of OSHA logs and assessments of employer record-keeping practices; comparisons of SOII estimates to estimates (or case numbers) from other data sources; and record-level linkages

[2] Occupational Safety and Health Act of 1970, 29 U.S.C. § 673 (1970).

between individual cases reported in SOII and cases appearing in other data sources. A discussion of these approaches follows.

1. **Evaluation of worksite injury logs**

As the stated basis of SOII data, evaluating the accuracy of OSHA logs provides valuable insight into the quality of SOII data.

In one of the earliest assessments of OSHA record-keeping compliance, on-site inspections of more than 4,000 establishments found that logs were maintained in 75% of the establishments required to do so (Seligman et al., 1988). Logs were less likely to be maintained in newer establishments and nonunionized establishments. Smaller establishments were less likely to maintain logs (61% among establishments with 11–99 workers) compared with larger establishments (96% of establishments with 500 or more workers).

In a 1987 joint BLS-OSHA effort, OSHA compliance officers conducted on-site visits to manufacturing facilities in two states to assess the completeness of establishment-based injury and illness records (Eisenberg and McDonald, 1988). Officers attempted to reconstruct OSHA logs by identifying OSHA-recordable cases from workers' compensation records, medical records, and accident reports, as well as through interviews with employees. Comparing the cases identified to those recorded on the establishment's OSHA log, researchers found sizeable record-keeping errors. Ten percent of establishments kept no log. Twenty percent of all recordable cases were not recorded and 25% of lost-time cases were not recorded. Fifteen percent of the cases that were recorded did not meet the recording criteria and should have been omitted from the log. The study was not designed to generalize record-keeping practices for a population beyond the manufacturing facilities visited but rather to assess the feasibility of verifying OSHA log data through independent sources.

In a similar attempt to reconstruct an establishment's OSHA log from workers' compensation records, medical records, accident reports, and worker interviews, OSHA conducts on-site audits of workplace injury and illness records for a sample of establishments that submit data as part of the agency's ODI. Only establishments with 40 or more employees in high-hazard industries, excluding construction, are eligible for inclusion in the ODI and the audits. Based on establishment data for the 1996–1998 ODI audits, 11% of all recordable cases were unreported[3] and 22%–23% of lost-workday cases were unreported (Conway and Svenson, 1998).

More recent audits found fewer record-keeping errors. The audit of 2006 ODI data identified instances of unreported cases, overreported cases (recorded cases that did not meet recording criteria), and misclassification of case severity, but only 6% of identified reportable cases were unreported, and 7% of identified injuries resulting in days away from work (DAFW) were unreported (Eastern Research Group and the National Opinion Research Center, 2009). A small number of establishments were responsible for most of the unreported cases, with accurate OSHA logs confirmed in 98% of sampled establishments.

There are several possible explanations for the greater underreporting uncovered in the audits from the 1980s and 1990s and the minimal underreporting found in the audit of the 2006 ODI data.

First, the populations included in each study differed by establishment characteristics. Earlier 1980s studies included small establishments while the ODI audits excluded establishments with fewer than 40 employees. The studies reported unweighted frequencies and percentages that were not adjusted to reflect a larger population of establishments. Thus, differences across studies could reflect the differences in the selected sample. Given the finding that smaller establishments were less likely than larger establishments to maintain logs, it's possible that smaller establishments are poorer record-keepers overall, and their inclusion in the earlier studies is reflected in the higher rates of unreported

[3] "Department of Labor; Occupational Safety and Health Administration; Occupational Injury and Illness Recording and Reporting Requirements; Final Rule" 66 Federal Register 13 (19 January 2001), pp. 5916–6135.

cases. Second, OSHA's recording and reporting rule changed significantly prior to the 2006 ODI data audit, in part to improve employer-reported injury data. The revised rule may have clarified case-inclusion criteria and classification guidelines, resulting in fewer unreported cases. Third, the methodology used to reconstruct the logs may contribute to the differences. The 1987 study of manufacturing facilities aimed to reconstruct the previous year's log whereas ODI audits are conducted two years after establishments submit the data. Workers' ability to recall injuries that occurred during the period in question diminishes with time, and workers interviewed by ODI auditors may have recalled fewer incidents. Finally, the high-hazard establishments that participate in the ODI are likely more familiar with OSHA record-keeping since they, by definition, have a high risk of workplace injuries, and routinely submit their injury data to OSHA. This increased exposure to the regulations may result in better knowledge of and compliance with the regulations. The differences in the degree of underreporting found in the studies suggest that record-keeping compliance merits further study, especially among smaller establishments and those not included in the ODI.

Other studies assessing OSHA record-keeping practices provide additional clues to record-keeping errors that may impact SOII data accuracy. Among cases of musculoskeletal disorders, incidence was accurately captured on the OSHA log, but duration of disability was underrecorded, especially among reinjuries (Evanoff et al., 2002). Common record-keeping errors uncovered among ODI participants in Minnesota included: failing to update log entries over time (including a change in severity); incomplete log entries; and failing to appropriately apply the record-keeping rules resulting in severity classification errors (Messiou and Zaidman, 2005). In one of the only studies to focus on the record-keeping practices of SOII respondents, Phipps and Moore (Phipps and Moore, 2010) found omitting temp-worker injuries from the host establishment's OSHA log was a pervasive practice, despite the requirement to record such injuries among temp workers provided through a staffing agency and supervised by the host employer.

2. **Comparison of injury estimates across data sources**

Another approach to evaluating SOII moves beyond underlying data and instead compares the end result—the estimated number of injuries—to an estimate (or case count) from other data sources. Comparisons have been made for total injuries and illnesses, and for specific conditions or types of injuries.

One challenge posed by estimate comparisons is the identification of the same workforce and case eligibility across data sources (although some studies use estimate comparisons as a way to expand the limited scope of SOII and document the undercount due to exclusion of classes of workers like the federal workforce and the self-employed). Using models that incorporate rates of underreporting published in the literature, employment data, and injury risk, the range of cases missed by SOII was estimated to be between 33% and 69%; however, 25% of missed cases were attributable to workers outside the scope of the survey (Leigh et al., 2004).

Using workers' compensation claim data to calculate injury rates among construction workers building the Denver International Airport, Glazner et al. (1998) found rates of total injuries to be at least 2.3 times higher than the SOII rate of total recordable injuries for construction nationwide. The underestimate was not as great when restricted to lost-work injuries, ranging from not statistically different in 1994 to 1.9 times the BLS estimate in 1991. Averaged over the four years, the BLS-estimated rate of lost-work injures was 80% of the lost-work injury rates based on claims. The authors acknowledged the differences in case definitions and concluded that, by including minor injuries reported in workers' compensation, they likely overestimated underreporting of total injuries in SOII. One the other hand, including DAFW injuries reported SOII but ineligible for workers' compensation lost-time compensation likely underestimated underreporting of more severe cases in SOII.

In a study utilizing workers' compensation data in Minnesota, researchers attempted to unify the scope of the covered workforce and injuries in both SOII and workers' compensation claims data. To

do so, they restricted the workers' compensation data to employment covered by the survey and excluded claims lacking evidence of missed work within three months of the survey year. They modified the SOII estimates to approximate the number of DAFW with four or more days of missed work, and would thus be eligible for time-loss compensation from the Minnesota workers' compensation system. Their alignment of the case definitions resulted in a SOII estimate found to be between 87% and 93% of the Minnesota workers' compensation data for years 1992–2000 and between 84% and 90% of the Minnesota workers' compensation data for years 1998–2001 (Oleinick and Zaidman, 2004, 2010).

Estimates of underreported lost-work cases were slightly higher in the Denver study compared with the Minnesota studies (80% and 84%–93%, respectively), although similar when considering the low end of the ranges reported by Oleinick and Zaidman. Poorer SOII reporting observed in the Denver study may be attributable to the use of national estimates for construction injuries rather than data from a specific geographic region or type of construction project. The authors' efforts to reconcile case definitions across data sources in the Minnesota study may be reflected in the smaller estimate of SOII underreporting compared with findings from the Denver study. Another possibility is that underreporting in the construction industry is greater than underreporting among all industries combined as demonstrated in the Minnesota studies.

In contrast with the results from the OSHA log audits, which found greater underreporting of cases involving missed work compared with total recordable injuries, the Denver and Minnesota findings suggest that lost-work injuries are more likely to be reported in SOII compared to minor injuries. In both the Denver and the Minnesota studies, SOII estimates were compared to workers' compensation data whereas the OSHA log audits were reconstructed using multiple data sources, one of which was workers' compensation claims data. This may suggest that SOII is more highly correlated with workers' compensation time-loss claims data than with other data sources, and that underreporting is greater among cases identified through data sources other than workers' compensation data.

The number of occupational injuries involving lost-work estimated from the NHIS study of households was 1.4 times greater than the SOII estimate (Smith et al., 2005). Surveying workers outside of the employment environment, as is done in the NHIS study, removes many of the barriers to reporting that impact workers' compensation claim filing and employer injury reporting. Finding greater SOII underreporting in the NHIS study than in the Minnesota study can be explained by the theoretical reduction in reporting barriers among NHIS surveyed respondents. The underreporting estimate based on NHIS data is in the range reported by Glazner et al. (Glazner et al., 1998) for underreported lost-work injuries in the construction industry based on workers' compensation claims data, and likely reflects differences in the study populations. If stratified by industry, the NHIS estimated injury rate among workers in the construction industry would undoubtedly exceed the injury rate for all private sector employees. As in other studies, comparisons to SOII estimates are inexact; worker-reported injuries with missed work may not meet the OSHA DAFW case definition used by SOII.

Incidence of specific health outcomes identified through other data sources have been compared to BLS-published estimates for DAFW cases coded for nature of injury or illness. Back injuries identified through workers' compensation data (Lipscomb et al., 2008a), musculoskeletal disorders identified from workers' compensation data and physician reports (Morse et al., 2001), and amputations identified through multiple data sources (Friedman et al., 2013, Largo and Rosenman, 2013), all exceed SOII estimates of the respective injuries. In addition to increased case reporting among non-SOII data sources, the injury classification codes themselves may lead to differences in case estimates. Within a single data source, the number of cases identified as amputations increased when ICD-9 codes were used in addition to using workers' compensation-assigned injury classification codes alone (Anderson et al., 2010). Lipscomb et al. (Lipscomb et al., 2008a) found little agreement between the nature of injury codes and the ICD-9 codes used to ascertain cases of back injury. Furthermore, classification differences could arise from the manner in which the data enter the surveillance source. For example, injury

classifications in workers' compensation are based on information or descriptions provided by a healthcare provider or by the worker in the presence of a healthcare provider. The SOII injury classifications are coded from descriptions provided by the employer. Differences in familiarity with the injury as well as with medical terminology may result in inconsistent injury classifications. No study has explored differences in injury classification among records matched to SOII cases.

3. **Record linkage of Department of Labor occupational injury data to other data sources**

The question that estimate comparisons cannot assess is whether the estimates from the multiple data sources reflect the same cases reported in both sources or different cases reported in similar numbers—i.e., how much overlap is there in case-capture across the different data sources? Record-linkage studies address the issue by attempting to identify and link individual incidents across multiple data sources. Rosenman et al. (2006) linked SOII DAFW injuries to Michigan workers' compensation claims for years 1999–2001. To align the SOII case-reporting criteria with the workers' compensation time-loss eligibility criteria, linking was attempted for cases with more than seven days of missed work. The authors relied on company name, location, and employer identifier to link employers across systems. Estimates of the SOII undercount were among the highest reported by any study, with SOII missing 61% and capturing only 39% of cases identified in the combined workers' compensation-SOII data for injuries with seven or more days of missed work.

Boden and Ozonoff expanded the record-linkage approach and utilized data from six states. For a business structure sampled at a more detailed level than identifiable in workers' compensation data, the authors imputed the number of claims for the sampled establishment by assuming the ratio of sampled claims to total claims was equal to the ratio of sampled employment to total firm employment. The SOII missed from 24% of cases in West Virginia and Minnesota to 46% of cases in Washington State (based on total distinct cases identified in either SOII or workers' compensation and weighted used the SOII survey weights) (Boden and Ozonoff, 2008).

The range of estimates, both within the six-state study and compared to the Michigan study, is striking. Several possible reasons explain or contribute to the differences in reporting among the seven states included in the two studies. The method used to identify SOII-sampled employment within the Michigan workers' compensation data may not have adequately limited claims to only those associated with sampled establishments, including more than those sampled by BLS and inflating the number of claims considered "unreported." Differences in methodology cannot explain the range of estimates reported by Boden and Ozonoff. Applying a single methodology to data from multiple states, their results suggest there may be true differences in SOII's case-capture by state. Mendeloff and Burns (2013) further the idea that state-level differences impact SOII reporting, finding a negative correlation between SOII injury rates and fatality rates based on data for the construction industry from 40 states. They put forth the idea that better reporting (among states with higher nonfatal injury rates) lead to more effective prevention activities (and lower fatality rates). Other variables—measured at the state level—associated with increased SOII injury rates include: unionization rate; adequacy of workers' compensation system; and the percent of the workforce identified as White (Zugel et al., 2006).

Several studies have examined underreporting in SOII by establishment, worker, or injury characteristics. A study of the construction industry concluded underreporting was greater for injuries among Hispanic workers and in small establishments (Dong et al., 2011). Increased underreporting among small establishments was also found in the construction of the Denver Airport (Glazner et al., 1998), a study of musculoskeletal disorders (Morse et al., 2004), and a comparison of Michigan establishment data (Oleinick et al., 1995). Based on the record-linkage results for Wisconsin, employers with multiple worksites had higher rates of underreporting compared to employers whose operations were limited to a single worksite (Nestoriak and Pierce, 2009). The same study found injuries less likely to be severe and acute were more likely to be missed by SOII (e.g., sprains, strains, tears versus amputations). Similarly, the Michigan record-linkage study found low rates of reporting in SOII among

traumatic injuries to muscles and tendons and occupational illnesses (Rosenman et al., 2006). The authors also document greater underreporting in the retail trade and the transportation, communications, electric, gas, and sanitary services industries.

Many of these studies focused on a single industry or health outcome, and most of the characteristics associated with underreporting were examined through bivariate assessment. Morse et al. (Morse et al., 2004) controlled for worker characteristics in their analysis, but the health outcome of interest was limited to the reporting of musculoskeletal disorders. These factors have not yet been examined in a multivariate analysis of underreporting that extends to all occupational injuries and illnesses.

C. **Next Steps in Department of Labor Undercount Research**

Additional research in several areas would further our understanding of the BLS-published estimates and the accuracy of the SOII data. State-level factors that impact SOII reporting, and worker reports of injuries and illnesses compared to SOII reports, with a special focus on minor injuries (OSHA-recordable injuries that do not result in missed work) are two examples.

Three additional topics that utilize workers' compensation data include:

- An assessment among linked records of the agreement in injury codes assigned by two independent data sources, BLS SOII and Washington State workers' compensation claims data;
- A multivariate analysis of workers' compensation claims unreported in SOII that evaluates establishment and injury characteristics; and
- An assessment of workplace injury and illness record-keeping practices among SOII respondents identified through interviews with respondents.

III. METHODS

The study utilized three data sources: the SOII summary and case and demographic files; Washington State workers' compensation data, and unemployment insurance (UI) data.

A. Description of Data Sources

1. Survey of Occupational Injuries and Illnesses

The BLS administers the SOII in partnership with participating states to estimate the incidence of work-related injuries and illnesses based on data reported by a sample of employers (US Department of Labor, 2012a). The scope of the SOII extends to all private-sector employment except for farms with fewer than 11 employees, private household workers, and the self-employed. State and local government employees have been included in national estimates since 2008 and in Washington State since at least 2000. The federal workforce is excluded.

Each year, the BLS selects a sample of establishments to participate in the survey, drawn from the UI data. The annual sample involves more than one-quarter of a million establishments, including approximately 5,000 Washington State establishments. Sampled establishments are contacted prior to the survey year and instructed to maintain OSHA injury and illness records for the duration of the survey year. Establishments otherwise exempt from OSHA record-keeping regulations based on establishment size or industry are required to follow the regulations when requested by BLS. As codified in the OSHA record-keeping regulations effective January 1, 2002,[4] work-related injuries and illnesses are recordable when they result in any of the following:

- death
- loss of consciousness
- one or more days of missed work

[4] 29 C.F.R. Part 1904 (2001).

- restricted work activity or job transfer
- medical treatment beyond first aid (the record-keeping regulation also defines “first aid”)
- significant work-related injuries or illnesses diagnosed by a licensed healthcare professional—including cancer, chronic irreversible disease, fractured bones or teeth, or punctured eardrums
- needle sticks or cuts from sharps contaminated with human blood or other infectious material
- medical removal as required by an OSHA standard
- tuberculosis infection
- hearing loss

After the survey year has ended, establishments are required to provide BLS with three types of data, each intended to be compiled from the OSHA 300 log and the 301 incident forms or equivalent forms (e.g., a workers’ compensation claim form): (1) general establishment information including the average number of workers employed by the sampled establishment during the survey year; (2) summary OSHA injury and illness data (e.g., total number of cases with job transfer or restriction, total number of days of job transfer or restriction); and (3) detailed case information, including worker identifiers and incident specifics, on injuries and illnesses that resulted in one or more calendar days of missed work beyond the day of injury. To limit the response burden, establishments with a high number of DAFW cases are instructed to report on a subsample of cases. Generally the subsample is defined as injuries occurring within dates specified by BLS. Responses are weighted to estimate the frequency and incidence rates of occupational injuries and illnesses by industry and injury type at the state and national levels.

To link SOII and workers' compensation records, two types of SOII data were obtained:

1. Establishment files that include characteristics such as industry, size, address, and aggregate totals of OSHA-recordable injuries that occurred during the survey year; and
2. The case and demographic data for DAFW injuries and illnesses that include worker name, date of injury, description of the injury, number of days of missed and restricted work, and incident characterization. The case information provided for DAFW injuries allow for linking individual reports of injuries and illnesses across data sources.

Both "final" and "unusable" datasets were provided for the establishment file and the case and demographic file. Final datasets are used to estimate the published injury rates. Unusable data are data submitted by establishments but not used in the estimation procedures. Establishment data may be deemed unusable because it was submitted for an establishment that was not sampled, the establishment went out of business before the survey data was collected, the establishment had non-mailable address data, or the establishment refused to participate. Case data are considered unusable when the case is recorded as having zero days away from work (respondents often erroneously include injuries limited to days of job transfer or restriction (DJTR) in their DAFW case data), data anomalies that could not be resolved before data processing ended (including missing data), and duplicate records.

Washington State SOII data for survey years 2003–2011 were provided through a cooperative agreement between the BLS and the Washington State Department of Labor and Industries (DLI).

2. **Washington State workers' compensation data**

The DLI regulates workers' compensation insurance for all nonfederal employers operating in Washington State covered by the state's industrial insurance laws.[5] In addition, DLI administers the Washington State-Fund workers' compensation insurance program, which is the sole workers' compensation insurance provider for all employers in the state except those covered by an

[5] Revised Code of Washington. § 51.12.010 (1972).

alternate workers' compensation system[6] or those who self-insure. Of the approximately 160,000 employer workers' compensation accounts state-wide, more than 99% are insured through the State Fund, covering approximately 70% of all workers in the state. The remaining workers' compensation accounts (approximately 400) are self-insured and typically represent the largest employers. Companies must meet specific requirements to self-insure and the self-insurance program has significant oversight by and reporting requirements to DLI.

Each employer in Washington State has a workers' compensation policy. The policy may cover one or more accounts, and each account may comprise one or more business locations. Workers' compensation businesses are also distinguishable through a Unified Business Identifier (UBI). The UBI is a Washington State-specific employer identifier that links an employer across state government administrative databases (e.g., the DLI, the Washington State Employment Security Department, and the Washington State Department of Revenue). The UBI does not always fit linearly into the hierarchical business structure of the workers' compensation employer data. In general, a workers' compensation policy consists of one or more UBI, each of which consists of one or more workers' compensation accounts. In some cases, however, multiple UBI may relate to a single workers' compensation account.

When a worker is entitled to compensation under the Washington State Industrial Insurance laws, the worker, with certification by the attending licensed healthcare provider, files the application directly with DLI.[7] The DLI then informs the employer that a claim has been opened. The statute of limitations for filing a workers' compensation claim for an occupational injury is one year after the injury.[8] For an occupational disease the statute of limitations is two years after the written notification from a healthcare provider for eligibility to file a claim.[9]

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[6] Alternate workers' compensation systems include those provided in the Longshore and Harbor Workers' Compensation Act, the Jones Act, and Federal Employees' Compensation Act

[7] Revised Code of Washington. § 51.28.020 (2005).

[8] Revised Code of Washington. § 51.28.050 (2007).

[9] Revised Code of Washington. § 51.28.055 (2004).

Workers' compensation claims are accepted and rejected by trained claims adjudicators in accordance with Washington State statutes, rules, and case law. Note that workers' compensation claim eligibility is independent from the OSHA-recordable case criteria; OSHA-recordable cases are defined by federal law to track workplace injuries whereas workers' compensation claim eligibility is regulated at the state level as a no-fault insurance system to cover the expenses of work injuries. Every filed claim is retained in the DLI database, whether eligible for wage replacement, accepted for medical-aid only, or rejected. Medical treatment, wage replacement benefits, and all other billed services are linked to the claim identification number and maintained in DLI databases. In Washington State, the waiting period for wage-replacement eligibility is three calendar days after the date of injury. The date of injury is not counted toward any part of the waiting period for wage-replacement eligibility. If the worker remains disabled at 14 days, the first three days of missed work are paid. An overview of the claim filing and employer recording processes is provided in Figure 1. The number of paid days of missed work is captured in these databases as are employer protests, formal legal appeals by the employer, timing of claim adjudication processes (e.g., disability determination, assignment of total permanent disability), and employer apportionment of occupational disease.

Claims are assigned to a business location, providing the business name and address. In some cases where the incident occurred somewhere other than the business location, an accident location is also recorded. Claimant (worker) identifiers include name, date of birth, sex, and social security number (SSN). Each claim has a date of injury and a date on which the department received the claim (claim established date). Claims may be assigned a date of injury based on adjudication and legal proceedings associated with the claim. Additionally, state-funded claims document the date of the first medical visit, the date the claimant was first unable to perform the job of injury (disability date), and the date the department made the initial payment for wage replacement (first time loss payment date). All compensable claims (State Fund and self-insured) are coded for nature of injury, body part, event or

exposure, and source according to the Occupational Injury and Illness Classification System 2007 (OIICS). State Fund claims for medical-aid only are also coded; self-insured claims for medical-aid only, while reported to DLI, are not coded for injury characteristics.

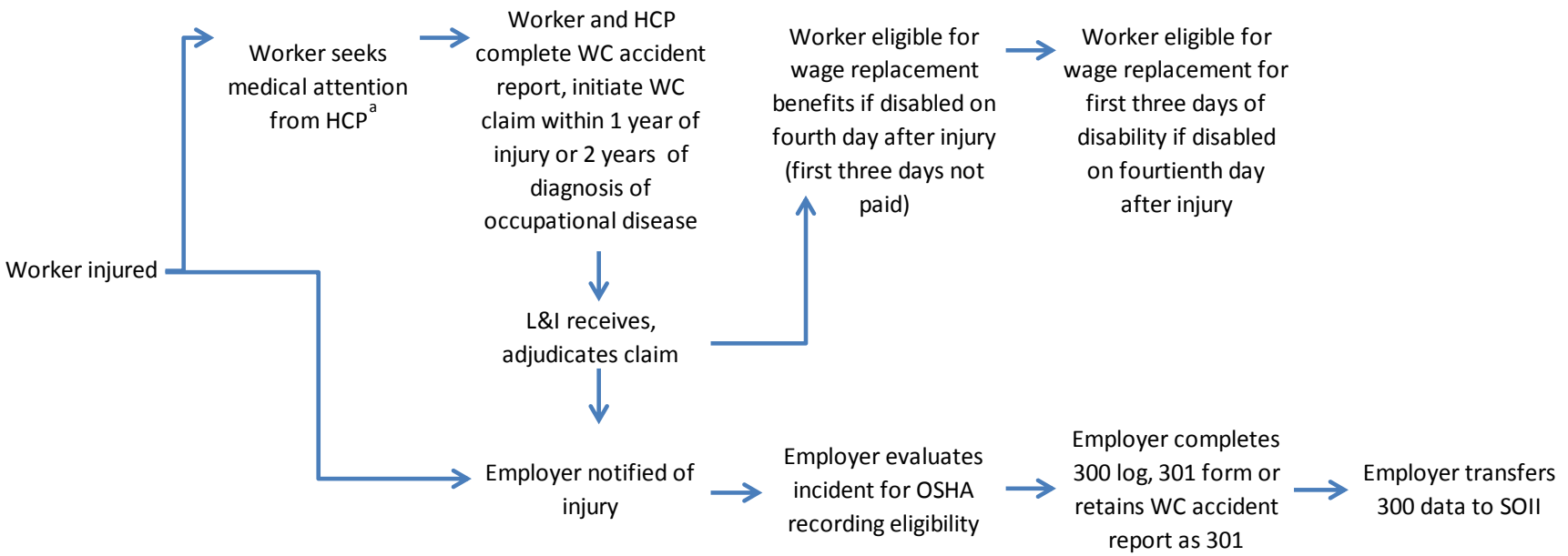

Figure 1. Conceptual reporting pathway from occupational injury/illness to receipt of workers' compensation benefits and completion of SOII.

[a]HCP: Healthcare Provider

3. **Washington State unemployment insurance data**

The UI data serve as the SOII sampling frame, in the form of the Quarterly Census of Employment and Wages (Selby et al., 2008). An employer is assigned a UI account, which may be divided into multiple individual locations, denoted by unique report unit numbers and described by an establishment address. The UI account identifies employees by SSN and worker name (employees are not linked directly to report units). The SOII-sampled employers are characterized as one of two reporting entities:

1. Entire UI accounts—identified as reporting-unit numbers "00000" and usually described in the SOII establishment data as "All Washington State employees," or
2. Reporting units (UI account subunits)—identified as reporting units other than "00000" and usually described in the SOII establishment data by an address.

The UI data bridges the SOII and workers' compensation data. Using the UI account ID and reporting-unit number, SOII establishments are isolated within the UI database to identify the establishments' Washington State UBI number. The UBI is then used to map the establishments into the Washington State workers' compensation data. Additionally, workers can be linked across systems using SSN. See Table I for a list of worker and employer data elements available in SOII, workers' compensation, and UI.

The UI data were made available through a data-sharing agreement with the Washington State Employment Security Department, the state agency responsible for maintaining UI data.

TABLE I

WORKER AND EMPLOYER DATA ELEMENTS[a] BY DATA SOURCE

	SOII Microdata	Washington State Workers' Compensation Data	Washington State UI Data
Worker			
First Name	X	X	X
Last Name	X	X	X
Date of Birth or Age at Injury	X	X	
Sex	X	X	
Social Security Number		X	X
Date of Injury	X	X	
Date of First Medical Treatment		X	
Date of Claim Establishment		X	
Date of Disability		X	
Date of First Time Loss Payment		X	
Employer			
Name	X	X	X
Address	X	X	X
Federal Employer Identification Number	X		
State Employment Security Agency Identification Number	X		X
Unified Business Identifier (UBI)		X	X

[a]Availability of data element indicated by "X"

B. Initial Procedure for Linking Department of Labor Injury Data to Workers' Compensation Data

1. Record linkage

Two separate record-linkage procedures were used in the three studies. The first (referred to as Record Linkage 1 (RL1)) employed probabilistic linkage and was used for the assessment of injury classification agreement and the interviews with SOII respondents. The second linkage (RL2), described later, relied on a matching algorithm developed by study personnel and expanded the linkage to years 2003–2011.

Record-linkage procedures for RL1 were patterned after those developed by researchers for another study linking similar BLS-case data to workers' compensation claims data (Boden and Ozonoff, 2008). Linking was attempted between SOII cases (OSHA recordable injuries and illnesses resulting in one or more days of missed work) reported by Washington State establishments for survey years 2006–2008 (n=30,192) and all filed workers' compensation claims with injury dates in 2006–2008 among state-funded and self-insured employers. Workers' compensation claims data (n=550,950) were extracted on July 31, 2010.

Data cleaning and standardization were necessary to make the data comparable between sources. Non-names recorded in SOII data such as "Case 1" and "Private Data" were identified and converted to blank names. First-name data in both SOII and workers' compensation were standardized using the US Bureau of Census's GDRIVER program (e.g., changing "Bob" to "Robert") (US Bureau of the Census, 1999). Age at injury was calculated so it could be used as a matching variable where date of birth was not available. Employer addresses were also standardized using GDRIVER (e.g., changing "Forty-fourth St." to "44TH ST"). Among the workers' compensation claims, there were 8,551 individuals in the workers' compensation claims data with both accepted and rejected claims for injuries on the same date. The rejected claims were considered duplicates and were removed. (This usually occurs when a claimant from a self-insured employer initiates the claim with the state fund; the state fund

claim is rejected and the self-insured claim accepted.) No records were identified as duplicates among the SOII data.

Record linkage was conducted in two stages. First, SOII cases were linked to workers' compensation claims through identical matches on eight of the nine linking variables: worker last name, first initial, sex, date of birth or age at injury, date of injury, employer name, employer address, zip code or city, and UBI. More than one-third of linked records matched identically across all nine linking variables; almost two-thirds matched identically on at least eight variables.

We then linked the remaining one-third of unmatched cases using the probabilistic software program LinkPlus version 2.0 (US Department of Health and Human Services, 2009), using the same nine linking variables. The Soundex system was used to convert worker last names to phonetic representations. LinkPlus assigns a score to each potential matched pair based on the degree of similarity in the common variables. Matching scores ranged from a high of 50 (reflecting a better match) to a low of 1 (reflecting a poorer match). All potential matches were scanned to identify an appropriate match score cut point for requiring manual review. Two researchers independently reviewed pairs with scores less than 30 to determine whether to accept the potential match. Scores of less than one were considered non-matches. Disagreements between the two reviewers were settled by a third reviewer. When multiple claims linked to one SOII case, the pair with the highest match score was retained.

Injury dates differed between data sources, although date differences were not allowed to exceed two months. Because the injury date in workers' compensation is adjudicated to reflect the last injurious exposure, the date reported by the employer may not be identical, especially for non-traumatic conditions with no clear precipitating event. The injury date documented by the employer may be the date the worker received medical treatment or the date of missed or restricted work. Injury dates more than two months apart were assumed to reflect separate injury events rather than

differences in the characterization of one singular event. Ninety-two percent of linked records had injury dates that were identical in both data sources; 97% were within seven days.

2. **Identification of linked and unlinked records eligible for both data systems**

After linking cases, we limited records to those eligible in both data sources. Exclusions were made after linking to allow for possible classification differences between the systems. This likely increased the number of records linked, identifying linked pairs in which one of the two cases would have been excluded based on data captured in one of the two systems.

We restricted the data to industries that report SOII data directly to BLS, excluding mining (North American Industry Classification System code (NAICS 212XXX) and railroad (NAICS 482XXX) establishments whose injury and illness data are not gathered through the annual survey of establishments but rather sent to BLS by the Mine Safety and Health and Federal Railroad Administrations.

Linked and unlinked cases were restricted to those meeting the most restrictive time-loss requirements measureable in either system. The SOII case and demographic microdata includes injuries and illnesses with at least one day away from work. The Washington State workers' compensation system collects lost time data on claims with missed work more than three days after the injury (and thus eligible for wage-replacement benefits). To make both data sources comparable in terms of time-loss, SOII cases with fewer than four days away from work were assumed not to meet workers' compensation wage-replacement eligibility and were excluded. To approximate SOII DAFW case-reporting criteria among workers' compensation claims, we used the type of indemnity payments awarded (to indicate work absence) and the transaction dates associated with the claim (to indicate whether the initial work absence occurred during the survey period or after). Unmatched workers' compensation claims eligible for time-loss payments or permanent total disability were considered SOII-eligible when the workers' compensation dates for injury, first medical treatment, claim establishment,

disability, and initial benefit payment did not occur after the study period. Claims limited to payments for medical care, claims-awarded benefits for loss of earning power (temporary partial disability), and rejected claims were assumed to involve zero days of missed work. This assumption likely resulted in an underestimate of unlinked workers' compensation claims. Although medical-aid claims include injuries that resulted in some missed work (and thus, would meet the OSHA-recordability criteria as a DAFW case), it was not possible to distinguish injuries with work absence less than the waiting period for wage-replacement benefits (four or more days after the day of injury) from those with no work absence.

Among establishments instructed by BLS to report on a subsample of cases based on injury dates, unmatched claims with injury dates outside the BLS-specified timeframe were excluded from the group of claims considered SOII eligible.

An overview of the record-linkage process and identification of unreported workers' compensation claims is provided in Figure 2.

One of two approaches was used to identify the SOII-sampled population within workers' compensation and to limit extracted workers' compensation claims to those among the SOII-sampled workforce. The business structure of the sampled establishment determined which approach was used. When a single UI account was associated with a UBI and the entirety of the UI account was sampled, all claims associated with the UBI were considered within the scope of SOII sampled employment. Approximately two-thirds of the 2008 SOII establishments were structured in this manner. When a UI account sampled in its entirety shared a UBI with another UI account, or when the sampled establishment was one of many reporting units within a UI account (and shared a UBI with other reporting units), the employer name, address, and, when available, a case-claim match were used to identify the sampled workforce in the workers' compensation data.

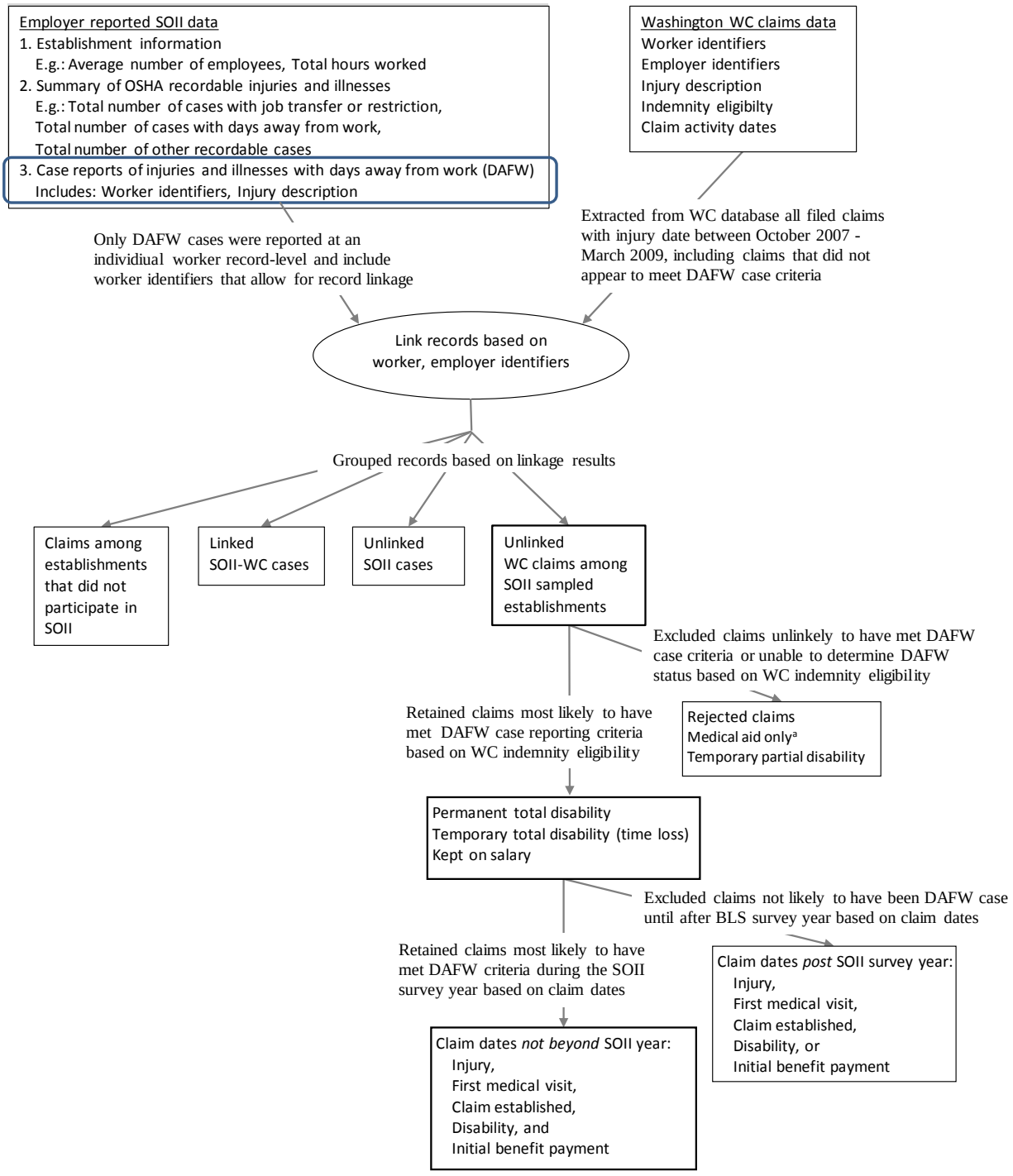

Figure 2. Overview of SOII-Washington State Workers' Compensation record linkage and identification of unreported SOII-eligible workers' compensation claims.

[a]Medical-only claims may have missed as many as 3 days of work. It is not possible to distinguish injuries and illnesses with 0 days of missed work (not reportable to SOII as a DAFW case) from injuries and illnesses with 1-3 days of missed work (reportable DAFW case).

All claims among workers' compensation business locations linked to SOII-sampled establishments through either employer name and address or a case-claim link were considered part of the SOII-sampled workforce. The accident location listed in the workers' compensation claim data was evaluated to determine if the claimant was among the office staff sampled for SOII and covered by Washington State workers' compensation for two industries, temporary employment services and water transportation. Temporary help agencies are not responsible for recording "temp worker" injuries on OSHA logs but they do carry workers' compensation insurance for the temp workers. The water transportation industry has a workforce that is split between state workers' compensation coverage and Longshore and Harbor Workers Compensation Act, depending on the occupation.

C. **Analysis of Linked Records for Agreement in Injury Classification**

During the survey years 2006–2008, both SOII and workers' compensation coded injury and illness characteristics according to the OIICS manual from 1992, with minor revisions adopted in 2007. The OIICS, developed by BLS, provides a classification system for coding four aspects of a work-related injury or illness: the principal physical characteristic or nature of the injury or illness; part of body affected; the source, namely objects, substances, or other factors responsible for the injury or illness; and the event or exposure to describe the manner in which the injury or illness occurred (US Department of Labor, 1992, 2007).

The OIICS employs a hierarchical structure with up to four digits used to describe each aspect of the case. The first digit designates the division that represents general categories of case characteristics. The second digit designates the major group, and, in certain prescribed instances, a third and sometimes fourth digit are used to designate the group and subgroup, respectively. For example, for the characteristic nature of injury, the division Traumatic Injuries and Disorders (0*) contains ten major groups including Open Wounds (03*) (an asterisk indicates the inclusion of all codes that begin with the character(s) listed). Nine of the ten groups within Open Wounds, a partial list of which includes Animal

or Insect Bites (032), Cuts, Lacerations (034), and Gunshot Wounds (036), allows for no more detail beyond the three-digit group level. Among the groups in Open Wounds, only Amputations (031*) includes subgroups: Amputations, Fingertip (0311) and Amputations, Except Fingertip (0319). The analysis of injury and illness classification agreement was limited to state fund claims linked through RL1 because injury classification codes are not systematically assigned to self-insured claims. More commonly assigned OIICS codes were assessed individually while less common codes were aggregated within major groups or divisions.

Using the SOII sample weights assigned to each case, two population estimates for each selected condition were calculated for comparison: one based on injury and illness characteristics as coded in SOII, and a second based on characteristics as coded in workers' compensation data. We selected for estimation two conditions that state-based surveillance efforts monitor using the SOII data: amputations and musculoskeletal disorders (Council of State and Territorial Epidemiologists (CSTE), Updated 2012). The CSTE surveillance definitions of amputations and musculoskeletal disorders are based on 1992 OIICS codes. Amputations are defined as cases with an Amputation Nature code (031*). Musculoskeletal disorders are defined by OIICS Nature and Event codes: OIICS Nature codes: 021 (Sprains, Strains, Tears); 0972 (Back Pain, Hurt Back); 0973 (Soreness, Pain, Hurt, Except Back); 1241 (Carpal Tunnel Syndrome); 153* (Hernia); or 17* (Musculoskeletal System and Connective Tissue Diseases and Disorders) and OIICS Event codes: 211 (Bending, Climbing, Crawling, Reaching, Twisting); 22* (Overexertion); or 23* (Repetitive Motion).

Kappa statistics, a measure of agreement adjusted for chance, were used to measure agreement in OIICS codes among linked SOII-workers' compensation records for three injury characteristics: Nature, Part of Body, and Event. Agreement was assessed for divisions, major groups, groups, and subgroups. When a major group or group was the greatest level of detail available in OIICS, the case was included in the analysis of more detailed classifications. McNemar's test was used to assess differences in

proportions of select injury classifications among the linked cases. Neither data source was regarded as the referent.

D. **Selection of Interview Participants**

To select interview participants, the 2008 SOII establishments were stratified by completeness of occupational injury and illness reporting, and three characteristics believed to impact reporting: establishment size; industry; and number of establishments operated by the employer. The SOII-workers' compensation record-linkage results were used to classify establishments as complete reporters (all eligible claims linked to a reported SOII case) or underreporters (one or more eligible claims not linked to a reported SOII case). Based on the SOII data, establishments were classified as small (1–49 employees) or large (50 or more employees), fixed-site industries or non-fixed (nonpermanent worksite locations identified from 4-digit NAICS codes, primarily within construction and transportation), and the sole establishment operated by an employer or one of multiple establishments. Establishments from mining and rail roads were excluded since they are not sampled by BLS and instead have their injury data submitted to BLS by the Mining Safety and Health Administration and the Federal Railroad Administration, respectively. Respondents located outside of Washington State were also excluded. Although the record-linkage process identified both SOII cases not identified in workers' compensation and workers' compensation claims not reported in SOII, we focused on the reporting of workers' compensation claims and left the unlinked SOII cases for a subsequent analysis since the reasons for unreported workers' compensation claims likely differ from the reasons for unreported SOII cases.

Establishments were selected within each sampling stratum and sent a recruitment letter addressed to the individual listed as the 2008 SOII contact. The recruitment letter outlined the investigator's interest in learning more about workplace injury and illness record-keeping, described participation in the study, and informed them that they would be contacted by telephone in about one

week to schedule an interview. We attempted to reach respondents via telephone until an interview had been scheduled or until we received a refusal to participate. Because the interview included questions on OSHA, SOII, and workers' compensation practices, we attempted to establish during telephone contact the person or persons responsible for each system to ensure that interviews were scheduled with the appropriate company representative(s). Respondents were contacted using the SOII contact data from 2008, which includes the name, address, and phone number of the individual who responded to the SOII. The preference was to conduct in-person interviews on-site at the surveyed establishment; however, the possibility of conducting interviews at a nearby location was an option if the respondent felt more comfortable speaking with DLI staff off-site. Participant recruitment was concluded once no new information was gained from additional interviews.

Prior to conducting the interview, a member of the research team informed participants that their responses were confidential and would not be shared with the state OSHA program. The team member then obtained written consent from the participant. Each interview lasted approximately one hour. The respondent was provided with blank copies of the SOII and the OSHA 300, 300A, and 301 forms to facilitate the discussion.

The semi-structured interviews covered a range of topics including: company injury and illness reporting process; compliance with the OSHA record-keeping regulations; and company uses of injury and illness data (Appendix A). All interviews took place between April 2011 and December 2011.

Completed interviews were discussed among the study team at bi-weekly debriefings. Codes for open-ended questions were developed after reviewing the responses. Two research staff then used the code book (Appendix B) to independently code responses to open-ended questions. When disagreements occurred, responses were discussed until consensus was reached. All disagreements were resolved in this manner. Given the exploratory nature of the study, descriptive statistics were used to summarize the data and examine relationships between select establishment characteristics and

incomplete injury and illness reporting. The study sample was not selected to be proportionally representative of SOII establishments in Washington State and therefore, distributions of record-keeping practices reflected only the study population and not the greater SOII population.

E. Modified Linkage Procedure for Linking Department of Labor Injury Data to Workers' Compensation Claims Data

A modified procedure, referred to as RL2, was used to link the 2003–2011 data. Whereas RL1 was patterned after previous studies as a method feasible in multiple states, RL2 was believed to be more efficient for linking nine years of data, making greater use of the UI data and employing a linking algorithm developed by the research team.

1. Establishment exclusion criteria

The data were restricted to establishments sampled by BLS from the UI data to and industries whose entire workforce is covered by the Washington State workers' compensation system. These exclusions were applied for two reasons: (1) the enhanced linkage procedures developed for this study rely on UI data to identify SOII-eligible claims within workers' compensation data, and (2) the Washington State workers' compensation claims data cannot be used to evaluate reporting of claims among industries with alternate workers' compensation insurance coverage. Injury and illness data for mining and railroads are not gathered through the annual survey of establishments but rather sent to BLS by the Mine Safety and Health and Federal Railroad Administrations. These establishments (7% of 2003–2011 establishments) are not sampled from UI and their UI account information is not recorded in SOII data. The maritime workforce is not covered by state workers' compensation systems and instead receives workers' compensation benefits through the Longshore and Harbor Workers' Compensation program or the Jones Act. Sovereign Native American tribes are not required to participate in Washington State's Industrial Insurance system. Industry classifications, available in UI as either

Standard Industrial Classification system codes (SIC) or NAICS were used to identify the water transportation, ship and boat building, seafood product preparation and packaging, and fishing establishments that have workers' compensation covered through either the Longshore and Harbor Workers Compensation Act or the Jones Act. The ownership code in UI was used to identify establishments owned by tribes. These exclusions applied to 2% of 2003–2011 establishments.

Additionally, of the 44,634 establishments that participated in the 2003–2011 SOII, 27 were excluded from the linkage attempt because the SOII-provided UI account information could not be found within the Washington State UI data.

2. **Establishment linkage**

Using the UI account and reporting-unit numbers provided in the SOII establishment file, BLS-sampled establishments were identified within Washington State's UI data from the quarter when the sample was drawn; specifically, seven quarters prior to the beginning of the survey year. The sampled establishments were mapped through successive quarters within the UI data to identify changes in ownership, physical location, or a break in liability (e.g., a quarter in which there was no employment reported) that might impact the identification in workers' compensation of the employer during the survey period.

Next, we identified workers employed by SOII respondents during the survey year using the UI account information current at the time of the survey. Worker identifiers, including SSN, for individuals reported in at least one of the four quarters of the survey year among SOII-participating UI accounts were extracted from the Washington State UI database. When a SOII establishment represented a report unit rather than the entire UI account, the workforce identified from the UI account data was greater than the workforce sampled since worker identifiers are reported at the UI account level. Establishment characteristics were used later in the record-linkage process to limit workers to those

likely employed at the sampled reporting unit. A discussion of this process occurs below; see "Identification of workers' compensation claims that meet SOII case criteria." Figure 3 provides an overview of the claim identification process where the sampled establishment represented an entire UI account. Figure 4 provides an overview of the process where the sampled establishment was a report unit within the UI account.

Using the UI-reported SSN for employees among SOII-participating UI accounts, we extracted workers' compensation claims among the sampled workforce with an injury date in the survey year in which the establishment participated. For linking to SOII cases, all workers' compensation claims were extracted regardless of claim liability status and included rejected claims, claims for medical-treatment only, and indemnity claims. To allow for differences between SOII and workers' compensation in the characterization of missed work, no restrictions were made to the workers' compensation claim-population prior to linking. This approach identified more claims than are likely eligible for reporting in SOII (similar to extracting all claims for an entire UI account when SOII participation was limited to a reporting unit). Record-level exclusions were applied after the linkage process was complete.

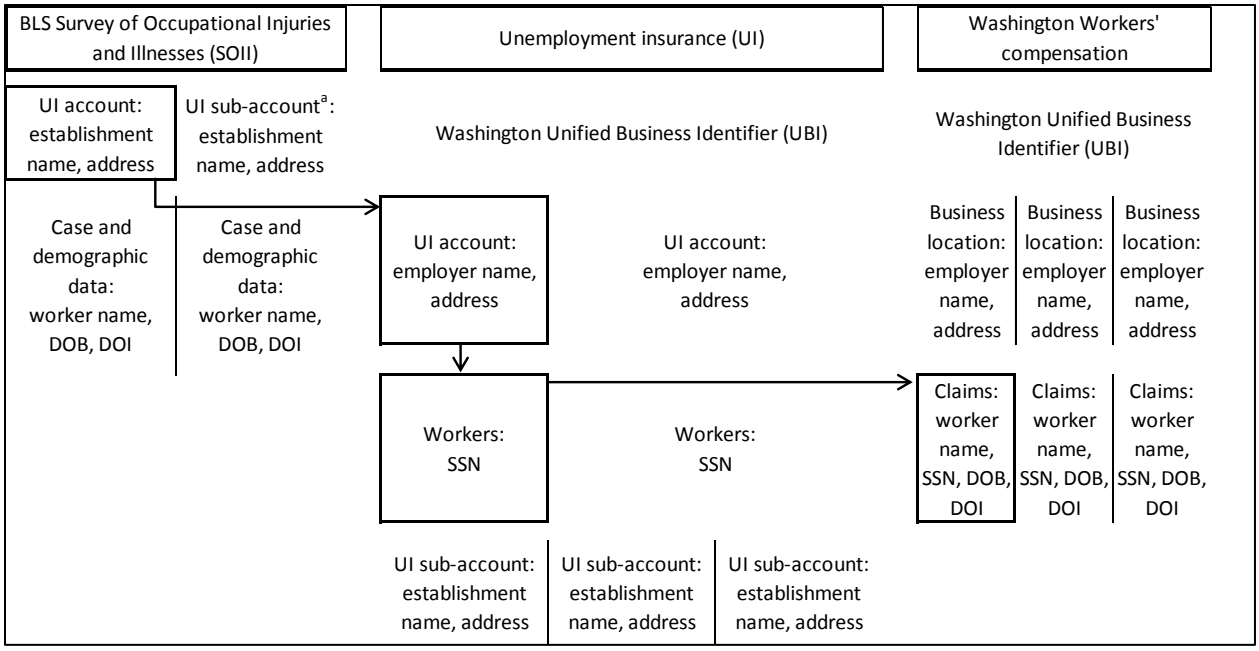

Figure 3. Process for identifying SOII-eligible workers' compensation claims among SOII-sampled UI accounts.

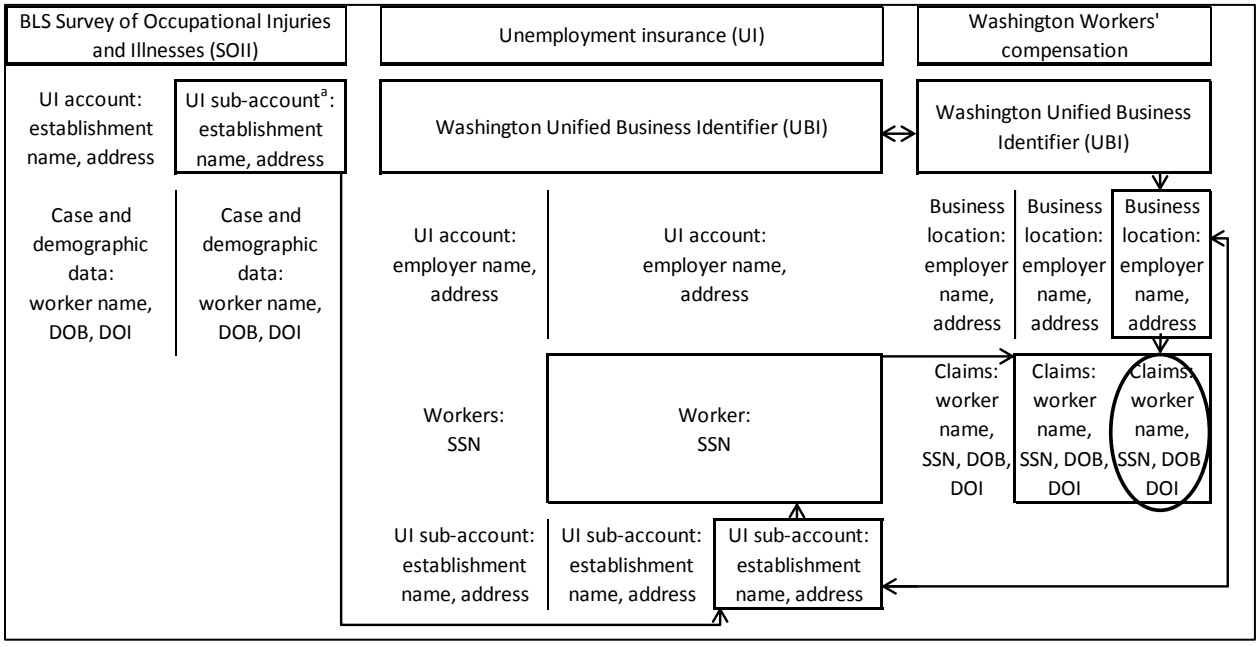

Figure 4. Process for identifying SOII-eligible workers' compensation claims among SOII-sampled UI sub-accounts.[a]

[a]UI sub-account also referred to as reporting unit within UI account.

3. **Injury record linkage**

Research staff developed SAS code to deterministically link records through an iterative process, altering the linking criteria of one or more variables in each successive attempt. The SOII cases were linked to workers' compensation claims based on the following data elements: worker first name, last name, date of birth or age at injury, and date of injury.[10] Extracting only claims among workers reported in UI by sampled employers established the claimant's relationship to the employer. First and last names were allowed to match identically or phonetically; on later attempts, first name was also allowed to match on first initial or not at all. Over the course of the multiple record-linkage attempts, the matching requirement for date of birth was broadened iteratively from exact match between SOII and workers' compensation to within 7 days, 31 days, 65 days, 365 days, 3,660 days, and finally 7,220 days. For cases where date of birth was not provided, the age at injury was allowed to vary from exact, to within 1 year, then within 10 years. After each iteration, potential links were manually reviewed by research staff to confirm that the new criteria identified true matches.

Linking iterations followed a hierarchy so that links to the more relevant claims preceded other attempts. Links to claims with wage replacement were attempted prior to links among medical-only claims, with all other variables being equal. Linkages were first attempted among the SOII cases in the final cases file and then followed by an attempt to link cases in the unusable case file. Once linked, both cases and claims were removed from the group of records available for subsequent linkage attempts. Two-thirds of linked records matched identically or phonetically on first and last names, and identical injury dates and birthdates or ages. Eighty percent matched phonetically on last name, first name or first initial, and had injury dates and birthdates that differed across data sources by no more than seven days. See Appendix C for record linkages by linkage criteria.

[10] SSN is available in the workers' compensation data and the unemployment insurance data. The SSN are not available in SOII data. The SSN were used to identify the population of SOII-sampled workers' compensation claims, but could not be used to link SOII cases to claims because SSN is not provided in SOII.

Record-linkage procedures resulted in three groups of records: linked SOII workers' compensation cases, unlinked SOII cases, and unlinked workers' compensation claims. As noted above, more workers' compensation claims were extracted than were expected to meet the SOII case reporting criteria because they were either: (1) employed by the sampled employer at some location other than the sampled reporting unit, or (2) filed for an injury that did not result in missed work (e.g., rejected claims). This necessitated reducing claims to those eligible for SOII as a DAFW case.

4. **Identification of linked and unlinked records eligible for both data systems**

For sampled establishments that represented the entirety of a UI account, all claims identified through an employee's SSN were retained since these workers were reported in UI data as employed within the sampled UI account. When the sampled establishment represented one of many reporting units within a UI account, we ascertained the claim's association with the sampled establishments through the UBI and address data—when the UBI or address of the workers' compensation business location associated with the unlinked workers' compensation claim differed from the UBI or address of the sampled reporting unit or from the reporting unit associated with the majority of linked SOII-workers' compensation cases, the unlinked claim was considered to be associated with a reporting unit other than the sampled unit. These claims were excluded from the group of unlinked claims and considered not reportable to SOII.

To evaluate SOII capture of workers' compensation claims, we used workers' compensation indemnity payment information to identify claims for injuries that resulted in one or more days of missed work (thus meeting the SOII DAFW case criteria). State fund claims that received payments for missed work, or self-insured claims classified as eligible for time-loss payments were considered to have met the missed-work criterion to be recordable as a DAFW case. Among these claims, we used claim-event dates to indicate whether the missed work occurred within the survey year. When the workers' compensation date for first medical treatment, claim establishment, disability, or initial time-loss

payment occurred after the survey year, records (both linked and unlinked workers' compensation claims) were excluded from further analyses. Although these injuries occurred during the survey year and eventually resulted in missed work, the claim data suggested the missed work did not occur until after the survey year concluded, and thus would not have been recordable as a DAFW case during the survey year. To evaluate workers' compensation capture of SOII cases, all SOII cases (among establishments eligible for Washington State workers' compensation coverage), linked and unlinked, were retained since a DAFW injury is likely eligible for workers' compensation—for medical-aid benefits if not wage replacement.

For establishments asked to report on a subsample of cases based on the injury date (e.g., injuries that occurred in the first three months of the year, or injuries that occurred on the 15th day of the month), any unlinked claim with an injury date outside the subsample timeframe was removed from the group of unlinked claims.

All records in the BLS unusable case file—both linked and unlinked—were excluded from analyses. Linking claims to cases reported in the unusable file identified claims that may otherwise have been considered unlinked or unreported in SOII in previous research. Between 2003 and 2011, there were 1,429 unusable DAFW cases linked to a workers' compensation claim. Without attempting to link claims to the unusable SOII cases, the 1,429 claims would have been considered unreported to SOII.

Linkage procedures allowed for an unlinked workers' compensation claim to be associated with more than one sampled establishment. This occurred when a claimant worked for an employer with a UI account with multiple sampled reporting units and few differences among the units' physical location data. When available, the injury location data in the workers' compensation claim data were used to link the claim to the appropriate reporting unit. If the workers' compensation city of injury was a location other than the physical location city of the sampled report unit, the claim was considered outside the scope of the sampled workforce and excluded from the analysis. In some cases, the data available were

insufficient to assign a claim to a single reporting unit. Unlinked self-insured claims were more likely to be associated with multiple sampled reporting units than state-funded claims (18% of unlinked self-insured claims compared to 1% of unlinked state-funded claims). Claims with multiple associations were randomly assigned to one of the associated reporting units. Random assignment did not alter the distribution of unlinked claims by industry or establishment size.

5. **Analysis of unreported injuries**

Reporting was assessed by workers' compensation insurer (state fund versus self-insured), sampled workforce (UI account versus sub-account), DAFW cases requested by BLS (all versus subset based on injury date), workplace injury record-keeping exemption status, establishment size, and industry. The SOII-size grouping was used to classify establishment size. The SOII NAICS codes combined with the ownership code (private industry, state government, local government) were used to classify industry. The UI-based SIC codes and BLS-size data were used to identify establishments exempt from annual record-keeping based on Washington State regulations.[11]

The SOII and workers' compensation capture rates by individual establishment characteristics are presented for observed case totals and weighted estimates to account for disproportionate sampling and nonresponse in SOII. Linked claims were assigned the weight of the corresponding SOII case and unlinked claims were assigned the weight associated with the establishment determined to be responsible for reporting the claim.

Unreported workers' compensation claims, defined as unlinked claims, were a common occurrence (approximately 30%) and binomial log-link regression models were used to estimate the PRs

[11] For the survey years included in the study, the record-keeping requirements in Washington State, an OSHA state-plan state, were identical to the federal OSHA regulations except that state law requires offices and clinics of healthcare providers and dentists and public educational services (except elementary and secondary schools and public libraries) to maintain annual injury and illness records. These establishments were partially exempt from federal record-keeping requirements. All establishments selected for SOII participation are required to maintain OSHA injury and illness records for the duration of the survey year, including establishments partially exempt from OSHA record-keeping requirements.

of unreported claims (Spiegelman and Hertzmark, 2005). Reference groups were selected as the group with both a large sample size and high percent of claims reported in SOII. All establishment characteristics were included in the multivariable regression model, which was adjusted for survey year and nature of injury or illness. The joint effect of size and industry on unreported claims was assessed as described by Knol and VanderWeele (Knol and VanderWeele, 2012). Regression models were limited to state-funded claims because of the granularity of workers' compensation data available compared to self-insured claims. Because the regression analysis focused on a subset of the population, the regression models did not include survey weights but did include variables related to the SOII sampling design including ownership, establishment size, and industry (Korn and Graubard, 1991).

IV. INJURY CLASSIFICATION AGREEMENT IN LINKED DEPARTMENT OF LABOR'S SURVEY OF OCCUPATIONAL INJURIES AND ILLNESSES AND WORKERS' COMPENSATION DATA[12]

A. Background

Occupational health surveillance data are used to monitor workplace exposures and health effects, develop workplace interventions, and guide policy. Accurate data are essential to inform the appropriate allocation of limited research and prevention resources. The United States Department of Labor's BLS SOII, an annual survey of sampled business establishments, is one of the primary sources of work-related injury and illness data in the country, providing both national, and for most states, state-level estimates of nonfatal occupational injuries and illnesses based on employer reports of OSHA-recordable cases (US Department of Labor, 2012a). Over the years, SOII has been the focus of many researchers, policy analysts, and others in the occupational health community who question the completeness of the survey data. Several studies report a failure by SOII to capture all eligible injuries (Boden and Ozonoff, 2008, Rosenman et al., 2006, Leigh et al., 2004) and other studies comparing SOII estimates of select conditions to cases identified through other data sources have concluded that SOII underestimates such conditions (Friedman et al., 2013, Kica and Rosenman, 2012, Lipscomb et al., 2008a, Morse et al., 2001).

Among the many potential reasons for the observed SOII undercount are: incomplete employer reports of injuries and illnesses, whether intentional or inadvertent; inadequate understanding of the reporting requirements; and constraints of the survey's methodology that limits the reporting of certain cases, including illnesses with long latencies, injuries that worsen over time, and those that are difficult to attribute to work (Seligman et al., 1988, Nestoriak and Pierce, 2009, Ruser, 2008, Dong et al., 2011, Azaroff et al., 2002, Pransky et al., 1999).

[12] Previously published as Wuellner, S. E., and D. K. Bonauto. "Injury Classification Agreement in Linked Bureau of Labor Statistics and Workers' Compensation Data." *Am J Ind Med* 57, no. 10 (2014): 1100–9. doi: 10.1002/ajim.22289.

Another possible explanation for apparent low SOII case-capture, yet to be explored, is the characterization of reported cases and whether it is consistent across data sources or differs by source. Identical injury events can appear distinct if the characterization of the injury differs by data source. For example, based on variant incident descriptions, a case may be coded as a crushing injury in the SOII but as an amputation in another data source. Depending on the data source used for case surveillance, this incident would be counted toward the total number of one condition instead of the other. Thus, differences in case classification may lead to divergent estimates of specific conditions.

In this study, we assessed injury-coding agreement among cases reported to multiple data sources and examined the impact of coding differences on estimates of select occupational injuries and illnesses.

B. Methods

1. Data sources

We linked three years of BLS SOII case data to Washington State workers' compensation claims data to assess injury-classification agreement among cases reported to both systems.

During the study period, both data sources coded injury and illness characteristics according to the OIICS manual from 1992, with minor revisions adopted in 2007. The OIICS, developed by BLS, provides a classification system for coding four aspects of a work-related injury or illness: the principal physical characteristic or nature of the injury or illness; part of body affected; the source, namely objects, substances, or other factors responsible for the injury or illness; and the event or exposure to describe the manner in which the injury or illness occurred (US Department of Labor, 2007, 1992).

The OIICS employs a hierarchical structure with up to four digits used to describe each aspect of the case. The first digit designates the division that represents general categories of case characteristics. The second digit designates the major group, and, in certain prescribed instances, a third and sometimes fourth digit are used to designate the group and subgroup, respectively. For example, for the

characteristic nature of injury, the division Traumatic Injuries and Disorders (0*) contains ten major groups including Open Wounds (03*) (an asterisk indicates the inclusion of all codes that begin with the character(s) listed). Nine of the ten groups within Open Wounds, a partial list of which includes Animal or Insect Bites (032), Cuts, Lacerations (034), and Gunshot Wounds (036), allows for no more detail beyond the three-digit group level. Among the groups in Open Wounds, only Amputations (031*) includes subgroups: Amputations, Fingertip (0311) and Amputations, Except Fingertip (0319).

a. **Survey of Occupational Injuries and Illnesses**

The BLS administers the SOII annually in partnership with participating states to estimate the incidence of nonfatal OSHA-recordable occupational injuries and illnesses. The BLS collects work-related injury and illness data from sampled private-sector employers as well as state and local governments. Sampled establishments are asked to submit the number of OSHA-recordable cases that occurred within the survey year. For injuries and illnesses resulting in at least one day of missed work following the date of injury, employers send detailed worker and incident characteristics including worker name, date of birth or age, sex, date of injury, and a description of the injury or illness as well as the activity immediately preceding the incident. Survey respondents are instructed to report detailed case information from any of the following sources: the OSHA Form 301; a workers' compensation report; an accident report; or an insurance form. Following a protocol established by BLS, participating states code the injury descriptions according to OIICS.

Washington State SOII data for survey years 2006–2008 were obtained through a cooperative agreement between the BLS and the Washington State DLI.

b. **Washington State workers' compensation**

The DLI regulates workers' compensation insurance for all nonfederal employers operating in Washington State.[13] In addition, DLI administers the Washington State-funded workers' compensation insurance program, which is the sole workers' compensation insurance provider for all employers in the state except those covered by an alternate workers' compensation system (e.g., Longshore and Harbor Workers' Compensation Act, Federal Employees' Compensation Act), specific employers or occupations exempt from mandatory coverage (e.g., self-employed), or those who are able to self-insure. Approximately 70% of workers under DLI jurisdiction are covered by state-funded employers and 30% work for a self-insured employer.

A workers' compensation claim is initiated when a worker and the healthcare provider complete and submit a report of accident (ROA). All filed state-funded claims, regardless of claim acceptance or award, are coded by trained DLI staff who review the narrative description of the incident and the resulting injury or illness as provided on the ROA to assign codes according to OIICS. In contrast, only a portion of self-insured claims-awarded indemnity payments are coded for injury characteristics (in Washington State, the waiting period for indemnity is three calendar days following the day of injury).

All filed workers' compensation claims with an injury date in years 2006–2008 were extracted from the DLI workers' compensation database on July 13, 2010. The claims data extracted included claimant name, sex, date of birth, date of injury or illness, employer name and address, and OIICS Nature, Event or Exposure, and Part of Body codes.

2. **Record linkage**

Record-linkage procedures were patterned after those developed by researchers for another study linking similar BLS case data to workers' compensation claims data (Boden and Ozonoff, 2008). In

[13] Revised Code of Washington. § 51.12.010 (1972).

preparation for linking, first names and addresses were standardized using the US Census Bureau's data standardization software GDRIVER (US Bureau of the Census, 1999). Linking was attempted between SOII cases (OSHA-recordable injuries and illnesses resulting in one or more days of missed work) and all filed workers' compensation claims among state-funded and self-insured employers, and was conducted in two stages. First, we linked cases to claims through identical matches on eight of the nine common variables: worker last name, first initial, sex, date of birth or age at injury, date of injury, employer name, employer address, zip code or city, and federal employer identification number. We then linked the remaining unmatched cases using the probabilistic software program LinkPlus (US Department of Health and Human Services, 2009), which assigns a score to each potential matched pair based on the degree of similarity in the common variables. Two researchers reviewed pairs with lower scores to determine whether to accept the potential match. Disagreements between the two reviewers were settled by a third reviewer. We allowed some difference in injury dates between data sources, although date differences were not allowed to exceed two months. Because the injury date in workers' compensation is adjudicated to reflect the last injurious exposure, the date reported by the employer may not be identical, especially for non-traumatic conditions with no clear precipitating event. The injury date documented by the employer may be the date the worker received medical treatment or the date of missed or restricted work. Injury dates more than two months apart were assumed to reflect separate injury events rather than differences in the characterization of one singular event.

3. **Data analysis**

The analysis of injury and illness classification agreement was limited to linked state-funded claims because injury classification codes are not systematically assigned to self-insured claims. More commonly assigned OIICS codes were assessed individually while less-common codes were aggregated within major groups or divisions.

The BLS assigns each reported case a sample weight that is used to estimate the number and rate of nonfatal occupational injuries and illnesses among the population. Using the SOII sample weights assigned to each case, two population estimates for each selected condition were calculated for comparison: one based on injury and illness characteristics as coded in SOII, and a second based on characteristics as coded in workers' compensation. We selected for estimation two conditions that state-based surveillance efforts monitor using the SOII data: amputations and musculoskeletal disorders (Council of State and Territorial Epidemiologists, Updated 2012). The CSTE surveillance definitions of amputations and musculoskeletal disorders are based on 1992 OIICS codes. Amputations are defined as cases with an Amputation Nature code (031*). Musculoskeletal disorders are defined by OIICS Nature and Event codes: OIICS Nature codes: 021 (Sprains, Strains, Tears); 0972 (Back Pain, Hurt Back); 0973 (Soreness, Pain, Hurt, Except Back); 1241 (Carpal Tunnel Syndrome); 153* (Hernia); or 17* (Musculoskeletal System and Connective Tissue Diseases and Disorders) and OIICS Event codes: 211 (Bending, Climbing, Crawling, Reaching, Twisting); 22* (Overexertion); or 23* (Repetitive Motion).

Kappa statistics, a measure of agreement adjusted for chance (Landis and Koch, 1977), were used to measure agreement in OIICS codes among linked SOII-workers' compensation records for three injury characteristics: Nature, Part of Body, and Event. Agreement was assessed for divisions, major groups, groups, and subgroups. When a major group or group was the greatest level of detail available in OIICS, the case was included in the analysis of more detailed classifications. McNemar's test was used to assess differences in proportions of select injury classifications among the matched cases (McNemar, 1947). Neither data source was regarded as the referent. All analyses were performed using SAS version 9.3. The Washington State Institutional Review Board approved the study.

C. **Results**

Record-linkage procedures matched 90% of the 29,862 SOII cases to workers' compensation claims, a total of 26,925 linked records. Links among state-funded workers' compensation claims totaled

15,447 claims (57%) and the remaining cases linked to workers' compensation claims among self-insured employers. The SOII and workers' compensation data documented identical injury dates in 14,049 state-funded claims (91% of linked state-funded claims); injury dates were within seven days in 14,943 linked state-funded claims (97%).

Among the 15,447 SOII cases linked to state-funded workers' compensation claims, Sprains, Strains, Tears were the most common injury or illness assigned in either SOII or workers' compensation (48% and 40%, respectively) and backs were the most frequently affected body part (23% of linked SOII cases, 24% of linked workers' compensation claims). Workers' compensation classified more cases than SOII as non-traumatic (1,519 records compared with 1,099 records, $p<.01$) although SOII coded 27 more cases as Carpal Tunnel Syndrome, the most frequently assigned non-traumatic Nature classification in either data source (236 records based on SOII-assigned codes, 209 records based on workers' compensation-assigned codes). Overexertion, specifically in lifting, was the most frequently assigned exposure, with a similar number of cases classified as Overexertion in SOII (4,299 records) as in workers' compensation (4,300 records).

1. **Injury classification agreement**

One in five linked records (3,205 cases) was classified identically in both data sources for all three injury characteristics: Nature, Part of Body, and Event. For 1,426 linked records (9%), none of the injury characteristics matched across data sources.

Classification agreement varied by injury characteristic and level of coding detail, with the portion of records in agreement decreasing as coding detail increased (Table II). For each injury characteristic (Nature, Body Part, and Event), at least 85% of cases linked to state-funded claims were coded identically in both data sources at the most general (1 digit) division level. For Nature and Body Part, one in three cases were assigned to groups (3-digit codes) that differed by data source. For Event, more than half were assigned to groups (3-digit codes) that differed by data source.

More than 90% of linked records were classified in SOII as one of thirteen 3-digit group codes; ten within traumatic injuries and three within systemic conditions or disorders. Among those thirteen group codes, agreement with workers' compensation-assigned Nature was lowest for Nonspecified Injuries and Disorders (k=.19), and greatest for Hernia (k=.89) and Heat Burns, Scalds (k=.89). Agreement for the most frequently assigned code, Sprains, Strains, Tears (k=.68), was exceeded only by agreement among cases classified as Hernia or Heat Burns, Scalds, although one in four cases classified in SOII as Sprains, Strains, Tears was classified differently in workers' compensation. Twenty percent of SOII-designated Sprains, Strains, Tears were classified in workers' compensation as some other traumatic injury or disorder, including: 7% as Multiple Traumatic Injuries and Disorders; 4% as Dislocations; and 4% as Nonspecified injuries and disorders. Four percent of SOII-designated Sprains, Strains, Tears were classified in workers' compensation as Systemic Diseases and Disorders.

TABLE II

AGREEMENT IN INJURY CLASSIFICATION CODES[a] BY LEVEL OF INJURY CODING DETAIL[b]

	Division (1-digit code)			Major Group (2-digit code)			Group (3-digit code)			Subgroup (4-digit code)		
	n	%	kappa	n	%	kappa	n	%	kappa	n	%	kappa
Nature of injury or illness	14,525	94%	0.62	10,966	71%	0.62	10,268	67%	0.57	10,041	65%	0.55
Part of body	13,376	87%	0.82	11,844	77%	0.74	10,100	65%	0.63	10,091	65%	0.63
Event or exposure	13,055	85%	0.78	10,672	69%	0.64	6,875	45%	0.42	6,647	43%	0.40

[a]Both the SOII and workers' compensation cases were coded using the Occupational Injury and Illness Classification System, a hierarchical classification system with general categories containing codes of greater specificity. Most codes available in OIICS are 3 or 4 digits in length, although some are limited to 1 or 2 digits. The most general category, the Division, is designated by the first digit of the code. To assess agreement in assignment of the Division, codes were aggregated to the first digit. Major Group included aggregation to the 2-digit level plus codes with no more detail beyond the 1-digit Division level. Group included aggregation to the 3-digit level plus terminal 1- and 2-digit codes. Subgroup consists of all codes as assigned with no aggregation.

[b]Agreement measured among 15,447 SOII cases linked to Washington State-fund workers' compensation claims. Data presented are number of linked records with matching codes, percent of total linked records, and kappa statistic.

For four of the thirteen most frequently SOII-assigned groups, cases not coded identically in workers' compensation were most often assigned another group within the SOII-assigned major group. When not coded identically in workers' compensation, SOII-assigned Cuts, Lacerations were classified in workers' compensation as some other Open Wound more than any other group code; SOII-assigned Abrasions, Scratches and Foreign Bodies were most often classified as some other Surface Wounds and Bruises in workers' compensation; and SOII-assigned Heat Burns, Scalds appeared in workers' compensation as some other Burn. More than 10% of cases within each of the following six SOII-assigned groups had codes assigned in workers' compensation that differed at the 1-digit division level: Rheumatism; Peripheral Nerve Damage; Nonspecified Injuries and Disorders; Hernia; Foreign Bodies; and Punctures. When not classified identically in workers' compensation, cases classified in SOII as Bruises, Contusions, or Fractures were more often assigned the code for Multiple Traumatic Injuries and Disorders than any other classification.

Table III presents the distribution of cases by the 2-digit major group codes assigned in each data source characterizing Nature. Even at this more general level of detail, coding disagreements between the two data sources persist. Of the 1,344 cases coded as Traumatic Injuries To Bones, Nerves, Spinal Cord (9% of linked records), 72% were classified the same in workers' compensation, 15% had a workers' compensation-assigned code for Multiple Traumatic Injuries and Disorders, and the remaining 13% of SOII-designated cases of Traumatic Injuries To Bones, Nerves, Spinal Cord were classified in workers' compensation as one of twelve other major groups, including non-traumatic conditions or disorders. For most traumatic major groups, injuries not classified the same in both data sources were often classified as Multiple Traumatic Injuries and Disorders in workers' compensation.

TABLE III

LINKED RECORDS[a] BY WORKERS' COMPENSATION AND SOII NATURE OF INJURY CODING[b]

Workers' Compensation-Assigned Codes[c]	SOII-assigned codes[c]									
	Traumatic Injuries to Bones, Nerves, Spinal Cord (01)	Traumatic Injuries to Muscles, Tendons, Ligaments, Joints, etc. (02)	Open Wounds (03)	Surface Wounds and Bruises (04)	Burns (05)	Multiple Traumatic Injuries and Disorders (08)	Other Traumatic Injuries and Disorders (09)	Systemic Diseases and Disorders (1)	All Others	Total
Traumatic injuries to bones, nerves, spinal cord (01)	972 (6)	378 (2)	55 (<1)	41 (<1)	0 (0)	84 (1)	57 (<1)	7 (<1)	3 (<1)	1,597 (10)
Traumatic injuries to muscles, tendons, ligaments, joints, etc. (02)	62 (<1)	5,760 (37)	15 (<1)	94 (1)	1 (<1)	91 (1)	227 (1)	93 (1)	8 (<1)	6,351 (41)
Open wounds (03)	28 (<1)	28 (<1)	1145 (7)	46 (<1)	2 (<1)	39 (<1)	52 (<1)	9 (<1)	4 (<1)	1,353 (9)
Surface wounds and bruises (04)	39 (<1)	149 (1)	59 (<1)	1257 (8)	9 (<1)	89 (1)	62 (<1)	31 (<1)	11 (<1)	1,706 (11)
Burns (05)	0 (0)	2 (<1)	1 (<1)	6 (<1)	204 (1)	1 (<1)	3 (<1)	23 (<1)	0 (0)	240 (2)
Multiple traumatic injuries and disorders (08)	199 (1)	520 (3)	123 (1)	241 (2)	2 (<1)	561 (4)	72 (<1)	18 (<1)	57 (<1)	1,793 (12)
Other traumatic injuries and disorders (09)	24 (<1)	362 (2)	18 (<1)	78 (1)	3 (<1)	29 (<1)	213 (1)	29 (<1)	11 (<1)	767 (5)
Systemic diseases and disorders (1)	6 (<1)	303 (2)	33 (<1)	60 (<1)	17 (<1)	4 (<1)	73 (<1)	794 (5)	11 (<1)	1,301 (8)
All others	14 (<1)	76 (<1)	10 (<1)	41 (<1)	4 (<1)	18 (<1)	36 (<1)	31 (<1)	109 (1)	339 (2)
Total	1,344 (9)	7,578 (49)	1,459 (9)	1,864 (12)	242 (2)	916 (6)	795 (5)	1,035 (7)	214 (1)	15,447 (100)

[a] n=15,447.

[b] Data presented are n (%).

[c] Codes with greater detail aggregated at the level indicated.

Agreement was better among traumatic injuries than non-traumatic conditions or disorders. Of the 14,348 linked records classified in SOII as Traumatic Injuries or Disorders, 66% had an identical Nature code assigned in workers' compensation, and 29% had a nonidentical workers' compensation-assigned code within the Traumatic Injury Division, including 8% with a workers' compensation-assigned code for Multiple Traumatic Injuries. Among SOII's 1,035 Systemic Diseases and Disorders, 55% were coded identically in workers' compensation, 21% were assigned a different code within the Systemic Diseases and Disorders division, and another 21% had a workers' compensation-assigned code within the Traumatic Injuries or Disorders. An additional 3% of SOII-designated Systemic Diseases and Disorders were classified in workers' compensation within some division other than Systemic Diseases and Disorders or Traumatic Injuries or Disorders.

More than 75% of linked cases were categorized in SOII using one of twelve body part codes. Among those twelve, high agreement with workers' compensation coding was found for five body parts (33% of SOII-designated cases): Eye, Knee, Finger, Ankle, and Shoulder (k>.80), and lower agreement was found for Wrist(s), Foot, Lumbar Region, Hand, and External Neck Injuries (kappa ranged from 0.76 to 0.60). Among body parts with less agreement, often codes assigned in workers' compensation described proximate body parts. Of the SOII-designated wrist injuries, 71% not coded identically in workers' compensation were coded as Finger, Hand, Arm, or Multiple Upper Extremities. Among SOII-classified injuries involving an unspecified part of the foot, 81% of cases those without a matching code in workers' compensation were classified in workers' compensation as Toe(s), Ankle(s), or some other part of the foot. Three out of four cases coded in SOII as involving the lumbar region and a different body part assigned in workers' compensation were classified as some other region of the back in workers' compensation, often Multiple Back Regions or Back, Including Spine, Spinal Cord, Unspecified. Among SOII hand injuries, 85% of those not classified as such in workers' compensation were classified as Finger(s), Wrist(s), Arm(s), or Multiple Upper Extremities.

Body part classifications not in agreement at the division level were often coded as injuries to Multiple Body Parts in one of the two data sources (Table IV). In both data sources, 11% of records were classified as injuries to Multiple Body Parts (p=.86); however, within-case agreement was modest (k=.49).

More than 90% of cases were classified in SOII within three Event or Exposure divisions: Bodily Reaction and Exertion (44%); Contact with Objects and Equipment (27%); and Falls (19%). Within Bodily Reaction and Exertion, Overexertion (28%, k=.77) was most commonly assigned, followed by Bodily Reaction (12%, k=.55), and Repetitive Motion (4%, k=.59) (Table V). When not assigned an identical code in workers' compensation, Bodily Reaction cases were generally classified as Overexertion and SOII-designated Overexertion cases were often coded in workers' compensation as Bodily Reaction.

Within the division Contact with Objects and Equipment, agreement was greatest for Rubbed or Abraded by Fiction or Pressure (k=.74) and lowest for Struck Against Object or Equipment (0.43). Like Bodily Reaction and Exertion, differences in coding were usually limited to the major group level, and agreement was high for the division (k=.81). Among Falls, agreement was greater for Falls to Lower Level (k=.71) than Falls on Same Level (k=.65). More than one in three cases classified in SOII as Falls on Same Level were classified as some other event or exposure in workers' compensation including: Falls to Lower Level; Bodily Reaction; and Struck Against Object or Equipment.

2. **Impact of discordant injury characterization on case estimates of select conditions**

The BLS weights each case reported in SOII to estimate the incidence of cases among the population. To examine the impact of coding differences on occupational injury and illness case estimates, we applied the SOII sample weights to reported cases of amputations and musculoskeletal disorders, identified through SOII-assigned codes or workers' compensation-assigned codes.

TABLE IV

LINKED RECORDS[a] BY WORKERS' COMPENSATION AND SOII BODY PART CODING[b]

	SOII-assigned codes[c]									
Workers' Compensation-Assigned Codes[c]	Head (0)	Neck, Including Throat (1)	Back, Including Spine, Spinal Cord (23)	Trunk, Excluding Back (2 Other Than 23)	Finger(s), Fingernail(s) (34)	Upper Extremities, Excluding Fingers (3 Other Than 34)	Lower Extremities (4)	Multiple Body Parts (8)	All Others	Total
Head (0)	914 (6)	7 (<1)	4 (<1)	3 (<1)	7 (<1)	11 (<1)	7 (<1)	37 (<1)	1 (<1)	991 (6)
Neck, Including Throat (1)	7 (<1)	163 (1)	5 (<1)	12 (<1)	0 (0)	5 (<1)	2 (<1)	50 (<1)	1 (<1)	245 (2)
Back, Including Spine, Spinal Cord (23)	5 (<1)	43 (<1)	3,228 (21)	114 (1)	4 (<1)	8 (<1)	22 (<1)	345 (2)	2 (<1)	3,771 (24)
Trunk, Excluding Back (2 Other Than 23)	7 (<1)	8 (<1)	132 (1)	1,640 (11)	3 (<1)	38 (<1)	20 (<1)	167 (1)	19 (<1)	2,034 (13)
Finger(s), Fingernail(s) (34)	6 (<1)	0 (0)	9 (<1)	3 (<1)	1,229 (8)	108 (1)	19 (<1)	6 (<1)	4 (<1)	1,384 (9)
Upper Extremities, Excluding Fingers (3 Other Than 34)	5 (<1)	6 (<1)	10 (<1)	53 (<1)	155 (1)	1,766 (11)	35 (<1)	79 (1)	12 (<1)	2,121 (14)
Lower Extremities (4)	2 (<1)	1 (<1)	24 (<1)	28 (<1)	7 (<1)	20 (<1)	2,945 (19)	64 (<1)	5 (<1)	3,096 (20)
Multiple Body Parts (8)	109 (1)	67 (<1)	149 (1)	200 (1)	12 (<1)	90 (1)	121 (1)	904 (6)	15 (<1)	1,667 (11)
All Others	10 (<1)	1 (<1)	5 (<1)	15 (<1)	1 (<1)	8 (<1)	11 (<1)	8 (<1)	79 (1)	138 (1)
Total	1,065 (7)	296 (2)	3,566 (23)	2,068 (13)	1,418 (9)	2,054 (13)	3,182 (21)	1,660 (11)	138 (1)	15,447 (100)

[a]n=15,447.

[b]Data presented are n (%).

[c]Codes with greater detail aggregated at the level indicated.

TABLE V

LINKED RECORDS[a] BY WORKERS' COMPENSATION AND SOII EVENT OR EXPOSURE CODING[b]

	SOII-assigned codes[c]								
Workers' Compensation-Assigned Codes[c]	Contact With Objects And Equipment (0)	Falls (1)	Bodily Reaction (21)	Overexertion (22)	Repetitive Motion (23)	Exposure to Harmful Substances Or Environments (3)	Transportation Accidents (4)	All Others	Total
Contact With Objects And Equipment (0)	3,646 (24)	204 (1)	155 (1)	106 (1)	15 (<1)	42 (<1)	94 (1)	26 (<1)	4,288 (28)
Falls (1)	145 (1)	2,367 (15)	190 (1)	41 (<1)	0 (0)	1 (<1)	14 (<1)	11 (<1)	2,769 (18)
Bodily Reaction (21)	76 (<1)	217 (1)	1087 (7)	265 (2)	83 (1)	0 (0)	2 (<1)	1 (<1)	1,731 (11)
Overexertion (22)	152 (1)	48 (<1)	290 (2)	3,601 (23)	175 (1)	5 (<1)	3 (<1)	26 (<1)	4,300 (28)
Repetitive Motion (23)	7 (<1)	5 (<1)	18 (<1)	59 (<1)	333 (2)	0 (0)	0 (0)	3 (<1)	425 (3)
Exposure To Harmful Substances Or Environments (3)	34 (<1)	2 (<1)	2 (<1)	3 (<1)	5 (<1)	467 (3)	0 (0)	7 (<1)	520 (3)
Transportation Accidents (4)	37 (<1)	14 (<1)	5 (<1)	5 (<1)	0 (0)	1 (<1)	453 (3)	3 (<1)	518 (3)
All Others	132 (1)	94 (1)	114 (1)	219 (1)	61 (<1)	51 (<1)	14 (<1)	211 (1)	896 (6)
Total	4,229 (27)	2,951 (19)	1,861 (12)	4,299 (28)	672 (4)	567 (4)	580 (4)	288 (2)	15,447 (100)

[a]n=15,447.

[b]Data presented are n (%).

[c]Codes with greater detail aggregated at the level indicated.

Among the 15,447 matched cases, 98 amputations were identified from the SOII-assigned codes and 119 from the workers' compensation-assigned codes (k=.65). Among the 119 cases classified in workers' compensation as Amputations, 60% were classified in SOII as Amputations, 18% as Cuts Lacerations, 8% as Avulsions, 6% as Fractures, 5% as Crushing Injuries, and the remaining 3% as some other traumatic injury. Among the 98 SOII-identified Amputations, 72% appeared in workers' compensation as Amputations, 11% as Multiple Traumatic Injuries and Disorders, 11% as some other Open Wound, and 5% as some other traumatic injury. Applying the SOII sample weights, there were an estimated 449 amputations based on the SOII nature of injury classifications and an estimated 871 amputations based on the workers' compensation classifications, an increase of 94% over the SOII estimate. Based on classification codes assigned in either SOII or workers' compensation, 146 cases were identified as amputations, representing an estimated 985 amputations.

The SOII-designated coding identified 5,922 cases of musculoskeletal disorders, 1,299 more cases than the 4,623 cases of musculoskeletal disorders based on workers' compensation classifications (k=.71). Among the 2,071 cases identified as a musculoskeletal disorder in one data source but not the other, 57% were assigned musculoskeletal disorder-related nature of injury code but lacked a disorder-related event or exposure code, 29% had an musculoskeletal disorder-related event or exposure code but lacked a disorder-related nature of injury code, and 14% lacked both the event or exposure codes and the nature of injury codes used to identify musculoskeletal disorders. After applying the SOII sample weights, the estimated number of cases of musculoskeletal disorders was 34% higher based on the SOII-assigned classification codes compared with the workers' compensation-assigned codes (32,172 estimated cases compared with 24,066 estimated cases). Based on classification codes assigned in either SOII or workers' compensation, 6,278 cases were identified a musculoskeletal disorder, representing an estimated 34,216 cases.

D. **Discussion**

Linking occupational injury and illness records from multiple data sources allowed us to compare injury classification codes assigned by two different systems to the same work-related incident. This is the first study we know of to measure agreement in injury coding between SOII cases and workers' compensation claims and to assess the impact of coding differences on case estimates.

There are several possible explanations for the differences in the injury classification codes assigned in SOII compared with workers' compensation. First, the forms used to collect the descriptions of the events differ. Compare the questions posed by each system to illicit the injury narratives that are then coded.

SOII form:

- *What happened? Tell us how the injury or illness occurred. Examples: "When ladder slipped on wet floor, worker fell 20 feet"; "worker was sprayed with chlorine when gasket broke during replacement"; "Worker developed soreness in wrist over time"* and
- *What was the injury or illness? Tell us the part of the body that was affected and how it was affected; be more specific than "hurt," "pain," or "sore." Examples: "strained back"; chemical burn, hand"; "carpal tunnel syndrome"*

Workers' compensation claims accident report:

- *Describe in detail how your injury or exposure occurred. Include tools, machinery, chemicals, or fumes that may have been involved*
- *Part of body injured or exposed*

The examples provided in the SOII questions may lead the survey respondent's description of the incident and injury or illness to conform to the examples provided. Indeed, among matched cases, a greater portion was coded in SOII as "strained backed" and "carpal tunnel syndrome" while workers' compensation codes reflected a greater variety of injury types.

Another possible explanation for differences in injury assignments may relate to the individuals involved in the documentation of the incidents. An injury or illness record-keeper from the sampled establishment provides the narrative description of the incident for the SOII. There may be a desire to downplay the severity of the injury (more injuries characterized in SOII as Surface Wounds or Bruises, injuries classified in workers' compensation as Amputations that were classified in SOII as Cuts, Lacerations, Avulsions, or some other injury) or, in characterizing the event, shifting blame on the worker to mitigate an employer's sense of culpability.

Workers' compensation claims are coded from injured workers' narratives of the injury and event on the initial accident report. The report is completed by the worker and the attending physician, each of whom are responsible for separate sections of the form. The worker's interaction with the healthcare provider likely influences the worker's description of the injury. The worker's account may be more medically technical and detailed after discussing the condition with the healthcare provider. This may explain the higher portions of systemic diseases and multiple injuries among workers' compensation codes compared with SOII codes. Additionally, when coders are unable to classify the injury based on the accident report, they review the medical records related to the workers' compensation claim to gather the necessary information. Employer injury and illness records are unlikely to include the detail contained in medical documents, and can be expected to describe the injuries using commonplace terms rather than medical terminology.

The timing of the injury reports may offer yet another explanation for the differences in codes. Employers are required to record injuries on their OSHA logs (which provide the source data for SOII) within seven days of recordability. In Washington State, workers, with their healthcare providers, are entitled to file a workers' compensation claim within one year of injury and within two years of written notification of an occupational disease and the ability to file a claim. Descriptions of injuries may be modified over time as the injury is evaluated and diagnoses are refined so that the employer's

description of the injury or illness at the time the case is recorded on the OSHA log may differ from the description provided by the worker at the time of claim filing.

Compared to SOII estimates, studies utilizing other sources of occupational injury and illness data including medical, hospital, workers' compensation data, or data combined from multiple sources consistently identify more cases of select conditions including amputations (Anderson et al., 2010, Friedman et al., 2013), burns (Kica and Rosenman, 2012), and musculoskeletal disorders (Lipscomb et al., 2008b, Silverstein et al., 1998). While other factors may contribute to differences in case-capture (including different case definitions, inclusion of non-surveyed populations, and underreporting to SOII), some of the discrepancy between the SOII case estimate and the case ascertainment achieved using other data sources may be explained by discordant injury characterization. The degree of discordant injury classification can be determined only by matching complete data sources, prior to applying exclusion or selection criteria. The implication of not doing so is the possible erroneous conclusion of incomplete case-capture within individual data systems.

In this study, estimates of amputations and musculoskeletal disorders varied based on the source of the injury and illness classification. Workers' compensation classifications resulted in an estimated number of amputations that was nearly twice the number of cases estimated from SOII classifications, while approximately one-third more cases of musculoskeletal disorders were estimated from SOII injury classifications compared to workers' compensation injury classifications. The greater difference in the amputation estimate may be due to the restrictiveness of the surveillance definition that is limited to a single-group code. The musculoskeletal disorder case definition employed by CSTE is broader and encompasses multiple possible codes. For example, a case classified as Sprains, Strains, Tears in one data source and as a Back Pain in another source could be included in the estimate of cases of musculoskeletal disorders. Also, as a rare occurrence, each amputation reported constitutes a greater portion of the total number of amputation cases compared to the contribution of a single

musculoskeletal disorder case to the total number of cases of musculoskeletal disorders. Classification differences among rare events may have a substantial impact on case estimates compared to estimates of more common injuries and conditions.

There are several limitations to this study. Narrative descriptions of the injuries were not reviewed to assess the accuracy of the assigned codes. Thus, we are unable to know whether the assigned codes appropriately characterized the incident. Additionally, we were unable to assess the training provided to either group of coders to determine whether it might account for differences between SOII-assigned codes and workers' compensation-assigned codes. Another limitation is that the workers' compensation data for the study was limited to Washington State-funded claims data. Data from workers' compensation systems with different coding procedures, claim filing processes, and injury documentation may result in alternate findings. Coding agreement will likely be greater in systems with higher source dependence between SOII data and workers' compensation records, and less in systems with independent data sources.

Our record linking procedures may not have identified all true matches between SOII cases and workers' compensation claims, failing to link some true matches and, conversely, linking some false matches. False linkages would likely have dissimilar injury characteristics, artificially lowering coding agreement. True matches left unlinked because of dissimilar record-linkage variables may or may not have dissimilar injury characteristics. It is unknown whether omitting these true matches improves coding agreement.

Further studies comparing the description of the injury provided in SOII to the description reported on the workers' compensation incident report, as well as any available incident or medical documentation would be able to assess whether classification differences are attributable to inter-rater coding choices, injury development that occurred between employer recording and workers' compensation claim filing, or the individual perspectives of those providing the narratives.

The BLS adopted a new version of the injury and illness classification system, OIICS 2.0, followed shortly by version 2.01, beginning with 2011 SOII data (US Department of Labor, 2012b). One of the objectives of the major revision was to increase uniformity by clarifying coding rules (Northwood et al., 2012). This newer version of the classification system may ease the selection of codes among conditions more difficult to characterize using the old version, potentially improving the accuracy of SOII estimates and reducing some of the observed differences in injury classification by data source. Additional coder training focused on the appropriate use of nonspecific and multiple injury codes may further improve injury data.

Given the differences in injury and illness classifications, surveillance efforts that compare estimates of select conditions across data sources without matching cases undoubtedly will conclude that case numbers or estimates differ by data source. Injuries reported to a system, such as SOII or workers' compensation, but classified in a way that excludes them from meeting a particular surveillance definition can make a valuable contribution to surveillance data. A multifaceted approach that incorporates various aspects of the incident may improve case ascertainment; however it may do so at the expense of specificity.

V. EXPLORING THE RELATIONSHIP BETWEEN EMPLOYER RECORD-KEEPING AND UNDERREPORTING IN THE DEPARTMENT OF LABOR'S SURVEY OF OCCUPATIONAL INJURIES AND ILLNESSES[14]

A. Background

The US Department of Labor provides annual estimates of nonfatal occupational injuries and illnesses. The national and state estimates are based on approximately 230,000 employer reports of OSHA-recordable cases collected through the SOII (US Department of Labor, 2012a). According to the Labor Department, SOII is the nation's largest occupational injury and illness surveillance system.

Increasingly, evidence suggests that the SOII fails to accurately estimate the number of occupational injuries and illnesses through the annual survey of employers, although estimates of the SOII undercount vary widely (Boden and Ozonoff, 2008, Leigh et al., 2004, Oleinick and Zaidman, 2010, Rosenman et al., 2006). In response to the most recent concerns of unreported injuries and illnesses on employer OSHA logs and in the SOII, the federal government undertook efforts to better understand employer record-keeping. The US Government Accountability Office evaluated OSHA's audit procedures used to verify the workplace injury and illness data collected through ODI (US Government Accountability Office, 2009); OSHA initiated a national emphasis program for record-keeping (US Department of Labor, 2009); and the BLS undertook its own studies and also funded extramural research projects to examine the nature of the observed undercount (Ruser, 2010).

The BLS intramural studies identified the SOII methodology as a source of incomplete case-capture. Collecting employer reports of injuries and illnesses within a few months following the survey year hinders the reporting of certain cases, including illnesses with long latencies, injuries that worsen over time, those that are difficult to attribute to work, and injuries reported after the survey year (Nestoriak and Pierce, 2009, Ruser, 2008).

[14] Wuellner, S. E., and D. K. Bonauto. "Exploring the Relationship between Employer Recordkeeping and Underreporting in the BLS Survey of Occupational Injuries and Illnesses." *Am J Ind Med* 57, no. 10 (2014): 1133–43. doi: 10.1002/ajim.22350.

Employer record-keeping practices may be another source of SOII's incomplete case-capture. In this study, we explored the relationships between employers' incomplete case reporting in SOII and compliance with OSHA record-keeping requirements and company uses of injury and illness data.

B. Methods

We conducted semi-structured interviews with workplace injury and illness record-keepers from Washington State establishments that had participated in the 2008 SOII. To compare responses among establishments that reported to SOII all survey-eligible workers' compensation claims ("complete reporters") to those with unreported workers' compensation claims ("underreporters"), we matched 2008 BLS SOII data to Washington State workers' compensation claims data.

1. Data sources

The BLS administers the SOII in partnership with participating states to estimate the incidence of work-related injuries and illnesses (US Department of Labor, 2012a). The SOII includes both public- and private-sector employment except for federal employees, private household workers, farms with fewer than 11 employees, and the self-employed.

Each year, the BLS selects a sample of establishments to participate in the survey. Establishments are drawn from UI data, contacted prior to the survey year, and instructed to record all injuries and illnesses that occur during the survey year in accordance with OSHA record-keeping regulations.[15] After the survey year has ended, establishments are required to provide the BLS with three types of data: (1) general establishment information including the average number of employees

[15] All establishments selected for participation in the SOII are required to maintain OSHA injury and illness records for the duration of the survey year, including establishments partially exempt from OSHA record-keeping requirements based on industry or number of employees. The record-keeping requirements in Washington State, an OSHA state-plan state, are identical to the federal regulations except in the lists of industries partially exempt from the record-keeping requirements. Federal regulations exempt offices and clinics of healthcare providers and dentists and public educational services except elementary and secondary schools and public libraries from record-keeping requirements (unless required in writing to do so by OSHA or BLS). Washington State law requires these establishments to maintain occupational injury and illness records.

for the year; (2) summary OSHA injury and illness data like the total number of cases with days away from work; and (3) detailed case information on injuries and illnesses that occurred in the survey year and resulted in one or more calendar days of missed work beyond the day of injury. The case information provided for DAFW injuries includes worker identifiers that allow for linking to other data sources.

Washington State SOII data for the 2008 survey year were obtained through a cooperative agreement between the BLS and the Washington State DLI.

The DLI regulates workers' compensation insurance for all nonfederal employers operating in Washington State covered by the state's industrial insurance laws.[16] In addition, DLI administers the Washington State-fund workers' compensation insurance program, which is the sole workers' compensation insurance provider for all employers in the state except those covered by an alternate workers' compensation system (e.g., Longshore and Harbor Workers' Compensation Act, Federal Employees' Compensation Act) or those who self-insure.

When a worker is entitled to compensation under the Washington State Industrial Insurance laws, the worker files the application together with certification by the attending physician.[17] The claim is submitted to DLI who then informs the employer that a claim has been opened. The waiting period for wage replacement compensation is three calendar days following the day of injury; if the attending healthcare provider recommends work restrictions resulting in time-loss from work beyond the three-day waiting period, the claimant becomes eligible for wage replacement benefits.

[16] Revised Code of Washington. § 51.12.010 (1972).

[17] Claims for workplace injuries must be filed within one year of the date of injury; claims for occupational diseases must be filed within two years following the physician's written notification to the worker of the presence of an occupational disease and eligibility to file a claim for disability benefits.

2. **Record linkage**

All filed workers' compensation claims (rejected, medical aid only, and claims eligible for indemnity payments for lost wages) with an injury date between October 31, 2007 and March 1, 2009 were eligible for linking to SOII cases reported for the 2008 survey year. Although not all workers' compensation claims meet the SOII case-reporting criteria, no exclusions were made prior to linking to allow for possible differences in classification across the two systems. The SOII cases were linked to workers' compensation claims using worker name, sex, date of birth or age, date of injury, employer name, employer address, and a Washington State-assigned UBI that can be used to identify an employer across state data systems, including the UI and workers' compensation systems.

The SOII-sampled establishments were linked to workers' compensation businesses through the UBI, employer name and address, and, when available, a case-claim match. When the BLS-sampled employment was less than the employer's entire workforce, the unit description from the SOII data was evaluated against the business location and accident location listed for the claim to determine whether the claimant was included in the workforce sampled for the SOII.

Data linkage was performed using the probabilistic linking software LinkPlus (US Department of Health and Human Services, 2009). The program scores each potential pair to indicate the degree of similarity between the two records. Pairs with lower scores, reflecting a poorer match, were reviewed independently by two research staff to determine true links. Disagreements between the two researchers were settled by a third reviewer.

Having identified unlinked workers' compensation claims among SOII-sampled establishments, we further limited claims to include only those that most likely met the SOII case-reporting criteria—i.e., an OSHA DAFW case. The SOII case-reporting criteria were approximated from the type of indemnity payments awarded (used to indicate work absence) and the dates associated with the claim (used to indicate whether the initial work absence occurred during the survey period or after). Unmatched

workers' compensation claims eligible for time-loss payments or total permanent disability were considered SOII-eligible when the workers' compensation dates for injury, first medical treatment, claim establishment, disability, and initial benefit payment did not occur after the study period. Claims limited to payments for medical care, claims awarded benefits for loss of earning power (temporary partial disability), and rejected claims were assumed not to have met OSHA criteria as DAFW case. This assumption likely resulted in a conservative estimate of unlinked workers' compensation claims. Medical-aid claims include injuries that resulted in some missed work; however, we could not distinguish injuries with work absence less than the waiting period for wage-replacement benefits from those with no work absence. Among establishments instructed by BLS to report on a subsample of cases based on injury dates, unmatched claims with injury dates outside the requested timeframe were excluded from the group of claims considered SOII-eligible. An overview of the record-linkage process and identification of unreported workers' compensation claims is provided in Figure 2 (chapter III).

3. **Selection of interview participants**

Establishments were selected from the 2008 Washington State BLS SOII respondents and stratified by four characteristics to provide a diverse pool of record-keeping experiences: establishment size; industry; number of establishments operated by employer; and completeness of occupational injury and illness reporting. Based on the SOII data, establishments were classified as small (1–49 employees) or large (50 or more employees), fixed-site industries or non-fixed (nonpermanent worksite locations identified from four digit NAICS codes, primarily within construction and transportation), and the sole establishment operated by an employer or one of multiple establishments. The SOII-workers' compensation record-linkage results were used to classify establishments as complete reporters or underreporters. Although the record-linkage process identified both SOII cases not identified in workers' compensation and workers' compensation claims not reported in SOII, in this paper we focus on the reporting of workers' compensation claims and leave the unlinked SOII cases for a

later discussion since the reasons for unreported workers' compensation claims likely differ from the reasons for unreported SOII cases.

Our preference was to interview the individual listed as the 2008 SOII contact. When that individual was no longer employed by the firm, we interviewed the person currently responsible for injury record-keeping. Interviews were conducted by trained research staff at the respondent's place of business, lasted approximately one hour, and were recorded with the participant's consent. The semi-structured interviews covered a range of topics including: company injury and illness reporting process; compliance with the OSHA record-keeping regulations; and company uses of injury and illness data. All interviews took place between April 2011 and December 2011.

4. **Data analysis**

Two research staff independently coded responses to open-ended questions. When disagreements in codes occurred, responses were discussed until consensus was reached. Given the exploratory nature of the study, descriptive statistics were used to summarize the data and examine relationships between select establishment characteristics and incomplete injury and illness reporting. Associations between select categorical variables were assessed using Pearson's chi-square and Fisher's exact tests.

The research study was approved by the Washington State Institutional Review Board. The process of informed consent involved obtaining written consent from each study participant prior to conducting the interview. Participants were informed that their responses were confidential and would not be shared with the state OSHA program.

C. Results

We contacted 271 Washington State establishments that participated in the 2008 BLS SOII. Forty-seven percent (127 establishments) agreed to be interviewed, although 14 scheduled interviews

were cancelled by the establishment, resulting in 113 completed interviews. Compared with interviewed establishments, a greater portion of contacted establishments that did not participate were small, in the construction or retail trade industries, and, in the 2008 SOII, reported zero injuries or illnesses resulting in one or more day of missed work (Table VI). Three establishments were excluded from the analysis because someone other than the interviewee completed the OSHA record-keeping forms and the respondent was unable to speak to the establishment's OSHA record-keeping practices. Among the remaining 110 interviews, 80% of respondents had completed the 2008 SOII for the establishment.

More than half of the interviews were conducted among establishments with 50 or more employees, 60% were from fixed-site industries, and 50% were the sole unit operated by the employer. Sixty-eight establishments (62%) were classified as complete reporters and 42 establishments (38%) were considered underreporters.

1. **Worksite injury record-keeping practices**

The OSHA record-keeping forms were maintained in 97 of the 110 interviewed establishments. No OSHA records were maintained at thirteen establishments. Seven of the thirteen establishments that did not complete OSHA forms were partially exempt from OSHA record-keeping requirements, requiring them to complete OSHA record-keeping forms only during participation in the SOII; the other six establishments were required to maintain OSHA forms each year, regardless of BLS survey participation. These nonexempt establishments were among a range of industries including: manufacturing (2 establishments); transportation (1 establishment); construction (1 establishment); healthcare (1 establishment); and public administration (1 establishment). Five of the six establishments that lacked mandated OSHA records employed between 1 and 49 workers.

TABLE VI

SELECT CHARACTERISTICS OF WASHINGTON STATE ESTABLISHMENTS CONTACTED FOR INTERVIEW[a]

	Completed Interviews[b]		Refusals[c]	
	n	%	n	%
Total	113	100%	158	100%
Establishment size				
1–10 Employees	3	3%	26	16%
11–24 Employees	15	13%	29	18%
25–49 Employees	30	27%	35	22%
50–99 Employees	27	24%	34	22%
100–999 Employees	29	26%	32	20%
1,000+ Employees	9	8%	2	1%
Industry				
Manufacturing	27	24%	28	18%
Construction	16	14%	38	24%
Agriculture, Forestry, Fishing and Hunting	14	12%	11	7%
Transportation, Warehousing and Utilities	13	12%	12	8%
Healthcare and Social Assistance	10	9%	14	9%
Retail Trade	8	7%	18	11%
Wholesale Trade	6	5%	8	5%
Public Administration	5	4%	2	1%
Educational Services	3	3%	5	3%
Leisure and Hospitality	3	3%	5	3%
Admin & Support, Waste Management & Remediation Services	3	3%	4	3%
Other	5	4%	13	8%
Total number of DAFW[d] cases reported to SOII				
0 cases	19	17%	48	30%
1–2 cases	50	44%	66	42%
3 or more	44	39%	44	28%

[a]n=271.

[b]Includes three interviews among establishments where someone other than the interviewee completed the OSHA record-keeping forms. These three interviews are excluded from additional analysis.

[c]Includes 83 establishments that refused to participate, 14 scheduled interviews canceled by the establishment, and 61 establishments that never returned calls requesting to schedule an interview.

[d]DAFW: injuries resulting in one or more days away from work following the day of injury.

Respondents from the 97 establishments that maintained OSHA records did not fully understand what to record as a case, when to document a case, and how to classify it. Half of the establishments that maintained OSHA logs reported using the OSHA case definition to determine which cases to record on the log, while the other half of respondents extended inclusion to all workers' compensation claims, all workplace injuries and illnesses that result in a medical visit, or all injuries reported to the respondent regardless of severity. Forty-four establishments did not record cases on the log within the timeframe required by the record-keeping regulations and, instead, logged cases at some other time interval, such as the end of each year or upon receipt of workers' compensation paperwork or medical documentation. One in five respondents erroneously classified certain DAFW cases as DJTR cases due to a misunderstanding of the classification criteria. For cases resulting in both missed work and restricted work or job transfers, these respondents classified the case as the outcome (DAFW versus DJTR) with the greater number of days.

The responsibility of recording injuries among temporary workers was widely misunderstood. Fifty-three establishments utilized temporary help to augment their workforce and provided day-to-day supervision of the temporary workers. Among these 53 establishments that used temporary help, 19 respondents (36%) stated that injuries among temporary workers would be included on the establishment's OSHA 300 log as required by the record-keeping regulations, while nearly half of the respondents would not include the injuries, either because they were omitted from the establishment's logs (21 respondents, 40%) or because temporary workers were used by an establishment where OSHA forms were not completed (5 respondents, 9%). The remaining eight respondents did not know whether to record temporary worker injuries. Some stated they would rely on the advice of the temporary staffing agency.

One in ten respondents (n=11) complied with all four measured aspects of the OSHA record-keeping regulations: using the OSHA case criteria to determine eligibility for OSHA records; recording

cases with the required time limit; correctly assigning severity for DAFW and DJTR cases; and appropriately recording injuries among temporary workers.

2. **Completeness of case reporting**

Table VII presents OSHA injury and illness record-keeping practices by completeness of injury reporting in SOII compared with workers' compensation data. Similar portions of complete reporters and underreporters referred to the OSHA case criteria to determine which events to record on the log. The greatest difference between complete reporters and underreporters was found for the practice of logging all injuries and illnesses resulting in a visit to a healthcare provider, a case definition employed by 24% of complete reporters compared with 5% of incomplete reporters.

In a simple bivariate analysis of complete reporting by each of the four aspects of OSHA record-keeping in which values were grouped into one of two response options (follows regulation, does not follow regulation), no association with underreporting was found for following any individual aspect of the regulation including: uses the OSHA case criteria (χ^2=0.01, p=.91); records within seven days (χ^2=0.77, p=.38); correctly classifies severity (χ^2=0.92, p=.34); or records injuries among temporary workers (χ^2=0.77, p=.38).

Table VIII presents select business characteristics by complete reporting of workers' compensation claims in SOII. Compared with establishments that reported all workers' compensation claims in SOII, a greater portion of underreporters operated multiple shifts (71% of underreports compared with 43% of complete reporters, p<.01) or used injury and illness data as a measure of job performance for supervisors or injury and illness record-keepers (33% compared with 13%, p<.05). Underreporting of workers' compensation claims in SOII was more common among establishments instructed to provide detailed case information for a sample of DAFW cases compared with establishments expected to detail all DAFW cases. Among the seven establishments instructed to submit only cases that occurred within dates defined by BLS, all seven had unreported workers' compensation

claims that met the SOII subsampling criteria, whereas 40% of the 103 establishments instructed to report all cases had unreported workers' compensation claims ($p<.001$).

Directing injured employees to a healthcare provider selected by the employer was more common among complete reporters (48%) than underreporters (26%). No statistical difference between complete reporters and underreporters was found for the use of injury and illness data to award prizes in safety competitions or including injury and illness data in bids for contacts or subcontracts.

TABLE VII

OSHA RECORD-KEEPING PRACTICES AMONG INTERVIEWED ESTABLISHMENTS BY DIFFERENCES IN INJURY AND ILLNESS REPORTING[a]

	Total		Complete Reporters		Under-reporters	
Total	110	100%	68	100%	42	100%
What Respondent Records on OSHA Log						
Injuries meeting the OSHA case definition	49	45%	30	44%	19	45%
Injuries resulting in a workers' compensation claim	23	21%	12	18%	11	26%
Injuries resulting in medical visit	18	16%	16	24%	2	5%
Injuries reported to company regardless of severity	7	6%	3	4%	4	10%
Establishment does not keep OSHA logs	13	12%	7	10%	6	14%
When Respondent Records Cases on OSHA Log						
Within 7 days	53	48%	35	51%	18	43%
End of year	15	14%	11	16%	4	10%
Other time interval	11	10%	5	7%	6	14%
After receiving documents (e.g., workers' compensation or medical)	18	16%	10	15%	8	19%
Establishment does not keep OSHA logs	13	12%	7	10%	6	14%
How Respondent Classifies Cases On OSHA Log as DAFW[b], DJTR[c], Other						
Follows OSHA's definition of most severe	78	71%	46	68%	32	76%
Classifies as outcome with greatest total days	19	17%	15	22%	4	10%
Establishment does not keep OSHA logs	13	12%	7	10%	6	14%
Whether Respondent Records Temporary Worker Injuries On OSHA Log						
Yes, respondent records	19	17%	14	21%	5	12%
No, respondent does not record	21	19%	14	21%	7	17%
DK, respondent unsure whether they record	8	7%	3	4%	5	12%
Supervises temp workers, does not keep OSHA logs	5	5%	4	6%	1	2%
Does not host or supervise temps	57	52%	33	49%	24	57%

[a]n=110.

[b]DAFW: a case with one or more days away from work following the day of injury

[c]DJTR: a case with one or more days of restricted work or transfer to another job following the day of injury

TABLE VIII

SELECT ESTABLISHMENT CHARACTERISTICS AMONG INTERVIEWED ESTABLISHMENTS BY DIFFERENCES IN INJURY AND ILLNESS REPORTING

	Total		Complete Reporters		Under-reporters		P-value[a]
Total	110	100%	68	100%	42	100%	
Cases Requested by BLS							.001
All cases at sampled unit	103	94%	68	100%	35	83%	
Cases with BLS-specified injury dates	7	6%	0	0%	7	17%	
Total[b]	109	100%	67	100%	42	100%	
Work Shifts Operated by Establishment							.004
Multiple shifts	59	54%	29	43%	30	71%	
Single shift	50	46%	38	57%	12	29%	
Company Uses of Establishment Injury and Illness Data							
Used to measure supervisors' or respondent's job performance	23	21%	9	13%	14	33%	.013
Not used as measure of job performance	86	79%	58	87%	28	67%	
Used as metric in worker safety award program	22	20%	12	18%	10	24%	.455
Not used as metric in worker safety award program	87	80%	55	82%	32	76%	
Included in bids for contracts or subcontracts	24	22%	16	24%	8	19%	.786
Not included in bids, or does not bid for contracts, subcontracts	71	65%	42	63%	29	69%	
Participates in bids, did not know whether data was included	14	13%	9	13%	5	12%	
Choice of Healthcare Provider							.025
Employer chooses healthcare provider	43	39%	32	48%	11	26%	
Injured worker chooses healthcare provider	66	61%	35	52%	31	74%	
Unionization							.193
Unionized workforce	41	38%	22	33%	19	45%	
Workforce not unionized	68	62%	45	67%	23	55%	

[a]Tests are Fisher's exact test or Pearson’s chi-square test.

[b]One respondent was excluded from the analysis because he could not speak to certain business practices. He was not an employee of the company but rather the company's contracted Third-Party Administrator for workers' compensation account management, and provided injury and illness record-keeping services; including completing the SOII.

D. **Discussion**

The SOII requires survey participants to report information on injuries and illnesses in accordance with the OSHA record-keeping regulations. However, 90% of the SOII respondents we interviewed failed to comply with one or more of the required components through either a misunderstanding of or a disregard for the OSHA record-keeping regulations. This included 12% of interviewed establishments where no OSHA injury and illness records were maintained. Noncompliance with OSHA record-keeping regulations extended to: (1) the criteria used to determine which incidents were recorded on the OSHA 300 logs; (2) the scope of the workforce covered by the establishment's records; (3) when incidents were documented on OSHA forms; and (4) how to classify the incident in terms of severity. While earlier research also found a failure of companies, especially smaller companies, to maintain OSHA records (Seligman et al., 1988) and identified misconceptions among company managers and health and safety personnel regarding the criteria used to determine which cases to record on the OSHA log (Pransky et al., 1999), this is the first study we know that assessed injury and illness record-keeping compliance for the current OSHA record-keeping regulations, implemented in 2002.

Many of the observed record-keeping practices that did not comply with the OSHA regulations were connected to workers' compensation administrative practices; OSHA-recordable cases were equated with workers' compensation claims, and often OSHA forms were not completed until workers' compensation paperwork was received or until a claim ruling had been made. Although there is some overlap between OSHA-recordable cases and workers' compensation claims, each system has distinct independent eligibility criteria. Despite the BLS's attempt to standardize national injury estimates and decouple the data from workers' compensation by replacing the workers' compensation-based Supplementary Data System with the current SOII (Abraham et al., 1996), in Washington State the relationship persists. When respondents equate SOII cases with workers' compensation claims, SOII

estimates of injuries and illnesses become a reflection of the state-based workers' compensation system rather than a standard definition employed nation-wide. Waiting periods for wage-replacement eligibility, restrictions related to coverage of conditions, choice of healthcare provider, and benefit adequacy are among the variable aspects of state-specific workers' compensation systems that may impact a worker's decision to file a claim (Azaroff et al., 2002). It is these characteristics that may explain some portion of the differences in state-specific estimates of occupational injuries and illnesses published by the BLS rather than true differences in injury rates (Boden and Ozonoff, 2008, Boden and Ruser, 2003, Mendeloff and Burns, 2013). The degree of dependence between SOII and workers' compensation data may vary by state, further complicating the comparability of the SOII estimates across states.

This dependence between OSHA cases and workers' compensation claims was most evident in the practice of recording injuries among temporary workers. The host or client employers frequently expressed the erroneous belief that the responsibility for recording injuries among temporary workers was aligned with the liability for the workers' compensation claim and would thus fall to the temporary staffing agency. Phipps and Moore (2010), in interviews conducted with Washington, DC, metropolitan-area SOII respondents, found strikingly similar results for recording temp worker injuries, despite interviewing a more knowledgeable group of respondents. Our interviews suggest that injuries among temporary workers are not captured in the national surveillance system since many respondents believe the temporary agency to be responsible for logging the incident on the forms used in data collection. Confusion surrounding the responsibility to record injuries among temporary workers may have substantial impact on the accuracy of employer-reported injuries and illnesses, especially as temporary help services continue to provide an attractive alternative to hiring permanent employees (Luo et al., 2010).

For many employers in Washington State, the workers' compensation claims data are a readily available source of injury and illness data and medical care information, accessible online through the Workers' Compensation Claim and Account Center. Yet, equating OSHA-log recording criteria with workers' compensation claim status did not result in complete reporting of all SOII-eligible workers' compensation claims. The workers' compensation data system requires some amount of effort to isolate all claims for a given time frame, and complete case ascertainment within the system may require more resources than those dedicated by respondents who reported using workers' compensation claims data for reports of workplace injuries and illnesses. Additionally, some respondents may have claimed to use workers' compensation data because interviewers were employees of the same state agency that operates the workers' compensation insurance program. Stated reliance on workers' compensation data may be an indication of absent or disorganized record-keeping, suggesting that respondents who lack an injury tracking system may instead gather whatever injury data are available when completing the SOII.

Of the business characteristics examined for a possible association with injury reporting, those related to communication appeared to be integral to reporting, namely communication between the injured worker and the establishment record-keeper, between the record-keeper and the healthcare provider, and between the record-keeper and the BLS data collection staff. For instance, multiple work shifts present a barrier to communication between the injured worker and the record-keeper. Internal injury-reporting systems may not be adequate for capturing incidents that occur outside the hours worked by the primary record-keeper, leading to discrepancies between SOII case reports and workers' compensation claims among establishments that operate multiple shifts. This is a nontrivial finding given the association between non-day shift work and increased risk of occupational injury (Mustard et al., 2013, Dembe et al., 2006). Healthcare providers provide many of the data elements captured in injury recording systems. Directing injured employers to a specific healthcare provider may help facilitate communication between the record-keeper and the healthcare provider regarding treatment provided,

estimated return-to-work dates, and opportunities for job modifications. This relationship between the healthcare provider and the establishment is then reflected in enhanced establishment record-keeping. Limited communication between the BLS data collection staff and survey respondents can also pose problems; all seven of the interviewed establishments instructed by BLS to report on cases occurring within a specified timeframe (to limit the response burden to approximately fifteen cases) were found to have unreported workers' compensation claims with BLS-requested injury dates. While some discrepancies in case reporting may be due to differences in the classification of injury dates between the employer and workers' compensation, in most cases a difference of a few days would not be sufficient to exclude the case from the eligible time frame. Instead, respondents appear not to follow the instructions provided by BLS defining the subsample of injuries to be reported.

Of the three uses of company injury and illness data we explored that are widely believed to incentivize underreporting (Pransky et al., 1999, US Government Accountability Office, 2012), workers' compensation claims not reported in SOII were found more often among establishments using injury and illness data as a measure of the respondent's job performance. This practice directly impacts respondents, rewarding the record-keeper for low injury rates and giving unfavorable performance reviews when rates are high. In response to this practice, individuals who control the company's injury data exercise discretion when deciding which cases to report and to make record-keeping decisions independent of workers' compensation claims data.

It is important to note that other practices, including the use of injury and illness data in workplace safety awards programs, may also discourage reporting, but an effect would not be seen when measured against workers' compensation claims data. Whereas rewarding record-keepers for low injury rates may have little impact on a worker's decision to file a workers' compensation claim, directly rewarding workers for low injury rates (through safety incentive programs) may be an effective method of dissuading a worker from reporting the injury to the employer and as well as from filing a workers'

compensation claim. Because we evaluated the completeness of the SOII data against the workers' compensation claims data, we would not identify incomplete reporting among establishments that sponsor such practices.

While we found evidence of underreporting, there were also examples of overreporting—i.e., reporting injuries and illnesses that did not meet the OSHA case criteria. Certain record-keeping practices such as recording all injuries and illnesses that result in a medical visit regardless of whether the services provided meet the OSHA definition of medical treatment and recording all injuries captured by the company's injury reporting system regardless of severity likely result in the recording of more cases than required. Because this practice was not observed in all establishments, it presents another challenge to comparing SOII data across establishments, artificially inflating the rate of injuries and illnesses among establishments who overreport, likely because they have no business incentive to minimize the number of cases reported, compared to establishments engaged in such activities.

Additional employer characteristics may be associated with underreporting but were masked by the selection criteria used to recruit interviewees. It is outside the scope of this study to assess the relationship between incomplete reporting and industry, employer size, or number of worksites, which would require a representative sample of SOII-eligible Washington State establishments. Also, a larger sample would allow for multivariate analyses. The bivariate analyses presented here, while contributing to our understanding of employer injury and illness record-keeping, do not address potential correlation among variables. For example, companies that operate multiple shifts may also tend to have a sufficient number of injuries to be asked by the BLS to report a subsample of injuries based on the date of injury. Including these factors in a multivariate model would explore the effect of each, independent of the other. The bivariate statistics suggest topics to explore in future studies.

There are several possible approaches to the classification of reporting completeness. Based on our SOII case-workers' compensation claim record linkage, most establishments with incomplete

reporting were found to underreport by one claim. We therefore chose to define underreporters as any establishment with at least one unreported workers' compensation claim. Another approach would be to look at degrees of underreporting, separating those with minimal underreporting from those with more substantial underreporting. This could be achieved by evaluating unreported cases as a portion of total cases, or by using the distribution of unreported claims among groups of similar establishments to create categories of reporting completeness (e.g., above or below the median number of unreported claims within each size and industry grouping). This would highlight the practices of the worst reporters, but possibly obscure the practices that differentiate the complete reporters from the majority of underreporters with few missed cases.

There are several limitations to this study. First, findings may have been affected by recall and self-reported data. The OSHA logs completed by the establishment were not reviewed during the course of the interview and respondents may have answered with what they considered to be socially desirable responses, since violations of the standards discussed during the interview are punishable under the law. Respondents in establishments that had not experienced an injury or illness in years had difficultly answering procedure-related questions. Also, respondents were asked to discuss typical injury and illness reporting practices, although it may be the atypical scenarios that explain a portion of the discrepancy between the SOII and workers' compensation data.

Second, completeness of injury reporting was assessed using only SOII and workers' compensation data, two data sources likely correlated—meaning, if a case was reported in SOII, it is probable that a workers' compensation claim was also filed. Another data source for occupational injuries, such as a worker survey, would have presented an opportunity to reconsider our classification of establishments as complete reporters and underreporters. However, reasons for data discrepancies between SOII data and workers' compensation claims data may differ from reasons for data discrepancies when compared with a third data source. Another constraint of linked SOII and workers'

compensation data is the inability to verify SOII reports of injuries among temporary workers. Although we can identify claims among temp workers within the workers' compensation data, we cannot determine whether the injury occurred while on assignment at an establishment participating in the SOII, nor can we determine whether the establishment provided supervision of the temporary help work and thus, whether the injury was eligible for inclusion on the client company's OSHA 300 log.

Third, the generalizability of our findings is limited. Because state-specific workers' compensation insurance regulations and administrative practices potentially impact record-keeping, our results may not hold in other states. Also, the findings should be viewed cautiously given the study response rate of 42%. The record-keeping practices of establishments that did not agree to participate may be sufficiently different from participants to alter the observed relationships. This is of particular concern since the characteristics of participants differed from nonparticipants; smaller establishments and the construction industry were less likely to participate than others. These establishments may have deficient record-keeping practices or actively discourage injury reporting and were reluctant to participate because of anticipated disapproval of their practices. It is reasonable to expect someone aware of their substandard or dubious practices to refuse to participate in a voluntary study; we did, however, interview many who were unaware of their noncompliance.

This study identified several employer misconceptions and noncompliant practices related to the OSHA record-keeping requirements. Many of the record-keeping practices discussed suggest a limited comparability of BLS data across employers, industries, or states. While some establishments report cases in accordance with the OSHA record-keeping regulations, others report cases gleaned from workers' compensation data. To improve compliance with the regulations, OSHA should increase outreach and improve the training they provide, especially regarding injuries among temporary workers. However, education may not be sufficient with no requirement to participate in record-keeping training. Revised OSHA forms or instructions that accompany the forms to clarify the requirements are another

option, and would reach a wider audience than education efforts alone. The BLS could echo such efforts, emphasizing in their survey instructions the responsibility to record injuries among temporary workers and augmenting the survey forms to ease the reporting of these incidents.

Beyond maintaining logs in compliance with the regulations, complete and accurate SOII data are dependent on the transfer of information between many parties: injured worker, establishment record-keeper, healthcare provider, and BLS data-collection staff. A barrier or breakdown in communication between any two parties can lead to unreported cases. The BLS can work to improve communication with SOII respondents, but other aspects of employer record-keeping must be addressed at the level of the individual establishment.

Finally, participation in the SOII is likely inconsequential for many respondents. By design, the average time required to complete the SOII is estimated to be 24 minutes, and there are no penalties for inaccurate responses. This motivates some respondents to complete the survey with whatever data are convenient rather than reviewing the year's incidents to determine eligibility. Without providing employers a reason for becoming more fully engaged in the data collection process, modifications to data collection forms and procedures may be limited to a marginal impact on data quality.

VI. UNDERREPORTING OF WORKERS' COMPENSATION CLAIMS TO THE DEPARTMENT OF LABOR'S SURVEY OF OCCUPATIONAL INJURIES AND ILLNESSES: ESTABLISHMENT FACTORS

A. Background

With the passage of the Occupational Safety and Health Act in 1970, the Department of Labor was charged with "[compiling] accurate statistics on work injuries and illnesses."[18] The BLS's annual SOII is central to the Labor Department's approach to fulfilling that requirement, producing annual estimates of nonfatal work-related injuries and illnesses based on data submitted by employers. Studies have sought to assess the accuracy of the SOII data almost from its inception (Eisenberg and McDonald, 1988, Seligman et al., 1988), and nearly all have concluded that the survey underestimates the true burden of work-related injuries and illnesses (Smith et al., 2005, Leigh et al., 2004, Rosenman et al., 2006, Boden and Ozonoff, 2008).

While consensus grows regarding underreporting to SOII, there is less agreement on the magnitude of underreporting. To measure underreporting, SOII data have often been compared to workers' compensation claims data, a source of detailed case-level information on injuries and illnesses for a population that largely overlaps the workforce covered by SOII. In studies linking SOII cases to various states' workers' compensation claims data, SOII was found to miss 25%–78% of injuries and illness reported in workers' compensation (Rosenman et al., 2006, Boden and Ozonoff, 2008). The SOII performed more favorably when the number of injuries estimated by SOII was compared to the number workers' compensation claims identified as SOII-eligible; using this approach, the underreporting of workers' compensation claims was estimated at 3%–16% (Oleinick and Zaidman, 2004, 2010). One challenge to comparing SOII and workers' compensation data is that the representation of business units often differs across data systems. The SOII may sample an entire firm, consisting of one or more establishments, or a single establishment within a firm, whereas workers' compensation claim data are often organized by firm with no further delineation of establishments. The lack of establishment

[18] Occupational Safety and Health Act of 1970, 29 U.S.C. § 673 (1970).

Information in workers' compensation data makes it difficult to identify the workers' compensation claims attributable to the SOII-sampled location, possibly overestimating the number of claims considered reportable to SOII.

Underreporting has been found to vary by establishment characteristics. Several studies suggest that underreporting is greater for injuries among smaller establishments (Oleinick et al., 1995, Glazner et al., 1998, Dong et al., 2011, Morse et al., 2004), and varies by industry (Rosenman et al., 2006). Research also suggests that injuries among multi-establishment firms are more likely to be missed than injuries among single-establishment firms (Nestoriak and Pierce, 2009, Boden, 2014). What is currently unknown is the relationship between underreporting and these characteristics when examined in a multivariable analysis.

We attempted to address gaps in the existing SOII underreporting literature through two study objectives. First, we sought to estimate the magnitude of unreported workers' compensation claims from one state using an enhanced method to reconcile business structures across data sources. The method relies on inclusion of the state UI data to recreate the BLS SOII establishment sample and identify workers employed at sampled establishments. Identifiers obtained from the UI data for both the sampled establishment and worker (e.g., SSN) enhance the accuracy of the matching between the SOII and workers' compensation data. Second, we evaluated differences in reporting by establishment characteristics using multivariable regression analysis to assess the association between unreported workers' compensation claims and several establishment characteristics simultaneously. Understanding more about the characteristics associated with underreporting may help identify approaches for improving the accuracy of occupational injury and illness surveillance data.

B. **Methods**

The purpose of this study was to identify workers' compensation claims eligible for inclusion within the BLS SOII and the degree to which the BLS SOII microdata includes these claims. This is called

the “SOII capture rate.” Additionally, the study identifies BLS SOII DAFW cases eligible for inclusion into the Washington State workers’ compensation system and the degree to which the Washington State workers’ compensation data includes these cases. This is called the “Washington State workers’ compensation capture rate.” For survey years 2003–2011, we assessed for variations in the BLS SOII capture rate and the Washington State workers’ compensation capture rate by establishment size, and industry, as well as by record-keeping exemption status, workers’ compensation insurer, and sampled workforce.

1. **Data Sources**

a. **Washington State workers’ compensation data**

1) **Overview**

Washington State mandates workers’ compensation insurance for all employers in Washington State except those covered by federal workers’ compensation programs (e.g., Harbor and Longshore worker, Federal workers—Office of Workers Compensation Programs) or specifically exempt from requirements for mandatory insurance (e.g., self-employed, family member younger than 18 working on family farms, and other specific occupations or employment arrangements). Exclusions from coverage are defined in Washington State statute.

Washington State employers are required to purchase workers’ compensation insurance from the Washington State Fund unless they are able to self-insure. Companies must meet specific requirements for self-insurance and the Self Insurance program has significant oversight and reporting requirements to the Washington State DLI. The Washington State Fund is administered by DLI.

Of the approximately 160,000 employer workers’ compensation accounts state-wide, more than 99% are insured through the State Fund covering approximately 70% of employed workers in Washington State. The remaining workers’ compensation accounts (approximately 400) are self-insured and typically represent the state’s largest employers.

2) **Employer data**

Each employer in Washington State is required to have a workers' compensation policy. The workers' compensation policy may be composed of one or many accounts. Each account may have one or multiple business locations. A workers' compensation policy, account, and business location each has an assigned address within the workers' compensation system. Workers' compensation accounts are associated with the employer's UBI. The UBI is a Washington State-specific employer identifier that links an employer across Washington State government administrative databases (e.g., Washington State Department of Labor and Industries and Washington State Employment Security Department). The UBI does not correlate to a specific level of the business hierarchy within the workers' compensation system. In general, a workers' compensation policy consists of one or more UBI, which consists of one or more workers' compensation accounts. In some cases, however, multiple UBI may relate to a single workers' compensation account. The most common organizational structure with the Washington State workers' compensation system is a policy with a single account, a single business location, and a single UBI.

3) **Worker's compensation claims data**

A workers' compensation claim is initiated in Washington State by an injured or ill worker seeking medical care from a healthcare provider. The injured worker and healthcare provider complete a report-of-accident form that is sent to either the state fund or the self-insured employer or the self-insured employer's third-party administrator. The statute of limitations for filing a workers' compensation claim for an occupational injury is one year after the injury. For an occupational disease the statute of limitations is two years after the written notification from a healthcare provider for eligibility to file a claim. The employer is always notified by DLI of a workers' compensation claim.

For state-funded claims, the claim is initiated on the ROA, which includes worker identifiers (name, SSN, date of birth, gender), employer name, and details about the incident (the injured worker's

description of the occupational injury or illness, whether the injury occurred on the employer premises, and the injury location and address). A unique claim-identification number is assigned to each filed ROA.

Workers' compensation claims are accepted and rejected as work-related by trained claims managers in accordance with Washington State statutes, rules, and case law. Medical treatment, wage-replacement benefits, and all other billed services are linked to the claim-identification number and recorded in DLI databases. Washington State's waiting period for wage-replacement eligibility is three calendar days after the date of injury. The date of injury is not counted toward any part of the waiting period for wage-replacement eligibility. Each compensable state-funded claim has a date of injury, a date of first medical treatment for the work injury or illness, an establishment date when DLI received the claim, a disability date when the claimant was first unable to perform the job of injury, and the date when the department made the first payment for wage replacement.

For the Self-Insured claims, data for all claims are available within the DLI workers' compensation databases. The same worker identifiers recorded for state-funded claims are available for self-insured claims, as are employer name and location data. Supplemental injury location data are not available for self-insured claims. Each self-insured claim has a date of injury and the date DLI received notification of the claim. Notification requirements differ by benefits paid. For wage-replacement claims, the self-insurer must notify DLI within five business days of the first indemnity payment; for medical-aid only claims, DLI must be notified by the end of the month following claim closure.

b. **Unemployment insurance data**

The UI data serves as the SOII sampling frame, in the form of the Quarterly Census of Employment and Wages (Selby et al., 2008). An employer is assigned a UI account, which may be divided into multiple individual locations, denoted by unique report-unit numbers and described by an establishment address. The UI account identifies employees by SSN and worker name (employees are not linked directly to report units). In Washington State, the UI data and DLI data are linked by UBI

number. Additionally, workers can be linked across systems using SSN. The UI data were made available through a data-sharing agreement with the Washington State Employment Security Department, the state agency responsible for maintaining UI data.

c. **Survey of Occupational Injuries and Illnesses data**

The BLS provided four Washington State SOII datasets each year for the survey years 2003–2011: final case file, unusable case file, final establishment file.[19] The final case files contain data on individual injuries and illnesses as well as demographic characteristics used for published estimates. The unusable case files consist of cases reported in the SOII but not included in final estimates.[20] Final establishment files contain establishment data that contribute to the final published estimates.

The SOII establishment data include: the employer name, address, zip code, UI account number, and reporting-unit number. Also included are the OSHA-recordable injury and illness summary data submitted by the sampled employer. The SOII case data are collected for OSHA DAFW cases and include the worker's name, gender, date of injury, date of birth or age at injury, and codes for nature of injury or illness, body part, source, and event. The DAFW cases are those with at least one day away from work not including the day of injury and are counted based on the number of calendar days of missed work.

Sampled establishments were grouped into one of two categories based on the report-unit number. Unit numbers of "00000" and a unit description of "All Washington State Employees," indicating an entire UI account, comprised one group (single-site firms and multi-site firms where all sites are sampled) while all other establishments were grouped into the second category: sampled

[19] An unusable establishment file was also provided by BLS but was not used in the record linkage.
[20] Reasons for assigning a reported case to the unusable case file include: a duplicate case, an unusual case that was unable to be verified by survey staff, a case with no days away from work reported, or one that fell outside of the BLS sub-sampling timeframe.

establishments representing a sub-account within a UI account—i.e. one location within a multi-site firm.

2. **Record linkage**

The BLS sampled establishments from the state UI data for participation in the SOII. We used the Washington State UI data to recreate the BLS SOII sample and determine establishments covered under the state's worker compensation system.

a. **Establishment exclusion criteria**

The data were restricted to establishments sampled from the UI data and industries whose entire workforce is covered by the Washington State workers' compensation system. Injury and illness data for mining and railroads are not gathered through the annual survey of establishments but rather sent to BLS by the Mine Safety and Health and Federal Railroad Administrations. These 3,217 establishments (7%) are not sampled from UI and their UI account information is not recorded in SOII data. The maritime workforce is not covered by state workers' compensation systems and instead provided workers' compensation benefits through the Longshore and Harbor Workers' Compensation program or must make a legal claim through the Jones Act. Establishments operated by sovereign Native American tribes and located on tribal reservations are not required to participate in Washington State's Industrial Insurance system. Industry classifications, available in UI as both SIC codes and NAICS codes were used to identify the water transportation, ship and boat building, seafood product preparation and packaging, and fishing establishments that have workers' compensation covered through the Longshore and Harbor Workers Compensation Act or where workers who must make a legal claim under the Jones Act. The ownership code in UI was used to identify establishments owned by tribes. These exclusions applied to 2% of establishments (n=892).

Additionally, of the 44,634 establishments that participated in the 2003–2011 SOII, 27 were excluded from the linkage attempt because the SOII-provided UI account information could not be found within the state UI data.

b. **Establishment linkage**

Using the UI account and reporting-unit numbers provided in the SOII establishment file, BLS-sampled establishments were identified within Washington State's UI data from the quarter when the sample was drawn; specifically, seven quarters prior to the beginning of the survey year. The sampled establishments were mapped through successive quarters within the UI data to identify changes in ownership, physical location, or a break in liability (e.g., a quarter in which there was no employment reported) that might impact the identification in workers' compensation of the employer during the survey period.

Next, we identified workers employed by SOII respondents during the survey year using the UI account information current at the time of the survey. Worker identifiers, including SSN, for individuals reported in at least one of the four quarters of the survey year among SOII-participating UI accounts were extracted from the Washington State UI database. When a SOII establishment represented a report unit rather than the entire UI account, the workforce identified from the UI account data was greater than the workforce sampled since worker identifiers are reported at the UI account level. Establishment characteristics were used later in the record-linkage process to limit workers to those likely employed at the sampled reporting unit. A discussion of this process occurs below; see "Identification of workers' compensation claims that meet SOII case criteria." Figure 3 provides an overview of the claim-identification process where the sampled establishment represented an entire UI account; Figure 4 provides an overview of the process where the sampled establishment was a report unit within the UI account (chapter III).

Using the UI-reported SSN for employees among SOII-participating UI accounts, we extracted workers' compensation claims among the sampled workforce with an injury date in the survey year in which the establishment participated. For linking to SOII cases, all workers' compensation claims were extracted regardless of claim liability status and included rejected claims, claims for medical-treatment only, and indemnity claims. To allow for differences between SOII and workers' compensation in the characterization of missed work, no restrictions were made to the workers' compensation claim population prior to linking. This approach identified more claims than are likely eligible for reporting in SOII (similar to extracting all claims for an entire UI account when SOII participation was limited to a reporting unit). Record-level exclusions were applied after the linkage process was complete.

c. **Injury record linkage**

Research staff developed SAS code to deterministically link records through an iterative process, altering the linking criteria of one or more variables in each successive attempt. The SOII cases were linked to workers' compensation claims based on the following data elements: worker first name, last name, date of birth or age at injury, and date of injury. Extracting only claims among workers reported in UI by sampled employers established the claimant's relationship to the employer. First and last names were allowed to match identically or phonetically; on later attempts, first name was also allowed to match on first initial or not at all. Over the course of the multiple record-linkage attempts, the matching requirement for date of birth was broadened iteratively from exact match between SOII and workers' compensation to within 7 days, 31 days, 65 days, 365 days, 3,660 days, and finally 7,220 days. For cases where date of birth was not provided, the age at injury was allowed to vary from exact, to within 1 year, then within 10 years. After each iteration, potential links were manually reviewed by research staff to confirm that the new criteria identified true matches.

Linking iterations followed a hierarchy so that links to the more relevant claims preceded other attempts. Links to claims with wage replacement were attempted prior to links among medical-only

claims, with all other variables being equal. Linkages were first attempted among the SOII cases in the final cases file and then followed by an attempt to link cases in the unusable case file. Once linked, both cases and claims were removed from the group of records available for subsequent linkage attempts. Two-thirds of linked records matched identically or phonetically on first and last names, and identical injury dates and birthdates or ages. Eighty percent matched phonetically on last name, first name or first initial, and had injury dates and birthdates that differed across data sources by no more than seven days.

Record-linkage procedures resulted in three groups of records: linked SOII-workers' compensation cases, unlinked SOII cases, and unlinked workers' compensation claims. As noted above, more workers' compensation claims were extracted than were expected to meet the SOII case reporting criteria because they were either: (1) employed by the sampled employer at some location other than the sampled reporting unit, or (2) filed for an injury that did not result in missed work (e.g., rejected claims). This necessitated reducing claims to those eligible for SOII as a DAFW case.

d. **Identification of linked and unlinked records eligible for both data systems**

For sampled establishments that represented the entirety of a UI account, all claims identified through an employee's SSN were retained since these workers were reported in UI data as employed within the sampled UI account. When the sampled establishment represented one of many reporting units within a UI account, we ascertained the claim's association with the sampled establishments through the UBI and address data—when the UBI or address of the workers' compensation business location associated with the unlinked workers' compensation claim differed from the UBI or address of the sampled reporting unit or from the reporting unit associated with the majority of linked SOII-workers' compensation cases, the unlinked claim was considered to be associated with a reporting unit other than the sampled unit. These claims were excluded from the group of unlinked claims and considered not reportable to SOII.

To evaluate SOII capture of workers' compensation claims, we used workers' compensation indemnity-payment information to identify claims for injuries that resulted in one or more days of missed work (thus meeting the SOII DAFW case criteria). State Fund claims that received payments for missed work, or self-insured claims classified as eligible for time-loss payments were considered to have met the missed-work criterion to be recordable as a DAFW case. Among these claims, we used claim-event dates to indicate whether the missed work occurred within the survey year. When the workers' compensation date for first medical treatment, claim establishment, disability, or initial time-loss payment occurred after the survey year, records (both linked and unlinked workers' compensation claims) were excluded from further analyses. Although these injuries occurred during the survey year and eventually resulted in missed work, the claim data suggested the missed work did not occur until after the survey year concluded, and thus would not have been recordable as a DAFW case during the survey year. To evaluate workers' compensation capture of SOII cases, all SOII cases (among establishments eligible for Washington State workers' compensation coverage), linked and unlinked, were retained since a DAFW injury is likely eligible for workers' compensation—for medical-aid benefits if not wage replacement.

For establishments asked to report on a subsample of cases based on the injury date (e.g., injuries that occurred in the first three months of the year, or injuries that occurred on the 15th day of the month), any unlinked claim with an injury date outside the subsample timeframe was removed from the group of unlinked claims.

All records in the BLS unusable case file—both linked and unlinked—were excluded from analyses. Linking claims to cases reported in the unusable file identified claims that may otherwise have been considered unlinked or unreported in SOII in previous research. Between 2003 and 2011, there were 1,429 unusable DAFW cases linked to a workers' compensation claim.

Linkage procedures allowed for an unlinked workers' compensation claim to be associated with more than one sampled establishment. This occurred when a claimant worked for an employer with a UI account with multiple-sampled reporting units and few differences among the units' physical-location data. When available, the injury-location data in the workers' compensation claim data were used to link the claim to the appropriate reporting unit. If the workers' compensation city of injury was a location other than the physical location city of the sampled report unit, the claim was considered outside the scope of the sampled workforce and excluded from the analysis. In some cases, the data available were insufficient to assign a claim to a single reporting unit. Unlinked self-insured claims were more likely to be associated with multiple-sampled reporting units than state-funded claims (18% of unlinked self-insured claims compared to 1% of unlinked state-funded claims). Claims with multiple associations were randomly assigned to one of the associated reporting units. Random assignment did not alter the distribution of unlinked claims by industry or establishment size.

3. **Data analysis**

Reporting was assessed by workers' compensation insurer (state fund versus self-insured), sampled workforce (UI account versus sub-account), DAFW cases requested by BLS (all versus subset based on injury date), workplace injury record-keeping exemption status, establishment size and industry. The SOII size grouping was used to classify establishment size. The SOII NAICS codes combined with the ownership code (private industry, state government, local government) were used to classify industry. The UI-based SIC codes and BLS size data were used to identify establishments exempt from annual record-keeping based on Washington State regulations.[21]

[21] For the survey years included in the study, the record-keeping requirements in Washington State, an OSHA state-plan state, were identical to the federal OSHA regulations except that state law requires offices and clinics of healthcare providers and dentists and public educational services (except elementary and secondary schools and public libraries) to maintained annual injury and illness records. These establishments were partially exempt from federal record-keeping requirements. All establishments selected for SOII participation are required to maintain OSHA injury and illness records for the duration of the survey year, including establishments partially exempt from OSHA record-keeping requirements.

The SOII and workers' compensation capture rates by individual establishment characteristics are presented for observed case totals and weighted estimates to account for disproportionate sampling and nonresponse in SOII. Linked claims were assigned the weight of the corresponding SOII case and unlinked claims were assigned the weight associated with the establishment determined to be responsible for reporting the claim.

Unreported workers' compensation claims, defined as unlinked claims, were a common occurrence (approximately 30%) and binomial log-link regression models were used to estimate the prevalence ratios of unreported claims (Spiegelman and Hertzmark, 2005). Reference groups were selected as the group with both a large sample size and high percent of claims reported in SOII. All establishment characteristics were included in the multivariable regression model, which was adjusted for survey year and nature of injury or illness. The joint effect of size and industry on unreported claims was assessed as described by Knol and VanderWeele (Knol and VanderWeele, 2012). Regression models were limited to state-funded claims because of the granularity of workers' compensation data available compared to self-insured claims. Because the regression analysis focused on a subset of the population, the regression models did not include survey weights but did include variables related to the SOII-sampling design including ownership, establishment size, and industry (Korn and Graubard, 1991). Analyses were conducted using SAS 9.3. The Washington State Institutional Review Board reviewed and approved the study.

C. **Results**

1. **Workers' compensation capture of employer-reported injuries**

There were 72,087 DAFW cases among the 40,498 SOII establishments included in the record-linkage procedures. Ninety-six percent of SOII cases linked to a workers' compensation claim (i.e., workers' compensation captured 96% of SOII cases). Table IX shows SOII case totals and the

percent reported in workers' compensation by establishment characteristics. There were few differences in the workers' compensation capture of SOII cases by establishment characteristic; for most characteristics, workers' compensation captured 96% of SOII cases after weighting.

Workers' compensation capture increased slightly with establishment size. The largest differences were observed within industry, where, after weighting, workers' compensation-capture ranged from 93% of SOII cases in Information and financial activities and professional and business services to 97% in retail trade.

TABLE IX

TOTAL SOII CASES[a] AND THE PERCENT REPORTED IN WORKERS' COMPENSATION BY ESTABLISHMENT CHARACTERISTICS, 2003–2011

	Unweighted Case Counts		Weighted Estimate	
	Total SOII Cases	Percent of SOII Cases Reported in WC	Total SOII Cases	Percent of SOII Cases Reported in WC
All	72,087	96%	372,311	96%
Sampled Workforce				
UI Account	45,146	96%	252,848	95%
Sub-account	26,941	97%	252,849	96%
Establishment Size				
1–10 Employees	793	95%	41,814	96%
11–49 Employees	6,185	95%	89,757	95%
50–249 Employees	26,654	96%	123,175	95%
250–999 Employees	21,857	96%	57,117	96%
1000 or More Employees	16,598	97%	60,448	98%
Industry				
Private Sector				
Agriculture, Forestry, Fishing, Hunting	3,680	96%	16,743	96%
Transportation, Warehousing, Utilities	5,118	96%	25,329	96%
Construction	5,244	95%	42,398	96%
Manufacturing	13,033	96%	46,112	96%
Wholesale Trade	3,238	95%	19,057	94%
Retail Trade	9,262	98%	43,662	97%
Information and Financial Activities	2,060	93%	12,087	93%
Professional and Business Services	2,378	94%	25,798	93%
Educational Services	575	94%	1,092	95%
Healthcare and Social Assistance	9,263	96%	40,275	96%
Leisure and Hospitality	2,553	91%	23,867	94%
Other Services	1,067	95%	8,370	94%
Public sector				
State government	3,530	96%	17,855	97%
Local government	11,086	98%	49,665	97%

[a]SOII cases with 1 or more DAFW among establishments eligible for Washington State workers' compensation coverage.

2. **Employer reporting of workers' compensation claims**

After restricting workers' compensation claims to those with documented time-loss payments in the survey year, there were 55,745 claims eligible for SOII reporting among sampled establishments. Sixty-six percent of claims linked to a SOII case. After weighting, SOII captured an estimated 70% of workers' compensation time-loss claims. The SOII capture of workers' compensation claims was greater for state-funded claims (73%) compared to self-insured claims (67%), and among UI accounts sampled in their entirety compared to a sub-account (i.e., a sampled reporting unit within a UI account). Table X shows the unweighted and weighted percent of claims reported in SOII by establishment characteristics for all wage-replacement claims and for state-funded claims alone.

After weighting, SOII capture was greater among establishments required to maintain annual injury and illness records and lower for establishments usually exempt from record-keeping requirements. The SOII capture of workers' compensation claims differed by the instructions provided to establishments regarding which DAFW cases to report. Among establishments instructed to report a subset of DAFW cases based on injury date (to reduce response burden), SOII captured 89% of workers' compensation claims after weighting, whereas among establishments instructed to report all DAFW cases that occurred during the survey year, SOII captured 66% of estimated claims.

Based on the weighted estimates, SOII capture increased with establishment size, from 63% of claims among establishments with fewer than 50 employees to 86% of establishments with 1,000 or more establishments. Fewer than half of the estimated claims among information and financial activities were captured by SOII. The highest SOII capture rate (84%) was observed for claims among state government establishments.

TABLE X

TOTAL WORKERS' COMPENSATION CLAIMS[a] AND THE PERCENT REPORTED IN SOII
BY ESTABLISHMENT CHARACTERISTICS, 2003–2011

	All Claims				State Fund Claims			
	Unweighted Claim Counts		Weighted Estimate		Unweighted Claim Counts		Weighted Estimate	
	Total Claims	Percent of Claims Reported in SOII	Total Claims	Percent of Claims Reported in SOII	Total Claims	Percent of Claims Reported in SOII	Total Claims	Percent of Claims Reported in SOII
All	55,745	66%	263,078	70%	23,575	72%	156,059	73%
Workers' Compensation Insurer								
Washington State Fund	23,575	72%	156,059	73%	23,575	72%	156,059	73%
Self-insured	32,170	62%	107,019	67%	-		-	
Sampled Workforce								
UI Account	32,438	73%	163,127	78%	17,995	73%	120,200	75%
Sub-account	23,307	57%	99,950	57%	5,580	68%	35,859	63%
Record-Keeping Exemption Status[b]								
Not Exempt	51,193	66%	205,385	72%	20,141	73%	106,934	74%
Partially Exempt	4,552	67%	57,693	65%	3,434	68%	49,125	69%
Injuries Requested by BLS								
All DAFW in Survey Year	43,213	67%	213,076	66%	21,392	72%	145,553	71%
Subset of DAFW Based in Injury Date	12,532	64%	50,002	89%	2,183	70%	10,506	91%
Establishment Size								
1–10 Employees	609	63%	28,767	69%	538	69%	26,621	73%
11–49 Employees	4,539	61%	65,318	61%	3,450	73%	51,840	70%
50–249 Employees	17,616	69%	82,928	68%	10,947	73%	54,421	71%
250–999 Employees	16,846	65%	40,721	73%	5,999	71%	15,860	79%
1000 or More Employees	16,135	66%	45,344	86%	2,641	69%	7,317	87%

TOTAL WORKERS' COMPENSATION CLAIMS[a] AND THE PERCENT REPORTED IN SOII
BY ESTABLISHMENT CHARACTERISTICS, 2003–2011

	All Claims				State Fund Claims			
	Unweighted Claim Counts		Weighted Estimate		Unweighted Claim Counts		Weighted Estimate	
	Total Claims	Percent of Claims Reported in SOII	Total Claims	Percent of Claims Reported in SOII	Total Claims	Percent of Claims Reported in SOII	Total Claims	Percent of Claims Reported in SOII
Industry								
Private Sector								
Agriculture, Forestry, Fishing, Hunting	2,043	69%	9,031	72%	1,575	70%	7,888	73%
Transportation, Warehousing, Utilities	3,812	71%	19,485	74%	1,339	73%	9,292	76%
Construction	2,991	66%	25,917	72%	2,529	69%	24,828	73%
Manufacturing	8,975	71%	28,648	77%	4,587	77%	15,584	77%
Wholesale Trade	2,198	68%	13,207	68%	1,296	72%	9,926	71%
Retail Trade	7,106	66%	33,175	64%	1,982	70%	14,669	68%
Information and Financial Activities	1,404	62%	9,064	48%	680	73%	4,432	66%
Professional and Business Services	2,143	51%	19,720	59%	1,196	60%	15,484	64%
Educational Services	259	80%	461	74%	194	80%	376	76%
Healthcare and Social Assistance	7,758	65%	28,653	73%	2,454	71%	14,573	74%
Leisure and Hospitality	1,821	66%	18,841	59%	1,420	69%	14,291	66%
Other Services	710	70%	5,521	69%	552	73%	5,027	71%
Public Sector								
Local Government	11,894	62%	39,073	77%	1,143	80%	7,412	81%
State Government	2,631	74%	12,282	84%	2,628	74%	12,277	84%

[a]Claims among SOII sampled establishments with wage replace paid in survey year.

[b]Washington State record-keeping exemption status.

3. **Multivariable analysis of unreported workers' compensation claims**

Table XI presents the PRs for unreported state-funded claims for industry by size, adjusted for survey year, nature of injury, sampled workforce, and DAFW cases requested by BLS. Compared to manufacturing establishments with 250 or more employees, unreported claims were more than twice as prevalent in educational services establishments with fewer than 50 employees (PR=2.47, 95% CI: 1.52–4.01) and construction establishments with 250 or more employees (PR=2.05, 95% CI: 1.77–2.37). The only establishments with more complete reporting of claims than manufacturing establishments with 250 or more employees were local government establishments with 250 or more employees and state government establishments with 50–249 employees.

Within the industry strata, the prevalence of unreported claims was greater among the largest establishments compared to the smallest for: agriculture, forestry, fishing, hunting; construction; transportation, warehousing and utilities; and retail trade. Unreported claims were more common among the smaller establishments than larger establishments in educational services and state government.

Within the size stratum of establishments with fewer the 50 employees, three industry classes differed significantly from small manufacturing establishments: educational services, professional and business services, and leisure and hospitality. There was more difference within the large employers, where compared to manufacturing establishments with 250 or more employees, seven industry classes had more unreported claims and one (local government) had fewer.

After controlling for survey year, nature of injury, and the joint effect of size and industry, increased underreporting was found both for claims among sampled sub-accounts (compared to sampled UI accounts), and for claims among establishments instructed to report a subset of cases based on injury dates (compared to claims among establishments instructed to report all cases in the survey year) (Table XII).

TABLE XI

PREVALENCE RATIOS (PR) FOR UNREPORTED WASHINGTON STATE FUND WORKERS' COMPENSATION CLAIMS IN SOII BY ESTABLISHMENT SIZE AND INDUSTRY[a]

	<50 Employees	50–249 Employees	250+ Employees	**PR (95% CI) for <50 Employees within Strata of Industry**	**PR (95% CI) for 50–249 Employees within Strata of Industry**
	PR (95% CI)	PR (95% CI)	PR (95% CI)	(ref=250+Employees)	(ref=250+Employees)
Agriculture, Forestry, Fishing, Hunting	1.23 (0.96, 1.58)	1.06 (0.91, 1.24)	1.58 (1.36, 1.83)**	0.72 (0.56, 0.93)*	0.63 (0.54, 0.74)**
Construction	1.03 (0.89, 1.20)	1.26 (1.10, 1.45)*	2.05 (1.77, 2.37)**	0.49 (0.43, 0.57)**	0.62 (0.54, 0.70)**
Manufacturing	0.91 (0.77, 1.09)	0.96 (0.85, 1.09)	Referent	0.95 (0.80, 1.14)	1.00 (0.88, 1.14)
Transportation, Warehouse, Utilities	0.96 (0.77, 1.20)	0.93 (0.79, 1.11)	1.41 (1.19, 1.67)**	0.61 (0.48, 0.78)**	0.60 (0.49, 0.73)**
Wholesale Trade	1.14 (0.92, 1.41)	0.95 (0.81, 1.13)	1.43 (1.21, 1.69)**	0.85 (0.66, 1.09)	0.72 (0.58, 0.89)*
Retail Trade	1.23 (1.04, 1.45)*	1.16 (1.01, 1.33)*	1.34 (1.13, 1.59)*	0.82 (0.67, 1.00)*	0.80 (0.67, 0.96)*
Information and Financial Activities	1.39 (1.02, 1.89)*	1.06 (0.84, 1.32)	1.04 (0.84, 1.28)	1.28 (0.91, 1.79)	0.95 (0.72, 1.24)
Professional and Business Services	1.75 (1.44, 2.13)**	1.50 (1.29, 1.73)**	1.58 (1.35, 1.83)**	1.07 (0.87, 1.31)	0.91 (0.77, 1.07)
Educational Services	2.47 (1.52, 4.01)*	1.54 (0.89, 2.66)	0.61 (0.42, 0.90)*	4.73 (2.35, 9.50)**	2.67 (1.30, 5.49)*
Healthcare and Social Assistance	1.31 (1.05, 1.64)*	1.10 (0.96, 1.26)	1.09 (0.95, 1.26)	1.16 (0.93, 1.45)	0.97 (0.85, 1.12)
Leisure and Hospitality	1.42 (1.16, 1.74)*	1.22 (1.04, 1.42)*	1.20 (1.02, 1.42)*	1.18 (0.95, 1.47)	0.97 (0.82, 1.16)
Other Services	1.14 (0.88, 1.48)	1.15 (0.95, 1.40)	0.57 (0.27, 1.21)	1.81 (0.83, 3.96)	1.82 (0.85, 3.91)
Local government	1.34 (0.93, 1.94)	0.95 (0.75, 1.20)	0.71 (0.59, 0.85)*	1.31 (0.86, 2.01)	1.13 (0.84, 1.52)
State government	1.77 (1.09, 2.87)*	0.76 (0.60, 0.98)*	0.98 (0.86, 1.12)	2.01 (1.24, 3.26)*	0.81 (0.63, 1.04)

PREVALENCE RATIOS (PR) FOR UNREPORTED WASHINGTON STATE FUND WORKERS' COMPENSATION CLAIMS IN SOII BY ESTABLISHMENT SIZE AND INDUSTRY[a]

	<50 Employees	50–249 Employees	250+ Employees	**PR (95% CI) for <50 Employees within Strata of Industry (ref=250+Employees)**	**PR (95% CI) for 50–249 Employees within Strata of Industry (ref=250+Employees)**
	PR (95% CI)	PR (95% CI)	PR (95% CI)		
PR (95%CI) for Industry within Strata of Establishment Size					
Agriculture, Forestry, Fishing, Hunting	1.29 (0.99, 1.68)	1.10 (0.97, 1.26)	1.55 (1.34, 1.80)**		
Construction	1.17 (0.98, 1.39)	1.32 (1.18, 1.47)**	2.02 (1.74, 2.34)**		
Manufacturing	Referent	Referent	Referent		
Transportation, Warehouse, Utilities	0.99 (0.77, 1.26)	0.97 (0.83, 1.13)	1.42 (1.20, 1.68)**		
Wholesale Trade	1.17 (0.92, 1.48)	0.99 (0.85, 1.15)	1.44 (1.21, 1.70)**		
Retail Trade	1.18 (0.97, 1.43)	1.19 (1.06, 1.34)*	1.31 (1.10, 1.55)*		
Information and Financial Activities	1.35 (0.97, 1.86)	1.08 (0.88, 1.34)	1.09 (0.88, 1.34)		
Professional and Business Services	1.73 (1.39, 2.15)**	1.54 (1.36, 1.75)**	1.59 (1.36, 1.85)**		
Educational Services	2.86 (1.73, 4.71)**	1.59 (0.92, 2.74)	0.60 (0.41, 0.88)*		
Healthcare and Social Assistance	1.24 (0.97, 1.59)	1.14 (1.02, 1.28)*	1.11 (0.96, 1.29)		
Leisure and Hospitality	1.35 (1.08, 1.70)*	1.26 (1.10, 1.44)*	1.23 (1.04, 1.45)*		
Other Services	1.23 (0.93, 1.63)	1.19 (0.99, 1.42)	0.56 (0.27, 1.19)		
Local government	1.27 (0.87, 1.86)	0.98 (0.79, 1.23)	0.67 (0.56, 0.81)**		
State government	1.56 (0.95, 2.55)	0.83 (0.65, 1.05)	0.98 (0.86, 1.12)		

[a]PRs adjusted for survey year, nature of injury, sampled workforce, and injuries requested by BLS.

*p<.05

**p<.0001

TABLE XII

PREVALENCE RATIOS (PR) FOR UNREPORTED WASHINGTON STATE FUND WORKERS' COMPENSATION CLAIMS IN SOII BY SOII SURVEY CHARACTERISTICS[a]

	PR (95% CI)
Sampled Workforce	
Sub-account vs. UI Account	1.13 (1.08, 1.18)
Cases Requested by BLS	
Subset Based on Injury Date vs. All In Survey Year	1.16 (1.07, 1.26)

[a]PRs adjusted for survey year, nature of injury, and joint effect of industry and size

D. **Discussion**

In a novel approach for linking SOII and workers' compensation injury data that utilizes UI data to identify the SOII-sampled workforce among workers' compensation claims data, this study estimated that SOII captures 70% of SOII-eligible Washington State workers' compensation claims. Our overall estimate of SOII reporting is greater than previous studies linking SOII data to workers' compensation data. Rosenman et al. reported that SOII captured 22% of Michigan workers' compensation claims (Rosenman et al., 2006). Boden and Ozonoff found reporting of workers' compensation claims in SOII varied by state; their estimate of SOII capture of Washington State workers' compensation claims was 57% (Boden and Ozonoff, 2008). The higher percentage of workers' compensation claims reported in SOII found in this study likely reflects three differences in methodology: (1) the availability and use of UI data to link SOII and workers' compensation; (2) utilization of workers' compensation worksite location data for multi-site firms, which enhances identification of the surveyed workforce within workers' compensation among sampled reporting units; and (3) the restriction of claims to those involving missed work during the survey (as opposed to initial missed work sometime after the close of the survey). Also, both studies involved data collected prior to the implementation of the current OSHA record-keeping regulations, which may further impact comparability of the estimates. Our estimate of SOII capture is lower than that of Oleinick and Zaidman, who found SOII to estimate 86%–90% of Minnesota workers' compensation claims (Oleinick and Zaidman, 2010). Their analysis is based not on record linkage but on a comparison of total injuries and does not address the overlap of cases reported in each data source. Data from the NHIS suggested that 70% of injuries with work absence were reflected in SOII (Smith et al., 2005), an estimate similar to the SOII capture reported here.

Underreporting by workers' compensation insurer in Washington State is analogous to underreporting by industry in other linkage studies. In many other states, the workers' compensation employer data more closely resemble the Washington State self-insured data, with minimal data on

worksite locations. In contrast, the Washington State Fund workers compensation data delineate business locations within a firm, allowing for better alignment with the SOII establishment data compared to workers' compensation data. The appearance of poorer reporting among self-insured employers was likely due to overestimating the number of SOII-sampled workers' compensation claims among reporting units and not from true differences in case reporting between state-funded and self-insured employers. In other linkage studies, industry underreporting variations may be more a reflection of the difficulties in identifying the SOII-sampled workforce within workers' compensation data—a task more complex for some industries—than true industry-based reporting patterns.

Underreporting was evident within each industry division, but the magnitude of underreporting varied. After controlling for survey, injury, and establishment factors, large construction establishments had among the highest prevalence of unreported claims. The construction industry has been the focus of several underreporting studies, and the frequently cited reason for employer underreporting specific to the industry is a reliance on a bidding process that includes injury and illness rates in the competition for work among firms, creating an incentive to not report injuries (Glazner et al., 1998, Dong et al., 2011). But reporting disincentives hypothesized for the construction industry seem unsuitable for explaining underreporting across all industries and establishment factors. Compared to large manufacturing establishments, increased underreporting was also found among large establishments in agriculture, forestry, fishing, and hunting, and transportation and warehousing, as well as small establishments in information and financial activities, educational services, and healthcare and social assistance, and among establishments of all sizes in retail trade, professional and business services, and leisure and hospitality. The range of industries and establishment sizes with unreported claims suggests that the reasons for underreporting likely differ by industry, possibly even by establishment. Larger establishments in higher-hazard industries may have programs in place that create incentives to underreport such as awarding supervisors and injury record-keepers for low injury rates. Others may

underreport because they misinterpret the reporting requirements, or they lack an adequate system to report and track workplace injuries (Phipps and Moore, 2010, Wuellner and Bonauto, 2014). Establishments that maintain records sporadically, such as small establishments in lower-hazard industries that experience few injuries and those usually exempt from record-keeping requirements, may be less familiar with the OSHA record-keeping regulations than those who routinely maintain records, and poor record-keeping knowledge likely results in underreporting cases on the OSHA log (US Government Accountability Office, 2009, Eisenberg and McDonald, 1988).

Our findings suggest that claims among state and local government workers are more likely to be reported than claims among the private sector. This may be due to the increased emphasis on transparency within government relative to the private sector, or it may reflect other factors that improve reporting such as unionization, the rate for which is five times higher among public-sector workers than among private-sector workers (Bureau of Labor Statistics, 2015). Unionization may improve reporting by offering increased protection for reporting injuries to employers, or by reviewing posted injury logs to ensure that they are complete and accurate. Additional research is needed to understand the reasons for reporting differences between the public and private sectors.

Two factors related to the implementation of the survey were associated with unreported workers' compensation claims. First, our findings suggest that SOII reporting is less complete when the sampled establishment is one of many within a UI account, a pattern found in a previous SOII-workers' compensation record-linkage study (Nestoriak and Pierce, 2009, Boden, 2014). For an injury to be recorded on a company's OSHA log, details of the incident must be transferred across one or more individuals within the company—for example, from the injured worker to the supervisor, and from the supervisor to the establishment record-keeper. When the record-keeper is located offsite, the transfer of information across multiple locations presents an additional barrier to maintaining accurate and current injury records. Alternatively, it is possible that the increased risk of underreporting in SOII

among sampled sub-accounts may be due to irreconcilable differences in the sampled employer's business structure across administrative data systems. The relationship between reporting and the second survey factor, injuries requested by BLS (all DAFW versus those occurring on specified dates), was more complex. More complete reporting among establishments instructed to report cases based on injury dates compared to establishments instructed to report all DAFW cases in the survey year likely reflected differences in size and industry distributions between the two groups; larger establishments were more likely to be instructed to report a subset of cases and also had high estimates of SOII capture. Multivariable analysis suggested greater underreporting among subsampled establishments compared to establishments of similar size and industry. The BLS may be able to improve reporting accuracy through increased outreach to these establishments to ensure they report the intended cases.

There are several limitations to this study. The lack of detail available for claims among self-insured employers presented a challenge in determining SOII-eligibility among self-insured claims. Whereas state-funded claims readily linked to SOII establishments based on location data, the location data alone were insufficient for assigning self-insured claims to an establishment within a multi-site firm. Findings may not be representative of other states, given the evidence that the magnitude of underreporting varies by state (Boden and Ozonoff, 2008, Mendeloff and Burns, 2013). State-level factors that potentially impact reporting include: rates of unionization; rates of unemployment; and workers' compensation benefits. It is unknown whether patterns of underreporting by establishment characteristics are similar across states.

The study evaluated only SOII cases and workers' compensation claims and did not consider underreporting of injuries and illnesses not captured by either SOII or workers' compensation, often estimated through capture-recapture methods (Rosenman et al., 2006, Boden and Ozonoff, 2008, Morse et al., 2001). We have chosen not to apply capture-recapture methods here because of the possible biases introduced when the two data sources are dependent (Boden, 2014, Jones et al., 2014);

specifically, cases reported in SOII are likely reported in workers' compensation and vice versa. Indeed, SOII cases appear to be a subset of workers' compensation claims in Washington State, with workers' compensation capturing 96% of SOII cases. A third data source independent of workers' compensation and SOII would greatly enhance capture-recapture estimates. This study's assessment of unreported claims can be considered a lower bound of underreporting; estimates would increase if eligible injuries not captured in either data source were included. Furthermore, with evidence that "underclaiming" varies by industry, occupation, and worker characteristics (Fan et al., 2006), an evaluation of underreporting that includes injuries not reported in either workers' compensation or SOII may alter the relative rates of SOII underreporting. This may explain, in part, our finding of more unreported workers' compensation claims among the largest construction establishments compared to smaller construction establishments where others have found the opposite (Dong et al., 2011). Within certain industries, smaller employers lacking sophisticated injury-tracking systems may default to their workers' compensation claims data when completing the SOII and report only injuries for which claims were filed. Larger employers may utilize an injury-tracking system independent of the workers' compensation claims data. Also, smaller companies may employ workers least likely to file workers' compensation claims, either because they are unaware of their right to do so, or because the employer has provided an incentive to seek care outside the workers' compensation system. To avoid a workers' compensation claim and an increase in premiums, employers may offer to pay the medical bill directly and the worker's salary during the recovery period. Smaller employers may also be more likely to hire temp workers, whose workers' compensation claims would be filed with the temporary staffing agency, or hire day laborers who may not be aware that they are eligible for workers' compensation coverage. These injuries would be absent from the workers' compensation claims data, and would not appear in a comparison between SOII cases and workers' compensation claims.

The SOII data accuracy may be improved through modifications to the survey and increased education of employers on the record-keeping requirements. To help standardize and improve injury record-keeping across employers, both BLS and OSHA can increase education and outreach efforts with employers regarding record-keeping requirements. Interactive record-keeping software that reminds users of the record-keeping regulations and performs data quality checks in real time may help reduce record-keeping errors. Collecting data quarterly rather than once at the end of the year may improve employers' familiarity with the record-keeping requirements by requiring periodic data submission during the course of the survey year. Finally, BLS could revisit conducting audits among a sample of respondents. Although the audit process has been considered too labor intensive to be useful in validating submitted SOII data (Eisenberg and McDonald, 1988), the mere threat of an audit may improve record-keeping among all participating establishments.

The advantages of SOII include the consistent collection of case-level injury and illness data by detailed industry and the ability to generate national and state-level estimates through the utilization of a federally regulated system of incident tracking uniform across the nation, but the system is hampered by incomplete case ascertainment (Ruser, 2008). Moreover, any occupational injury surveillance system dependent on employer-reported data will face allegations of underreporting so long as the business environment continues to incentivize workplace-injury data. Barring a shift in business incentive programs from injury data to hazard identification and mitigation, BLS may never alleviate concerns about underreporting. Other sources of occupational injury and illness data have their own limitations: workers' compensation data are not comparable across states and face similar concerns about underreporting, and hospital discharge or emergency department data provide little if any information on industry or occupation and are often related back to workers' compensation data through the identification of work-related incidents using payer data. Development of an enhanced surveillance system that links establishment-reported data with worker-reported data would be an improvement

over either individual data-collection system, but the cost to implement such a system that tracks workers within each participating establishment likely would be substantial.

The SOII underestimates of the true incidence of work-related injuries and illnesses, and the magnitude of the underestimate appears to vary across employers. The variation in reporting across establishment characteristics impedes the ability to identify and prioritize groups at increased risk of work injury and illness. Absent changes to the current system, other data sources, despite their limitations, may be more appropriate for gauging injury risk across establishment or injury characteristics.

VII. CONCLUSION

A. Summary of Findings

The accuracy of SOII data has been a concern for as long as the BLS has been collecting workplace-injury data from employers (National Research Council Panel on Occupational Safety and Health Statistics, 1987, US House of Representatives, 2008, Drudi, 1997), and a growing body of research supports these concerns (Rosenman et al., 2006, Boden and Ozonoff, 2008, Glazner et al., 1998, Leigh et al., 2004, Mendeloff and Burns, 2013). This series of studies builds on previous research by examining several aspects of the BLS SOII undercount issue to expand our understanding of the BLS's occupational surveillance data and its limitations. Specifically, we estimated underreporting of Washington State workers' compensation wage-replacement claims in SOII, identified establishment and survey characteristics associated with underreporting, evaluated the impact of differences in injury classification by data source on estimates of select work injuries or conditions, and assessed the workplace injury record-keeping practices of SOII respondents.

This research confirms earlier investigations that found that SOII fails to capture all reportable injuries and illnesses. Using a novel approach to identifying the SOII-sampled workforce among workers' compensation claims data for linking SOII and workers' compensation injury data, this study estimated that SOII misses more than 30% of SOII-eligible Washington State workers' compensation claims. A more modest estimate of underreporting compared to other studies (Rosenman et al., 2006, Boden, 2014, Boden and Ozonoff, 2008), our finding that SOII misses nearly one in three time-loss claims is nonetheless a substantial number of injuries, suggesting that, in its current state, SOII is limited in its ability to estimate the magnitude of work injuries and illnesses.

Underreporting to SOII is not consistent across the entire population of establishments, but rather, varies by employer (Nestoriak and Pierce, 2009, Oleinick et al., 1995, Dong et al., 2011). Controlling for establishment characteristics, nature of injury, and survey factors, we found greater

underreporting among private industry, larger establishments, and certain industries; unreported claims were approximately 30% more prevalent among construction, agriculture, forestry, fishing, and retail trade compared to manufacturing. Two aspects of the SOII survey methods were also found to be associated with underreporting. First, adjusting for establishment characteristics and nature of injury, claims among establishments that were one of many within a UI account were more likely to go unreported compared to claims among UI accounts sampled in their entirety. Second, claims among establishments instructed to report a subset of DAFW cases defined by injury date were more likely to be unreported compared with establishments instructed to report all DAFW cases that occurred in the survey year. Varying levels of underreporting mask the true occurrence of work injury and the relative risk of injury by industry or other establishment characteristics. This variation in reporting complicates the utility of the published SOII estimates, making it difficult to meaningfully compare work injury and illness rates across employers and hindering the ability of stakeholders to use the SOII data for identifying and prioritizing workplaces in need of injury prevention efforts.

Underreporting is not the only explanation for dissimilar injury estimates across data sources. We found discordant injury classification resulted in conflicting estimates of specific conditions. Given the differences that often exist between data sources in data-collection forms, the individuals tasked with completing the forms, and the timing of the injury reporting, variations in injury characterization are not unexpected.

While the responsibility to maintain OSHA injury and illness records lies with the employer, the records are intended to be compiled, in part, from information provided by the attending healthcare provider.[22] Treatment provided (often necessary to determine OSHA recordability) and the number of days of missed or restricted work are two examples of information provided by the healthcare provider that inform the employer's OSHA injury records. This information is often difficult to obtain in a timely

[22] 29 C.F.R. Part 1904 (2001).

manner from the healthcare provider, and rather than waiting on medical records, the employer may document the incident with the information at hand. In the event that medical records are obtained, it may be the employer's interpretation of the medical documentation that is recorded on the OSHA form instead of verbatim medical documentation.

Based on our interviews with workplace injury record-keepers, reasons employers fail to report all eligible workers' compensation claims to SOII include, in broad terms, noncompliance with the OSHA record-keeping regulations and breakdowns in communication along the injury-reporting pathway.

Since SOII reporting criteria mirrors the OSHA record-keeping regulations, accuracy of the SOII data is, in part, dependent on employer compliance with the OSHA regulations (Seligman et al., 1988, Phipps and Moore, 2010, US Government Accountability Office, 2009). Misclassifying injury severity, incorrectly counting days of disability, and omitting from the OSHA log injuries among temporary workers can result in underreporting. Interestingly, these record-keeping errors were reported not only by establishments that underreported workers' compensation claims, but also by those that reported all workers' compensation claims, suggesting that noncompliant record-keeping practices are not the sole explanation for underreporting. Moreover, while some noncompliant practices result in underreporting, others can lead to overreporting—i.e., including cases on the OSHA log that do not meet the OSHA recordability criteria, such as recording all cases regardless of severity and including minor injuries that required only first aid. Noncompliance with the OSHA record-keeping regulations was widespread among our study respondents.

Failures along the injury-reporting pathway are another potential reason for unreported cases. For an injury to be captured by SOII, two key reporting processes must occur. First, the incident must be reported to the employer. Second, the employer must report the case to the SOII data collector.

Employers are commonly notified of an incident by the worker or the supervisor, but the employer may also learn of an injury from an external source such as the healthcare provider, lawyer, or

workers' compensation insurer (when the employer is removed from the claim-filing process). The incident-reporting process can be impeded by several barriers, as detailed by Azaroff et al. (2002). Our findings suggest that multiple work shifts may be one such barrier. The establishment's injury-reporting procedures may be inadequate for capturing work injuries that occur outside of the record-keeper's work hours and result in underreporting cases to SOII relative to workers' compensation claim data. In contrast, other establishments appear to have ameliorated injury-reporting barriers. By sending injured workers to a preferred healthcare provider with whom the employer has an established relationship, the employer increases the likelihood that they are informed of relevant work-injury information. (An alternate interpretation is that the employer is sending the worker to a healthcare provider whose diagnoses and treatment align with the employers' interest in minimizing work injuries.)

Barriers are also present in the reporting pathway between the establishment and the SOII data collector. Interviews with SOII respondents suggested that BLS-provided instructions to report DAFW cases based on injury date was a barrier to complete reporting (of cases meeting the requested injury dates), echoing the finding from this study's record-linkage project. Also, underreporting was associated with the practice of using injury and illness data to measure the job performance of the supervisor or SOII respondent. Rewarding the respondent or supervisor for favorable injury data may have less impact on claim filing than other incentive scenarios, such as safety incentive programs that reward workers based on injury benchmarks; this may impact the accuracy of the injury data submitted to SOII but also suppress workers' compensation claim filing and would thus be undetectable in a comparison between SOII and workers' compensation claims data.

Employer injury-reporting practices—whether compliant or noncompliant—are likely influenced by the business environment, which varies greatly across establishment characteristics. Employers with no consequences tied to the workplace injury data may simply record all injuries as an easy and convenient means of record-keeping. Employers with an incentive to minimize the number of cases

recorded on the OSHA logs, such as those using work injury and illness data to measure job performance, may be more familiar with the provisions in the OSHA record-keeping regulations related to the determination of work-relatedness. Respondents motivated to record as few cases as possible may enlist one of several exclusions provided in the OSHA record-keeping regulations (e.g., the injury resulted from the employee's engagement in personal tasks or the injury resulted from a motor vehicle accident in a company parking lot). Or, employers may conclude that the precipitating event or exposure occurred outside the work environment, even if this contradicts the determination by the workers' compensation insurer. The OSHA record-keeping regulations and workers' compensation claim eligibility are separate and independent systems and although eligibility overlaps between the two systems, there are nuanced differences between the two. Employers with little motivation for learning the OSHA record-keeping rules may default to using their workers' compensation claims data when completing SOII, whereas employers incentivized to minimize recorded cases of work injuries can benefit from exploiting the differences in eligibility between OSHA cases and workers' compensation claims.

B. **Recommendations**

There are several ways to improve the accuracy of the published SOII estimates. Approaches include: improving the injury data recorded by establishments; focusing on survey data-collection efforts; and adjusting the survey weights used to estimate the injury experience of the larger population.

The range of record-keeping practices used by SOII respondents highlights the lack of uniformity of the data submitted to SOII and, like the differences in the magnitude of underreporting across establishment characteristics observed from the record-linkage study, threatens the comparability of the SOII data across employers. To help standardize injury record-keeping across employers, both BLS and OSHA can increase education and outreach efforts. Guidance on record-keeping requirements should be readily available to establishments participating in the SOII. Additionally, interactive record-

keeping software that reminds users of the record-keeping regulations and performs data quality checks in real time may help reduce record-keeping errors. Such a program could be implemented by OSHA—with data transferrable to SOII—or independently by BLS.

The occupational safety and health community should educate employers on the value of injury reporting as a tool for workplace safety so that employers encourage reporting rather than engaging in practices that suppress it. The OSHA lists several employer practices that likely suppress injury reporting including disciplining workers for: experiencing a work injury; failing to follow injury-reporting policies; and failing to follow safety rules, especially when the rules are as nonspecific as "work safely" (Occuaptional Safety and Health Administration, 2012). Additionally, safety incentive programs that reward workers for meeting injury benchmarks are a continued concern for their potential to deter reporting (US Government Accountability Office, 2012). Companies should shift the focus of such programs from injuries to hazard identification and mitigation. Increasingly, employers are aware of the negative impact injury-based safety incentive programs can have on reporting; however, many remain uninformed. The OSHA can expand efforts to educate employers on the potential coercive nature of such programs and offer alternatives that would foster workplace safety without suppressing injury reporting.

Rather than address the complex issues related to establishments' characteristics associated with underreporting, perhaps a more immediate and feasible approach to improving SOII data is for BLS to focus on survey factors associated with underreporting. The BLS should improve communication with establishments to clarify the intended sample when requesting a subset of injuries or locations. Alternate ways to minimize the reporting burden without sacrificing data accuracy should be investigated. The BLS could collect data quarterly rather than once at the end of the year; requiring periodic data submission during the course of the survey year may improve employers' familiarity with the record-keeping requirements. The BLS should revisit conducting audits among a sample of

respondents. Although the audit process has been considered too labor intensive to be useful in validating submitted SOII data (Eisenberg and McDonald, 1988), the mere threat of an audit may improve record-keeping among all participating establishments.

The BLS survey weighting procedures should be explored as a potential means of improving SOII data accuracy. The findings from several undercount research studies—combined with a few key assumptions—may suggest a modified estimation procedure that compensates for employer underreporting by state and by establishment characteristics. Mendeloff and Burns' (2013) results on the relationship between SOII and fatal occupational-injury data can be used to infer variations in underreporting by state, assuming the negative correlation between the two datasets reflects SOII reporting. The relative rates of underreporting by establishment characteristic reported by this research can be applied across states, assuming the motivating factors for underreporting are the same in all states. Additionally, estimates of underreporting within workers' compensation would further inform modifications, addressing the issues of underreporting within workers' compensation and source dependence between workers' compensation and SOII. Although weighting procedures adjusted for employer underreporting may produce more accurate estimates of occupational injuries and illnesses, the current body of knowledge is insufficient for amending estimates for industry groupings more granular than the NAICS sector level.

The accuracy of SOII data can be improved through modifications to the survey and increased education of employers on the record-keeping requirements. However, any occupational injury surveillance system dependent on employer-reported data will face allegations of underreporting so long as the business environment continues to incentivize workplace injury data. Barring a shift in business incentive programs from injury data to hazard identification and mitigation, BLS may never alleviate concerns about underreporting. Development of an enhanced surveillance system that links establishment-reported data with worker-reported data would be an improvement over either

individual data-collection system, but the cost to implement such a system that tracks workers within each participating establishment likely would be substantial. The BLS should continue to pursue methods to feasibly integrate worker-reported injury data with establishment data.

With its reliance on employer-provided records, SOII may not be the optimal data source for the surveillance of medically detailed or nuanced conditions. By contrast, SOII is uniquely situated to gather rich information on the precipitating event or exposure, as an employer need only examine his or her own worksite to determine the event or exposure that caused the injury. Enhancing employer-reported descriptions of events or exposures could provide SOII with data invaluable to informing workplace injury prevention efforts.

The SOII is one of a number of sources available for the surveillance of occupational injuries and illnesses, each with its own strengths and weaknesses. The SOII captures worker demographics, establishment characteristics, and details about the incident and injury but is hampered by incomplete case ascertainment (Ruser, 2008). Workers' compensation claims data can provide extensive information on the disability and cost of the injury as well as the characteristics of the worker and the employer but are not comparable across the different state workers' compensation systems and face similar concerns of underreporting (Fan et al., 2006, Biddle et al., 1998, Spieler and Burton, 2012). Medical data such as hospitalization, emergency department, or ambulatory surgery data capture details about the injury and the treatment provided during the encounter, but record minimal data, if any, on industry and occupation (Davis et al., 2011, Sears et al., 2011). Additionally, determination of work-relatedness in medical data is often linked to workers' compensation through the payer field, creating the same concerns about underreporting. Worker surveys may achieve more complete reporting than other data sources, but often capture less detail on injury and establishment characteristics, and case ascertainment is more expensive per injury than establishment surveys (Smith

et al., 2005). The occupational surveillance community should continue to explore the utility of available data sources.

Although not without its own limitations, a preferred alternate source for a national estimate of occupational injuries may be the National Electronic Injury Surveillance System-Work Supplement (NEISS-WORK), which estimates the number of work-related nonfatal injuries and illnesses treated in US hospital emergency departments (Centers for Disease Control and Prevention, 2007). While not a measure of OSHA recordable cases, the NEISS-WORK estimate is an indication of the magnitude of occupational injuries that, by circumventing the employer and the workers' compensation system in the determination of work-relatedness, may be a more accurate estimate of work injuries and illnesses nationally. The primary advantage of the NEISS-WORK data over many other medical data sources is that the determination of work-relatedness is made by trained hospital coders based on the medical records and *not* solely on workers' compensation insurance as payer or work-related E-codes. The limitations of NEISS-WORK are the lack of state-level data, the limited ability to capture non-acute injuries and illnesses like cumulative trauma cases, and the absence of industry and occupation data.

Other surveillance efforts, particularly at the state and local levels, should continue to utilize multiple data sources, either through record linkage or in aggregate, to overcome the limitations of any one data source. These efforts can be tailored to the research question, bringing in the appropriate data sources to assess burden, industry distribution, injury severity, or other characteristic of interest.

Finally, limited data sources are not the only impediment to the surveillance of work-related injuries and illnesses. A crucial barrier is the lack of state health departments' epidemiologic capacity in occupational health, lagging behind almost all other programs areas (Centers for Disease Control and Prevention, 2015). Capacity can be developed through increased funding to states through the Centers for Disease Control and Prevention's State Occupational Health and Safety Surveillance Program. As state-based capacity grows and other data sources are identified, SOII data become one of several tools

available for occupational-injury surveillance activities. Moreover, enhancing state-based epidemiologic capacity may amplify the current demand for better occupational-health surveillance data, providing the issue with the political will needed to effect change.

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APPENDICES

APPENDIX A

Employer Interview Guide

Interview Site#: _____
Interviewers: _____
Date: _____

Background Information *(The first question is a warm up to get comfortable)*

1. Could you tell me about your company and the kind of work employees do here? *(let them talk, ask a few questions to build rapport and learn more, capture # of employees and type of work. PROBE FOR:)*

    a. Company description:

    b. Type of work employees do:

    c. Total number of employees: _____
    □ Labor or trades: Percent: _____
    □ Professional, office, or administrative staff: Percent: _____

2. Are there multiple worksites or locations? □Yes □No
    a. [If yes] Is the corporate headquarters located separately? □ Yes □ No
    b. [If yes] Headquarters is: □ Here □ Elsewhere
3. IF MULTI–SITE: Would any of the locations have a higher injury rate than others? □Yes □No
    a. If yes, which location and type of activity at location:

4. Does the company ever participate in a bid process to compete for jobs? □ Yes □ No
    a. [If no] How do you get work?

5. Is there a union in your workplace? □Yes [If yes] Percentage: _____ □ No

6. Are there multiple shifts at the worksite? □ Yes □ No
    a. [If yes] Is there someone assigned during each shift to do injury and illness tasks like incident reports or injury logs? □ Yes □ No

Can you tell me a little about your position?

APPENDIX A (continued)

Department: □ HR □General Mgr. □Safety □Risk Mgmt. □Other

b. Years in **current position** with company _____ years

c. Total years with company _____ years

d. Total years in all jobs doing this type of work _____ years

Reporting of Cases

7. **Can you tell me how you learn about work–related injuries or illnesses?** *(PROBE FOR: employee, supervisor roles in injury reporting AND if reporting procedures are written down)*

_____

_____

_____

a. Who informs you? _____

b. When do you find out? ____ hours ____days ____weeks after injury/illness

c. What do you do in response? (Get chronology of activity)

_____

_____

8. *[SHOW RESPONDENT OSHA LOG FORM AND BLS SURVEY]*
   a. Does either of these forms look familiar? □ Yes–OSHA log □ Yes–BLS □ Neither
   b. Do you recall completing either of these forms? □ Yes–OSHA log □ Yes–BLS □ Neither

9. Who has primary responsibility for the OSHA log, Workers Comp claims, the BLS survey, and any other injury and illness record–keeping? *(PROBE FOR: If respondent does not have primary responsibility, record position, department of person with primary responsibility.)*
   a. OSHA LOG: □ Respondent □ Other: _____ Yrs responsible: _____
   b. WKRS COMP: □ Respondent □ Other: _____ Yrs responsible: _____
   c. BLS SURVEY: □ Respondent □ Other: _____ Yrs responsible: _____
   d. Other: _____ □ Respondent □ Other: _____ Yrs responsible: _____

10. Does anyone else share responsibility or assist?
    a. OSHA: □Coworker □Supervisor □Respondent □No one □Other_____
    b. WC: □Coworker □Supervisor □Respondent □No one □Other_____
    c. BLS: □Coworker □Supervisor □Respondent □No one □Other_____
    d. Other: □Coworker □Supervisor □Respondent □No one □Other_____

11. Are you responsible for or do you oversee the following for more than one location:
    a. OSHA LOG: □Yes #locations_____ □No, someone else responsible □Not multi–site
    b. WKRS COMP: □Yes #locations_____ □No, someone else responsible □Not multi–site

APPENDIX A (continued)

c. BLS SURVEY: □Yes #locations_____ □No, someone else responsible □Not multi– site

[If yes] What is most challenging about maintaining records for multiple locations?

_____

_____

OSHA–Specific Questions

12. Now focusing on the OSHA log *[give respondent a blank 300, 301, and 300A if he/she doesn't have them in hand]*, what resources do you turn to when completing the following forms or when you have questions about how to complete the forms?

	Written instruction	Computer	Advice from others	Uses no resources	Doesn't complete	Other (describe)
OSHA 300 log	□	□	□	□	□	□_____
OSHA 301 form	□	□	□	□	□	□_____
OSHA 300A	□	□	□	□	□	□_____

13. What information is hard to obtain to complete an OSHA log entry? *(PROBE FOR dafw, djtrw)*

_____

_____

14. Do you keep your injury and illness records in electronic form? □ Yes □ No
    a. [If yes] *(PROBE FOR software programs, what type of information is included, and whether it produces OSHA or BLS forms electronically)*

_____

_____

15. **How do you determine whether a case is recordable? If you're unsure, what do you do?**

_____

_____

APPENDIX A (continued)

16. Do you include cases that only require first–aid on the log? □ Yes □ No

17. When do you record injuries in the:

	As soon as notified of injury	End of each month	End of year	RTW w/o restrictions	Other (describe)
a. OSHA 300 log	□	□	□	□	□_____
b. OSHA 301 form	□	□	□	□	□_____

18.
    a. For cases that occur late in the year, do you include them on the following year's log?

    _____

    b. What about cases with days away from work that continue into the next year, do you continue counting days away on the old log or add them to the new year's log?

    _____

19. **Can you tell me about a case you didn't believe was work–related?** ***(PROBE FOR characteristics of case and whether included on log)***

_____

_____

_____

20. What injuries or illnesses are reported immediately after the incident and which are reported later? *(PROBE FOR injury or illness type, employee characteristics, employment characteristics)*

    – Immediately _____

    – Later _____ How much later? _____

21. Are there any kinds of cases that you find out about from *(PROBE FOR injury or illness type, employee characteristics, employment characteristics):*
    a. A healthcare provider: _____
    b. L&I: _____
    c. Insurer or TPA: _____
    d. An attorney: _____

APPENDIX A (continued)

22. Have you ever had a worker with a work–related illness like dermatitis, asthma; or an occupational disease?
    □ Yes [If yes] type of illness:_____ □ No

    a. How were you informed? _____

    b. How long after the injury date were you informed? _____

    c. Did you record it on your OSHA log? □ Yes □ No

23. What do you update in your OSHA logs? *(POINT TO COLUMNS ON 300 LOG)*

    □ a. Injury and illness descriptions?

    □ b. Number of days away from work?

    □ c. How a case is classified, for example, when it changes from Job transfer to Days away from work

    □ d. Never update or change

24. Do you ever cross out a recorded case? □Yes □ No
    a. Why would this occur?

    _____

    _____

25. How do you handle re–injuries of a previous injury? For example, a worker has a back or knee injury that is recorded on the log. The pain goes away, they're symptom–free for months, maybe years, and then the worker re–injures that same body part. Would you…

    □ Record it as a new case? □ Amend an old entry? □ Don't know

26. Do you always record the physician's initial estimate of the time loss days or do you try to accelerate the return to work *(For example, offer light duty)*

    _____

    _____

27. If a case had both days away from work and days of job transfer or restricted work activity *(POINT TO FORM):*
    a. How would you classify it? □DAFW □JTR □Don't know
    b. Which days would you record? □DAFW □JTR □Don't know

28. If a case had many more days of restricted work activity compared to days away from work, would you ever classify it as a job transfer or restricted work case?

    □Yes □No □ Don't know
    [if yes/no] Why or why not: _____

APPENDIX A (continued)

Workers' Compensation Record–keeping

29. I have a few questions about workers' compensation records. How are you usually informed of a workers' compensation claim?
    □Employee □Supervisor □HR □Physician □L&I □Other_____

30. Are your claims managed by a Third–Party Administrator (TPA)? □Yes □No

31. Do you ever use your WC claims to fill out the OSHA log? □Yes □No
    a. When would you do this?
       □ Immediately upon notification of claim □ End of year □Other_____

32. IF MULTI–SITE: Are WC claims from other company locations ever listed under your location?
    □Yes □No
    a. [If yes] How often does that happen? How long does it take to get them corrected?

33. What workers' comp claims do you include in the OSHA log?
    a. Rejected workers' compensation claims? □Yes □No □ DK
    b. Claims in which a workers' compensation decision has not yet been made? □Yes □No □ DK
    c. Accepted WC claims that are being protested or contested by the employer □Yes □No □ DK
    d. Re–injuries □Yes □No □ DK
    e. Claims employees do not report directly to someone in the company □Yes □No □ DK
    f. Cases where a first report is not filed as the employee is kept on the payroll □Yes □No □ DK
    g. Other _____

BLS Survey–Specific Questions

34. In 2008, your establishment was asked to complete the BLS Survey of Occupational Injuries and Illnesses.
    a. Do you recall completing the survey? □Yes □No
    b. Do you remember how you completed the survey?
       □No □Email □Web □Fax □Paper/mail in □Phone □Other_____

APPENDIX A (continued)

35. What information sources were used to complete the BLS Survey?
    □OSHA log □WC Data □Company injury and Illness records □Other_____

    a. Did you use: □Written Instructions □Computer □Advice from Others □Other

    b. Who do you get any needed additional information from?
    c.
    □Employee □Supervisor □HR □Physician □L&I □TPA □None needed

    d. What pieces of information are particularly hard to get? *(ASK FOR EXAMPLES)*

    _____

36. IF MULTI–SITE: How do you determine which locations should be included in each BLS survey?

    _____

    a. Is it ever unclear? □Yes □No
37. Did you receive help from WA BLS at L&I to complete the Survey? □Yes □No
    a. [If yes] what questions did you have?

    _____

    _____

    b. What information did they provide?

    _____

    _____

38. *(POINT TO RELEVANT SECTION OF SURVEY)* How did you know the average number of employees for the year? □Company records □Estimate
    a. [If estimate] how was it made?_____
39. How did you know total hours worked? □Company records □Estimate
    a. [If estimate] how was it made?_____

40. Are there cases on the OSHA logs that you would not include on the BLS Survey? □Yes □No
    a. [If yes] what types of cases? _____

41. Are there reportable injuries or illnesses that occur during the BLS Survey timeframe □Yes □No that are unknown to you until after you have sent in the BLS Survey?

    a. [If yes] what types of cases? _____

APPENDIX A (continued)

Musculoskeletal Disorders Claims

I have a few questions on some injuries that may be more difficult to report—injuries that are the result of repeated stress on muscles or tendons over a long time, like carpal tunnel syndrome, tendonitis, or back and neck injuries. Sometimes these injuries are referred to as cumulative trauma injuries, repetitive strain injuries, or musculoskeletal disorders, MSDs.

42. Have you ever recorded a MSD case on your OSHA log? □Yes □No
43. Have you ever had a workers' compensation claim for MSD? □Yes □No
44. How do you determine the date of injury on cumulative trauma or musculoskeletal cases?
    _____

    a. If a workers' compensation claim were filed on these types of cases, do you think that date of injury would be the same as that in the OSHA log? □Yes □No

       i. Why or why not? _____

    b. Do you think these kinds of injuries are more likely to show up in workers' compensation claims and not in OSHA logs or the BLS Survey? □Yes □No

       i. Why or why not? _____

45. Are these types of cases less likely to get recorded in the OSHA log compared to more acute injuries such as a fracture or puncture?
    □Yes □No Why or why not? _____

Other Factors

46. Has your company ever used temporary workers like those from Labor Ready or Kelly Services? □Yes □No

    a. [If yes], when was the last time temp workers were used? _____
    b. Do you currently use temp workers? □Yes □No
       i. How many? _____
       ii. What type of work do they do? _____
    c. If one of these temporary workers was injured while working here would you inform the temp agency? □Yes □No
    d. Would you include them on your OSHA log or BLS Survey? □OSHA □BLS □Neither
    e. Who supervises them onsite: □Hiring company □Supervisor from temp agency

47. Has your company ever used contractors? □Yes □No

    f. [If yes], when was the last time contractors were used? _____
    g. Do you currently use contractors? □Yes □No
       i. How many? _____
    h. If a contractor was injured while working here, would you include them on the OSHA log or BLS Survey? □OSHA □BLS □Neither

APPENDIX A (continued)

48. What kinds of safety campaigns, promotions, competitions, or awards programs does the company sponsor that promotes safety? *(PROBE FOR: Frequency and description of award and whether based on individual or group performance)*

□ Incentive programs [description]: _____

□ Other _____

49. Are workplace injury and illness rates included as a measure of performance in:
    a. **Your** performance reviews or evaluations □Yes □No □DK
    b. **Frontline supervisor** performance reviews or evaluations? □Yes □No □DK
    c. [if company bids on jobs] Are they included in the bid when competing for jobs? □Yes □No □DK

50. How do you discourage fraudulent reporting, if at all?

_____

_____

51. Do you ever compare the company's injury & illness rates to the industry average? □Yes □No
    [If yes] Where do you find the comparison data? _____

52. How does the company determine injury and illness–related performance goals?

_____

_____

53. Do you ever use the injury, illness, and fatality data available on the BLS's website? □Yes □No

54. Did you receive **formal training**, such as classes or seminars, to learn how to complete:

□The OSHA Log □The BLS Survey □Workers' Comp Forms □None

Years ago_____ Years ago_____ Years ago_____

APPENDIX A (continued)

Benefits/On–Site Medical

I have a few more questions on the benefits you provide to employees.

55. Do you offer medical insurance to employees? □ All □ Some □ None
    a. How many employees participate? □All □Some □None
    b. What is the waiting period before coverage is activated? _____
56. Do you offer paid sick leave? □All □Some □None
57. Paid vacation leave? □All □Some □None
58. Is there an option for employees to take vacation or sick leave instead of going through workers' compensation? □Yes □No

59. Do you have a health unit or office that provides treatment onsite? □Yes □No
60. Do you take an injured employee to a specific clinic? □Yes □No

(Hand respondent next page to have them complete.)

APPENDIX A (continued)

61. Companies emphasize different workplace injury and illness policies and practices. In your company, how would you rank the following in terms of priorities?

Policy or practice	Lower Priority	Medium Priority	Higher Priority
Safety and injury prevention	1	2	3
Bringing injured workers back to work	1	2	3
Arranging light duty	1	2	3
Assuring injured workers are 100% before returning	1	2	3
Assuring access to medical care for injured workers	1	2	3
Assuring quality of medical care for injured workers	1	2	3
Cost containment through claims management	1	2	3
Cost containment through injury prevention	1	2	3
Tracking work–related injuries and illnesses	1	2	3
Maintaining injury and illness records	1	2	3

62. Do you have any general thoughts or comments about OSHA log, BLS Survey, or injury and illness record–keeping?

_____

_____

APPENDIX B

Employer Interview Response Codebook

Question (may be paraphrased)	Codes	Definition	Includes/Examples
Company description	not coded		
Type of work employees do	not coded		
Worksite with higher injury rate and type of activity	not coded		
How company gets work if not from bid process	not coded		
Tell me about your position	not coded		
How do you learn about work–related injuries or illnesses	From IW	Injured worker informs respondent directly	Respondent receives report from IW in person, by phone, or by form completed and submitted by IW. If report completed by both IW and supervisor, code as From other internal
	From other internal	Injured worker informs other staff (e.g., supervisor) who informs respondent	IW's Supervisor informs respondent in person, by phone, or by form completed and submitted by supervisor. If report completed by both IW and supervisor, code as From other internal
	From multiple other internal	Injured worker informs other staff who reports to someone else who reports to respondent	IW tells supervisor who tells safety manager who tells respondent
	From external	Respondent informed of injury from HCP, L&I, TPA	Code if this is how they are usually informed of injury and mention no other process
What do you do in response	not coded		

APPENDIX B (continued)

Question (may be paraphrased)	Codes	Definition	Includes/Examples
Most challenging about maintaining record for multiple locations	Timely notification of injuries	Respondent finds it difficult to receive timely notification of injuries that occur at each location	Being notified immediately when injuries occur
	Receiving current information	Respondent has difficulty maintaining accurate, current case data	Delays in receiving information on total days of missed work, job transfer. May be waiting on physician, worker, offsite supervisor, other
	Employee totals	Respondent has difficulty determining total number of employees or hours worked by employees from each location	Getting work schedules; hours by location
	Nothing	Respondent does not find anything difficult about maintaining logs for multiple locations	
What information is hard to obtain to complete an OSHA log entry	Determining recordability – rules	Respondent finds it difficult to determine whether a case meets OSHA recordability due to confusion about the record–keeping rules	Not always clear from guidelines; some record all injuries to avoid underrecording;
	Determining recordability – info	Respondent finds it difficult to determine whether a case meets OSHA recordability because they lack sufficient information about medical treatment provided (often from physician)	Waiting on physician for diagnosis, treatment, or determination of work–relatedness
	Counting days—rules	Respondent finds it difficult to count days of missed work or DJTR due to confusion about the record–keeping rules	Include confusion over classifying case as DAFW vs. DJTR
	Counting days—info	Respondent finds it difficult to count days of missed work or DJTR because they lack sufficient information about missed, restricted work	Include difficulties getting current day data; limited updating of log

APPENDIX B (continued)

Question (may be paraphrased)	Codes	Definition	Includes/Examples
What information is hard to obtain to complete an OSHA log entry (continued)	Employee totals	Respondent has difficulty determining total number of employees or hours worked by employees	
	Nothing	Respondent does not find anything difficult about maintaining logs	
Software program used for injury records	Excel	Work injuries recorded in Excel or other electronic spreadsheet program	Include user–created format and excel version of OSHA 300 log
	Access	Work injuries recorded in Access database	
	Specialized injury software	Software program other than spreadsheet or access that tracks work injuries	Software programs related to WC claim tracking, risk management, proprietary programs with imbedded algorithms that determine OSHA recordability
How do you determine whether a case is recordable	OSHA	Injuries meeting the OSHA recordability criteria are recorded on the log	Mention of "OSHA decision tree," OSHA/DOSH/WAC/WISHA record–keeping standard; listing of recordability criteria: injuries with missed work, job transfer, loss of consciousness, medical treatment beyond first aid. Respondent need not list all criteria, but demonstrate familiarity with criteria. Include computer systems that determine OSHA recordability.
	WC	WC claims are recorded on log	Time–loss claims, filed claims, L&I incident report forms

APPENDIX B (continued)

Question (may be paraphrased)	Codes	Definition	Includes/Examples
How do you determine whether a case is recordable (continued)	Dr visit	Recorded cases are those where the worker goes to see a doctor/healthcare clinic. Injuries severe enough to be taken offsite to see a doctor, although treatment provided by doctor may not meet OSHA's definition of "medical treatment beyond first aid"	When worker seeks medical treatment; taken to the doctor; requires medical attention
	Inj	Records every known injury including first aid cases	"All injuries"; "anything that's reported"; "record everything"
	No OSHA	Establishment does not maintain OSHA logs	
Tell me about a case you didn't believe was work–related	Claim acceptance	May believe injury not caused by work but will record any claim accepted by L&I	Records accepted claims, removes rejected claims. May wait for claim decision before recording
	Claim filing	May believe injury not caused by work but will record any claim filed with L&I	Records filed claims, regardless of claim acceptance. May protest claim with L&I but still records.
	Employer discretion	Employer determines whether reported injury was work–related	Employer may consult several resources, makes decision based on that information. Ex., does not record accepted claims protested by employer.
	All injuries	Assumes all injuries reported by employees to be work–related	Records all injuries reported by employees, regardless of claim filing status.
What kinds of injuries/employees/employment characteristics are associated with immediate reporting	Severe acute injuries	Severe injuries resulting from a single work event	Examples: Broken bones, bloody cuts, stiches, requires immediate medical attention

APPENDIX B (continued)

Question (may be paraphrased)	Codes	Definition	Includes/Examples
What kinds of injuries/employees/employment characteristics are associated with immediate reporting (continued)	Minor acute injuries	Minor injuries resulting from a single work event	Examples: "Band–Aid only," first aid, injuries that start minor but progress to be more serious, injuries perceived to be minor by IW
	Slips, trips, falls	Slips, trips, falls (may be severe or minor)	Slips, trips, falls , Sprained ankles
	Nonobvious injuries	Injuries lacking visual confirmation (no open wound, no swollen ankle).	Pulled muscle, back strain, shoulder; Injuries that arise over time with no specific injury event; Hearing loss, CTS, MSD, repetitive motion, "soreness," dull pain
	Limited English	Workers with limited English skills	
	Former employees	Employees who report post–employment	Laid off workers, project workers
	Men	Male employees	Macho
	WC claim filing	Workers who don't understand WC claim–filing process	Self–insured workers who file state–fund claim
	Shift workers	Shift workers	Night shift, late shift
What kinds of injuries/employees/employment characteristics are associated with later reporting	same as Q21i		
What kinds of injuries/employees/employment characteristics are associated with reports from HCP	same as Q21i		
What kinds of injuries/employees/employment characteristics are associated with reports from HCP	same as Q21i		

APPENDIX B (continued)

Question (may be paraphrased)	Codes	Definition	Includes/Examples
What kinds of injuries/employees/employment characteristics are associated with reports from HCP	same as Q21i		
What kinds of injuries/employees/employment characteristics are associated with reports from HCP	same as Q21i		
Why would you cross out a recorded case?	Claim denied	Would cross out case if the claim was rejected by L&I	Claims denied/rejected
	Not OSHA–recordable	Would cross out case if respondent determined that the case did not meet OSHA recordability criteria, regardless of claim status.	Treatment limited to first aid, medical documentation does not support work–relatedness, exposure did not occur at current workplace
Classifying severity when worker experiences both DJTR and DAFW	Not coded—not very useful responses		
How often are claims from other company locations listed under your location?	Not coded—very rare occurrence		
What pieces of information are hard to get for BLS survey	Location	BLS–sampled worksite	
	Employee totals	Total number of employees or hours worked	
	Counting days	Tallying number of days of missed or restricted work	
	Race/ethnicity	R/E of injured worker	
	Incident	Other incident data requested by BLS	Time employee began work, time of event, what employee was doing before the incident
How do you determine which locations to include in each BLS survey?	BLS instructions	Uses written instructions to identify sampled locations	Address label, BLS instructions
	Call BLS	Calls BLS to clarify sampled locations	

APPENDIX B (continued)

Question (may be paraphrased)	Codes	Definition	Includes/Examples
What questions did you have for BLS	BLS called R	BLS contacted respondent about submitted data	BLS calling to check data accuracy. Calls with questions about: employee totals, case totals, number of days
	R called BLS about cases	Respondent contacted BLS with questions about cases	Case–related questions: Types of injuries, counting days
	R called BLS about sample	Respondent contacted BLS with questions about sample	Sample–related questions: location, subsample (usually based on injury dates)
	R called BLS about general	Respondent contacted BLS with general questions about survey	How to access online data entry, how to complete the survey
What information did they provide	Not coded		
How did you estimate the number of employees	Employees	Estimates employees by averaging number of employees over some time period	Monthly/weekly employment, head count, BLS/OSHA formula
	Hours	Estimates employees from total hours worked	Calculates FTE from hours
	Guess	Does not refer to documentation to estimate employees	Informal count, I just know
How did you estimate the total hours worked	Same as Q39a		
What types of cases did you omit from the BLS Survey	Not coded—rare occurrence		
What types of cases are unknown to you until after the BLS Survey	Not coded—rare occurrence		
How do you determine the date of injury on MSD cases	Treatment date	Date of first medical treatment	
	Report date	Date worker reported condition	
	Symptom date	Date worker was first symptomatic	
	WC date	Date WC lists as the injury date	

APPENDIX B (continued)

Question (may be paraphrased)	Codes	Definition	Includes/Examples
Why might MSD cases have same/different injury date in WC as OSHA log	Not coded		
Why might MSD cases be more likely to show up in WC claims and not OSHA logs	WC=OSHA	All claims are added to log	
	Work–related	May not show up on log because harder to confirm work–relatedness	Employer feels case not related to current job; relies on physician to determine whether work–related
	Delayed reporting	Less likely to be reported immediately, therefore may not get recorded on log —or may be recorded later	Workers go to doctor without informing employer; starts out minor, progresses over time; not immediately obvious to employer; no clear injury date
Why might MSD cases be more/less likely to be record on OSHA log compared with fracture	WC=OSHA	All claims are added to log	All claims treated equally (respondent does not mention whether MSDs less likely to result in claim)
	OSHA–recordability	All injuries evaluated against OSHA recordability criteria	All injuries (reported) treated equally (respondent does not mention whether MSDs less likely to be reported).
	Underreport all	Workers also fail to report all types of injuries—both acute and non–acute (acute and MSD equally unlikely to be reported)	Workers hide all types of injuries for any number of reasons
	Visible	Record–keeping and recording easier with a visible injury resulting from an injury event	Not obvious to employer; No clear injury date
	Delayed reporting	MSD less likely to be reported immediately, therefore may not get recorded on log—or may be recorded later	Workers go to doctor without informing employer; starts out minor, progresses over time; limited updating of logs over time

APPENDIX B (continued)

Question (may be paraphrased)	Codes	Definition	Includes/Examples
What type of work do temp workers do	Office–based	Work usually performed in an office environment, stationary (desk–based)	Accounting; admin; clerical; computer; HR; IT; office work
	Labor/production	Work usually performed outside of an office environment, requires movement	Assembly; clean–up; drivers; lifting; loading; nursing
Description of safety incentive program	Injury	Any measure of work–related injuries or illnesses used to determine award of prizes	OSHA recordable injuries, WC claims. Target measure can be some number or zero injuries/claims. Does not include posting injury–free days with no award tied to number of days. If both safety and injury are mentioned as measures, code as injury.
	Safety	Prizes awarded based on safety, not injuries	Reporting hazards, safety suggestions, participation in safety meetings/activities. If both safety and injury are mentioned as measures, code as injury.
	No incentive program	No prizes awarded	
How do you discourage fraudulent reporting	Not coded		
Where do you find injury data for comparison	BLS data	Uses published BLS injury estimates	BLS website; BLS data
	Industry association	Comparison data supplied by industry or trade association	Name of association; trade journal
	TPA, retro	TPA or retro group supplies comparison data	Name of TPA or retro group
	WC	Uses WC data to compare	Experience mod/rating/factor; claims data
	None	Does not compare	
How does the company determine injury–related performance goals	Zero	Goal is to have zero injuries	Measured as reported incidents; recordable injuries; claims

APPENDIX B (continued)

Question (may be paraphrased)	Codes	Definition	Includes/Examples
How does the company determine injury–related performance goals (continued)	Decrease	Aims for decrease in injuries	Percent reduction in recordable injuries or claims
	None	Does not set goals	
Do you have any general thoughts about work injury record–keeping?	Not coded		

APPENDIX C

TABLE XIII

LINKED RECORDS BY LINKAGE CRITERIA, 2003–2011

Last Name	First Name	Difference in Injury Dates	Difference in Birth Dates	Difference in Ages	Linked Records	Percent
Identical match	Identical match	0d	0d	.	39,730	57.4
Identical match	Identical match	0d	1wk	.	587	0.9
Identical match	Identical match	0d	>1wk	.	1,935	2.8
Identical match	Identical match	0d	.	same age	2,959	4.3
Identical match	Identical match	0d	.	1+ yrs diff	2,872	4.2
Identical match	Identical match	0d	.	.	124	0.2
Identical match	Identical match	1wk	0d	.	2,119	3.1
Identical match	Identical match	1wk	1wk	.	36	0.1
Identical match	Identical match	1wk	>1wk	.	113	0.2
Identical match	Identical match	1wk	.	same age	163	0.2
Identical match	Identical match	1wk	.	1+ yrs diff	225	0.3
Identical match	Identical match	1wk	.	.	12	0.0
Identical match	Identical match	>1wk	0d	.	1,511	2.2
Identical match	Identical match	>1wk	1wk	.	28	0.0
Identical match	Identical match	>1wk	>1wk	.	108	0.2
Identical match	Identical match	>1wk	.	same age	124	0.2
Identical match	Identical match	>1wk	.	1+ yrs diff	160	0.2
Identical match	Identical match	>1wk	.	.	8	0.0
Identical match	Identical match	.	.	same age	876	1.3
Identical match	Identical match	.	.	1+ yrs diff	2	0.0
Identical match	Phonetic match	0d	0d	.	1,704	2.5
Identical match	Phonetic match	0d	1wk	.	25	0.0
Identical match	Phonetic match	0d	>1wk	.	99	0.1
Identical match	Phonetic match	0d	.	same age	121	0.2
Identical match	Phonetic match	0d	.	1+ yrs diff	119	0.2
Identical match	Phonetic match	0d	.	.	4	0.0
Identical match	Phonetic match	1wk	0d	.	97	0.1
Identical match	Phonetic match	1wk	1wk	.	1	0.0
Identical match	Phonetic match	1wk	>1wk	.	9	0.0
Identical match	Phonetic match	1wk	.	same age	7	0.0
Identical match	Phonetic match	1wk	.	1+ yrs diff	12	0.0
Identical match	Phonetic match	1wk	.	.	1	0.0

APPENDIX C (continued)

LINKED RECORDS BY LINKAGE CRITERIA, 2003–2011

Last Name	First Name	Difference in Injury Dates	Difference in Birth Dates	Difference in Ages	Linked Records	Percent
Identical match	Phonetic match	>1wk	0d	.	50	0.1
Identical match	Phonetic match	>1wk	1wk	.	1	0.0
Identical match	Phonetic match	>1wk	>1wk	.	9	0.0
Identical match	Phonetic match	>1wk	.	same age	5	0.0
Identical match	Phonetic match	>1wk	.	1+ yrs diff	10	0.0
Identical match	Phonetic match	.	.	same age	38	0.1
Identical match	First initial match	0d	0d	.	4,390	6.3
Identical match	First initial match	0d	1wk	.	57	0.1
Identical match	First initial match	0d	>1wk	.	228	0.3
Identical match	First initial match	0d	.	same age	426	0.6
Identical match	First initial match	0d	.	1+ yrs diff	423	0.6
Identical match	First initial match	0d	.	.	9	0.0
Identical match	First initial match	1wk	0d	.	289	0.4
Identical match	First initial match	1wk	1wk	.	5	0.0
Identical match	First initial match	1wk	>1wk	.	16	0.0
Identical match	First initial match	1wk	.	same age	31	0.0
Identical match	First initial match	1wk	.	1+ yrs diff	43	0.1
Identical match	First initial match	1wk	.	.	3	0.0
Identical match	First initial match	>1wk	0d	.	164	0.2
Identical match	First initial match	>1wk	1wk	.	4	0.0
Identical match	First initial match	>1wk	>1wk	.	19	0.0
Identical match	First initial match	>1wk	.	same age	7	0.0
Identical match	First initial match	>1wk	.	1+ yrs diff	25	0.0
Identical match	First initial match	>1wk	.	.	1	0.0
Identical match	First initial match	.	.	same age	116	0.2
Identical match	First initial match	.	.	1+ yrs diff	1	0.0
Identical match	Similar name	0d	0d	.	79	0.1
Identical match	Similar name	0d	>1wk	.	5	0.0
Identical match	Similar name	0d	.	same age	9	0.0
Identical match	Similar name	0d	.	1+ yrs diff	7	0.0
Identical match	Similar name	1wk	0d	.	7	0.0
Identical match	Similar name	1wk	>1wk	.	3	0.0
Identical match	Similar name	1wk	.	1+ yrs diff	2	0.0
Identical match	Similar name	>1wk	0d	.	3	0.0
Identical match	Similar name	>1wk	>1wk	.	1	0.0
Identical match	Similar name	.	.	same age	3	0.0
Identical match	Other	0d	0d	.	425	0.6
Identical match	Other	0d	1wk	.	6	0.0
Identical match	Other	0d	>1wk	.	29	0.0

APPENDIX C (continued)

LINKED RECORDS BY LINKAGE CRITERIA, 2003–2011

Last Name	First Name	Difference in Injury Dates	Difference in Birth Dates	Difference in Ages	Linked Records	Percent
Identical match	Other	0d	.	same age	36	0.1
Identical match	Other	0d	.	1+ yrs diff	41	0.1
Identical match	Other	0d	.	.	3	0.0
Identical match	Other	1wk	0d	.	26	0.0
Identical match	Other	1wk	>1wk	.	50	0.1
Identical match	Other	1wk	.	same age	2	0.0
Identical match	Other	1wk	.	1+ yrs diff	10	0.0
Identical match	Other	>1wk	0d	.	19	0.0
Identical match	Other	>1wk	1wk	.	1	0.0
Identical match	Other	>1wk	>1wk	.	115	0.2
Identical match	Other	>1wk	.	same age	6	0.0
Identical match	Other	>1wk	.	1+ yrs diff	18	0.0
Identical match	Other	>1wk	.	.	3	0.0
Identical match	Other	.	.	same age	13	0.0
Identical match	Other	.	.	1+ yrs diff	3	0.0
Phonetic match	Identical match	0d	0d	.	1,539	2.2
Phonetic match	Identical match	0d	1wk	.	31	0.0
Phonetic match	Identical match	0d	>1wk	.	98	0.1
Phonetic match	Identical match	0d	.	same age	93	0.1
Phonetic match	Identical match	0d	.	1+ yrs diff	145	0.2
Phonetic match	Identical match	0d	.	.	10	0.0
Phonetic match	Identical match	1wk	0d	.	101	0.2
Phonetic match	Identical match	1wk	1wk	.	2	0.0
Phonetic match	Identical match	1wk	>1wk	.	6	0.0
Phonetic match	Identical match	1wk	.	same age	13	0.0
Phonetic match	Identical match	1wk	.	1+ yrs diff	9	0.0
Phonetic match	Identical match	>1wk	0d	.	78	0.1
Phonetic match	Identical match	>1wk	1wk	.	1	0.0
Phonetic match	Identical match	>1wk	>1wk	.	9	0.0
Phonetic match	Identical match	>1wk	.	same age	6	0.0
Phonetic match	Identical match	>1wk	.	1+ yrs diff	7	0.0
Phonetic match	Identical match	.	.	same age	29	0.0
Phonetic match	Phonetic match	0d	0d	.	93	0.1
Phonetic match	Phonetic match	0d	1wk	.	5	0.0
Phonetic match	Phonetic match	0d	>1wk	.	8	0.0
Phonetic match	Phonetic match	0d	.	same age	12	0.0
Phonetic match	Phonetic match	0d	.	1+ yrs diff	8	0.0
Phonetic match	Phonetic match	0d	.	.	1	0.0
Phonetic match	Phonetic match	1wk	0d	.	4	0.0

APPENDIX C (continued)

LINKED RECORDS BY LINKAGE CRITERIA, 2003–2011

Last Name	First Name	Difference in Injury Dates	Difference in Birth Dates	Difference in Ages	Linked Records	Percent
Phonetic match	Phonetic match	1wk	>1wk	.	2	0.0
Phonetic match	Phonetic match	1wk	.	same age	2	0.0
Phonetic match	Phonetic match	>1wk	0d	.	3	0.0
Phonetic match	Phonetic match	>1wk	>1wk	.	12	0.0
Phonetic match	Phonetic match	>1wk	.	1+ yrs diff	3	0.0
Phonetic match	Phonetic match	.	.	same age	2	0.0
Phonetic match	First initial match	0d	0d	.	222	0.3
Phonetic match	First initial match	0d	1wk	.	3	0.0
Phonetic match	First initial match	0d	>1wk	.	8	0.0
Phonetic match	First initial match	0d	.	same age	18	0.0
Phonetic match	First initial match	0d	.	1+ yrs diff	23	0.0
Phonetic match	First initial match	1wk	0d	.	10	0.0
Phonetic match	First initial match	1wk	>1wk	.	8	0.0
Phonetic match	First initial match	1wk	.	same age	2	0.0
Phonetic match	First initial match	1wk	.	1+ yrs diff	3	0.0
Phonetic match	First initial match	>1wk	0d	.	9	0.0
Phonetic match	First initial match	>1wk	>1wk	.	38	0.1
Phonetic match	First initial match	>1wk	.	same age	1	0.0
Phonetic match	First initial match	>1wk	.	1+ yrs diff	9	0.0
Phonetic match	First initial match	.	.	same age	4	0.0
Phonetic match	Similar name	0d	0d	.	2	0.0
Phonetic match	Similar name	0d	.	.	1	0.0
Phonetic match	Similar name	1wk	.	1+ yrs diff	1	0.0
Phonetic match	Similar name	>1wk	>1wk	.	1	0.0
Phonetic match	Other	0d	0d	.	26	0.0
Phonetic match	Other	0d	>1wk	.	14	0.0
Phonetic match	Other	0d	.	same age	3	0.0
Phonetic match	Other	0d	.	1+ yrs diff	7	0.0
Phonetic match	Other	1wk	1wk	.	1	0.0
Phonetic match	Other	1wk	>1wk	.	113	0.2
Phonetic match	Other	1wk	.	same age	2	0.0
Phonetic match	Other	1wk	.	1+ yrs diff	20	0.0
Phonetic match	Other	1wk	.	.	1	0.0
Phonetic match	Other	>1wk	0d	.	2	0.0
Phonetic match	Other	>1wk	>1wk	.	311	0.5
Phonetic match	Other	>1wk	.	same age	6	0.0
Phonetic match	Other	>1wk	.	1+ yrs diff	42	0.1
Phonetic match	Other	>1wk	.	.	6	0.0
Similar name	Identical match	0d	0d	.	697	1.0

APPENDIX C (continued)

LINKED RECORDS BY LINKAGE CRITERIA, 2003–2011

Last Name	First Name	Difference in Injury Dates	Difference in Birth Dates	Difference in Ages	Linked Records	Percent
Similar name	Identical match	0d	1wk	.	13	0.0
Similar name	Identical match	0d	>1wk	.	27	0.0
Similar name	Identical match	0d	.	same age	46	0.1
Similar name	Identical match	0d	.	1+ yrs diff	40	0.1
Similar name	Identical match	1wk	0d	.	44	0.1
Similar name	Identical match	1wk	1wk	.	1	0.0
Similar name	Identical match	1wk	>1wk	.	5	0.0
Similar name	Identical match	1wk	.	same age	3	0.0
Similar name	Identical match	>1wk	0d	.	13	0.0
Similar name	Identical match	>1wk	.	same age	3	0.0
Similar name	Identical match	.	.	same age	30	0.0
Similar name	Phonetic match	0d	0d	.	46	0.1
Similar name	Phonetic match	0d	1wk	.	3	0.0
Similar name	Phonetic match	0d	.	same age	2	0.0
Similar name	Phonetic match	0d	.	1+ yrs diff	1	0.0
Similar name	Phonetic match	1wk	0d	.	2	0.0
Similar name	Phonetic match	.	.	same age	3	0.0
Similar name	First initial match	0d	0d	.	133	0.2
Similar name	First initial match	0d	1wk	.	1	0.0
Similar name	First initial match	0d	>1wk	.	3	0.0
Similar name	First initial match	0d	.	same age	11	0.0
Similar name	First initial match	0d	.	1+ yrs diff	2	0.0
Similar name	First initial match	1wk	0d	.	8	0.0
Similar name	First initial match	.	.	same age	9	0.0
Similar name	Similar name	0d	0d	.	4	0.0
Similar name	Similar name	0d	.	same age	1	0.0
Similar name	Other	0d	0d	.	14	0.0
Similar name	Other	0d	1wk	.	1	0.0
Similar name	Other	0d	>1wk	.	4	0.0
Similar name	Other	1wk	0d	.	3	0.0
Other	Identical match	0d	0d	.	576	0.8
Other	Identical match	0d	1wk	.	8	0.0
Other	Identical match	0d	>1wk	.	15	0.0
Other	Identical match	0d	.	same age	38	0.1
Other	Identical match	0d	.	1+ yrs diff	38	0.1
Other	Identical match	1wk	0d	.	27	0.0
Other	Identical match	1wk	1wk	.	2	0.0
Other	Identical match	1wk	>1wk	.	10	0.0
Other	Identical match	1wk	.	same age	7	0.0

APPENDIX C (continued)

LINKED RECORDS BY LINKAGE CRITERIA, 2003–2011

Last Name	First Name	Difference in Injury Dates	Difference in Birth Dates	Difference in Ages	Linked Records	Percent
Other	Identical match	>1wk	0d	.	10	0.0
Other	Identical match	>1wk	>1wk	.	18	0.0
Other	Identical match	>1wk	.	same age	11	0.0
Other	Identical match	.	.	same age	16	0.0
Other	Phonetic match	0d	0d	.	39	0.1
Other	Phonetic match	0d	1wk	.	2	0.0
Other	Phonetic match	0d	>1wk	.	1	0.0
Other	Phonetic match	0d	.	same age	1	0.0
Other	Phonetic match	0d	.	1+ yrs diff	2	0.0
Other	Phonetic match	1wk	>1wk	.	1	0.0
Other	Phonetic match	1wk	.	1+ yrs diff	1	0.0
Other	First initial match	0d	0d	.	63	0.1
Other	First initial match	0d	>1wk	.	3	0.0
Other	First initial match	0d	.	same age	7	0.0
Other	First initial match	1wk	0d	.	4	0.0
Other	First initial match	1wk	>1wk	.	1	0.0
Other	First initial match	1wk	.	1+ yrs diff	1	0.0
Other	First initial match	>1wk	>1wk	.	1	0.0
Other	First initial match	>1wk	.	same age	1	0.0
Other	First initial match	.	.	same age	2	0.0
Other	Similar name	0d	0d	.	3	0.0
Other	Other	0d	0d	.	34	0.1
Other	Other	0d	1wk	.	1	0.0
Other	Other	0d	>1wk	.	35	0.1
Other	Other	0d	.	same age	6	0.0
Other	Other	0d	.	1+ yrs diff	1	0.0
Other	Other	1wk	0d	.	2	0.0
Other	Other	1wk	.	1+ yrs diff	33	0.1
Other	Other	1wk	.	.	1	0.0
Other	Other	.	.	same age	5	0.0
Other	Other	.	.	1+ yrs diff	1	0.0
Not provided	Not provided	0d	0d	.	104	0.2
Not provided	Not provided	0d	1wk	.	3	0.0
Not provided	Not provided	0d	>1wk	.	3	0.0
Not provided	Not provided	0d	.	same age	20	0.0
Not provided	Not provided	0d	.	1+ yrs diff	138	0.2
Not provided	Not provided	0d	.	.	5	0.0
Not provided	Not provided	1wk	0d	.	5	0.0
Not provided	Not provided	1wk	>1wk	.	4	0.0

APPENDIX C (continued)

LINKED RECORDS BY LINKAGE CRITERIA, 2003–2011

Last Name	First Name	Difference in Injury Dates	Difference in Birth Dates	Difference in Ages	Linked Records	Percent
Not provided	Not provided	1wk	.	same age	25	0.0
Not provided	Not provided	1wk	.	1+ yrs diff	247	0.4
Not provided	Not provided	1wk	.	.	19	0.0
Not provided	Not provided	>1wk	>1wk	.	3	0.0
Not provided	Not provided	>1wk	.	.	3	0.0
Not provided	Not provided	.	.	same age	4	0.0

APPENDIX D

IRB Approval

APPROVED

DEC 1 8 2009

Washington State
Institutional Review Board

Washington State Institutional Review Board (IRB)
Research Application: Human Subjects Protection Review

WSIRB USE ONLY
D-20109-L

1. Project Identification

1.1 **Project Title** **Matching BLS Data to Workers Compensation Claims**

1.2 **Anticipated Start Date** **12/01/2009** **End Date** **10/31/2014**

1.3 **Research Abstract.** Provide a brief synopsis of the research that describes the purpose, methods and significance of the proposed activity. Please limit to 350 words.

Current estimates of the burden of worker occupational injury and illness rely on employer reporting of occupational injury and illness (OII) on the statutorily required workplace OSHA log. The federally sponsored surveillance system, the US Bureau of Labor Statistics (BLS) Survey of Occupational Injury and Illness (SOII), samples employer OSHA log data across industries to provide annual state and federal estimates of the number and incidence rate of OII. Recent published capture recapture estimates matching BLS SOII microdata to WA workers compensation (WC) case records suggest a significant discrepancy between the two data systems with possibly significant underreporting of OII on the BLS SOII (Boden, 2008). This research proposal seeks to further evaluate the reasons for the discrepancies between WA WC data and state OII estimates from WA BLS SOII and to pilot a multisource surveillance system for amputation and CTS cases using multiple data sources.

We propose linking Washington State WC claims data to BLS SOII data for cases reported to either system from 2006 - 2009 to estimate and further characterize the cases that appear uniquely in each dataset and explore possible reasons for the discrepancy in capture between the data systems. The match between the two systems requires both a match at the employer establishment level and at the individual record of the individual worker.

Concurrently, we anticipate using both the WA WC claims data and the BLS SOII data to pilot the development of a multisource surveillance system for amputation injuries and occupational carpal tunnel syndrome (CTS). Identification of CTS and amputation cases across data systems will be made by using available injury and illness classification codes across systems e.g. BLS Occupational Injury and Illness Classification (OIICS) codes, ICD-9 diagnosis and procedure codes, CPT codes, DRG and other coding systems. Key words in the injury narratives available in the workers' compensation data will also be used to identify cases. Clinical case confirmation of amputation and CTS cases will occur using WC medical record files. Ultimately, our findings may suggest ways in which more complete case ascertainment could be accomplished, improving occupational injury and illness estimates that are used to inform state surveillence and intervention programs.

1.4 **Principal Investigator** (PI)

NAME	HIGHEST DEGREE(S) EARNED
David Bonauto	**MD**
AGENCY OR ORGANIZATION NAME (AGENCY, UNIVERSITY, PROFESSIONAL ORGANIZATION, COMMERCIAL RESEARCH FIRM, ETC.)	
Washington State Department of Labor and Industries, SHARP	
COMPLETE MAILING ADDRESS (INCLUDE CITY, STATE, ZIP CODE)	
PO Box 44330, Olympia, WA 98501	
TITLE	EMAIL ADDRESS
Associate Medical Director	**bone235@lni.wa.gov**

APPENDIX D (continued)

OFFICE PHONE NUMBER	CELL/PAGER NUMBER	FAX NUMBER
360-902-5664	360-878-0185	360-902-5672

WSIRB requires principal investigators and co-investigators to complete training in human subjects protection every three years.

Most recent human subjects protection training (describe): Date completed: 6/12/2008

CITI Refresher Training

As **Principal Investigator**, I acknowledge that I am responsible for the submission of this application. I have fully reviewed the application forms and instructions and believe this application is complete and accurate. I affirm that, if approved, this research will be conducted in compliance with WSIRB-approved procedures and requirements.

SIGNATURE OF PI	DATE
	12/11/09

1.5 **Supervisor of the PI.** PI's direct supervisor or person in the organization responsible for this research.

NAME	TITLE
Barbara Silverstein	SHARP Research Director
AGENCY OR ORGANIZATION NAME (AGENCY, UNIVERSITY, PROFESSIONAL ORGANIZATION, COMMERCIAL RESEARCH FIRM, ETC.)	
Washington State Department of Labor and Industries, SHARP	
SIGNATURE / DATE	EMAIL ADDRESS
Barbara Silverstein 12/4/09	silb235@lni.wa.gov

Investigators who are not affiliated with DSHS, DOH, or L&I must complete and sign Appendix E: Unaffiliated Investigator Agreement and submit it with the signed original application

1.6 **Co-Investigator(s) and Research Staff.** Include all individuals who will conduct procedures with subjects, collect data from subjects or have access to subjects' identifiable personal information.

NAME		HIGHEST DEGREE(S) EARNED
Darrin Adams		BS
ROLE IN PROJECT		EMAIL ADDRESS
Data extraction, matching		adam235@lni.wa.gov
AGENCY OR ORGANIZATION NAME (AGENCY, UNIVERSITY, PROFESSIONAL ORGANIZATION, COMMERCIAL RESEARCH FIRM, ETC.)		
Washington State Department of Labor and Industries, SHARP		
MAILING ADDRESS		
PO Box 44330, Olympia, WA 98501		
OFFICE PHONE NUMBER	CELL/PAGER NUMBER	FAX NUMBER
360-902-4531		360-902-5672

WSIRB requires principal investigators and co-investigators to complete training in human subjects protection every three years.

Most recent human subjects protection training (describe): Date completed: 07/10/07

CITI Online

* If there are additional co-investigators and research staff, complete Appendix A: Additional Research Staff and include it with the application.

1.7 **Student Research.** Proposals submitted by graduate students also must be approved by their academic advisor or chair of their committee.

ADVISOR/COMMITTEE CHAIR NAME	HIGHEST DEGREE(S) EARNED	EMAIL ADDRESS
AGENCY OR ORGANIZATION NAME (AGENCY, UNIVERSITY, PROFESSIONAL ORGANIZATION, COMMERCIAL RESEARCH FIRM, ETC.)		
MAILING ADDRESS		
OFFICE PHONE NUMBER	CELL/PAGER NUMBER	FAX NUMBER

As **Academic Advisor/Committee Chair** to the Student Investigator, I will provide oversight for this research. I have read and approved the research design and methods.

APPENDIX D (continued)

SIGNATURE OF ADVISOR/COMMITTEE CHAIR	DATE

1.8 **Person preparing this document** (if other than PI)

NAME	PHONE NUMBER	FAX NUMBER
Sara Wuellner	**360-902-6727**	**360-902-5672**
ROLE IN PROJECT	EMAIL ADDRESS	
Project Director	**wues235@lni.wa.gov**	

1.9 **Attach curriculum vitae or resumes for the PI, co-investigator(s), and research staff (definition in Section 1.6). Do not exceed five pages per person.**

2. Funding

2.1 Is this research funded by any organization?

☐ No - Explain how proposed research will be supported.

☒ Yes

TYPE OF FUNDING SOURCE(S)
☐ Federal - HHS ☒ Federal - other ☐ State, local government ☐ Private foundation
☐ Other (describe):

FUNDING AGENCY(S) NAME		MAILING ADDRESS
US Bureau of Labor Statistics		**2 Massachusetts Ave., NE**
CONTACT PERSON		**Washington, DC 20212**
John Ruser, PhD		
PHONE NUMBER	FAX NUMBER	EMAIL ADDRESS
(202) 691-6304	**(202) 691-7862**	**ruser.john@bls.gov**

APPENDIX D (continued)

If this project is funded by an external agency and DSHS, DOH, or L&I is the grantee, include a copy (double-sided) of the entire grant with this application.

2.2 **Research budget total:** $834,904 Start Date 9/1/2009 End Date 8/30/2012

2.3 **Provide a summary of the major budget categories. If this is a multi-site study, include only the amount of the budget allocated to the study site described in this proposal.**

Personnel: $600,390
Travel: $23,250
Equipment: $19,182
Consultant: $18,000
Other: $30,000
Indirect: $143,617

3. Conflict of Interest

3.1 **Does any member of the research team, or a member of his/her immediate family, have a financial interest in the research, its products, or the study sponsor?**

☒ No
☐ Yes - Identify the individual(s):

Explain the nature and the monetary value of the financial interest.

Explain how this potential conflict of interest will be managed.

3.2 **Does any member of the research team have a potential non-financial conflict of interest in the research?** (e.g., recruiting own clients/patients)

☒ No
☐ Yes - Identify the individual(s):

Explain the nature of the potential non-financial conflict of interest.

Explain how this potential non-financial conflict of interest will be managed.

4. Requests for State Agency Record Information and/or Staff Resources

If the research requires record information or resource contributions from DSHS, DOH, or L&I, you must discuss your plans with the administrator responsible for the records or resources requested. Submit a copy of the application to each administrator and obtain their signature(s) on **Appendix G** and/or **Appendix H** to document their support for the research.

4.1 **Does the research require use and/or disclosure of identifiable records or Protected Health Information (PHI) from DSHS, DOH, L&I, or from DOH records housed at the UW Department of Epidemiology?**

☒ No
☐ Yes – Complete **Appendix G: Requests for Use or Disclosure of Records.**

4.2 **Does the research require other resources or assistance from DSHS, DOH, or L&I?** (Including professional consultation, clerical services, facilities/equipment, and assistance in identifying /contacting subjects.)

☒ No
☐ Yes – Complete **Appendix H: Resource Requests.**

5. Study Description

Use lay language that can be understood by a person unfamiliar with your area of research. Do not refer to, or copy and paste from, a grant application or from the research abstract in Section 1.3 of this application.

APPENDIX D (continued)

5.1 **Describe the purpose and the conceptual rationale of the proposed research.** Specify the research questions and/or hypotheses the research will attempt to address. Include a brief summary of the pertinent literature with citations, if applicable. (If this is evaluation research, provide a summary description of the program or intervention being evaluated.)

Rationale: This IRB application has two components which are submitted together since both rely on the same data sources and the efficiencies gained with completing both projects as one research proposal. The two proposals are a Matching Study and Piloting a Multisource Surveillance System.

Matching Study: Current estimates of the burden of worker occupational injury and illness rely on employer reporting of occupational injury and illness on the statutorily required workplace OSHA 300 log. The federally sponsored surveillance system, the US Bureau of Labor Statistics (BLS) Survey of Occupational Injury and Illness (SOII), samples employer OSHA log data across industries to provide annual US and state estimates of the number and incidence rate of workplace injuries and illnesses. Estimates are stratified by worker demographic groups, industry, occupation and by severity with special attention to those injuries requiring days away from work (DAFW).

Recent research suggests that when directly comparing injured worker cases reported to the BLS SOII to other data systems including workers compensation data, there is a significant discrepancy between the eligible cases reported (Boden, 2008; Rosenman, 2006). Capture recapture estimates by Boden and Ozonoff suggest that approximately 52% of qualifying cases (>3 DAFW) appearing in Washington State workers compensation (WC) data were also captured by the BLS SOII, while 96% of the cases in the BLS SOII also were in WA WC. The results and concerns related to the underreporting of occupational injuries prompted the US Congress and others for a research program to further characterize the reasons for this discrepancy and asked the BLS and others to propose additional research regarding the cause of this discrepancy. The suggested activities are conducting research to identify the source for underreporting on the BLS SOII and to pilot a proposed modification of state and national surveillance using multiple data sources to estimate the burden of select occupational injuries and illness, specificially, amputations and CTS.

Possible reasons for the discrepancy between BLS SOI data and WA WC data are numerous (Ruser, 2008; Nestoriak and Pierce, 2009). Current suggested ideas, among many, include:

a) there are defined timelines for reporting cases to the BLS system (within seven days of employer notification) which may not match those timelines for workers compensation case reporting (if cases are reported after the BLS SOII data is collected, BLS will underestimate the number of cases). Washington State WC transactional data (billing records, administrative records (acceptance, rejection of case), date of injury, date claim established) will likely provide clarity regarding the timelines associated with matched cases and mismatched cases;

b) employer knowledge, and beliefs associated with what injuries and illnesses to record on the OSHA log and subsequently SOII (e.g. contested WC claims; updated injury descriptions associated with administrative and medical procedures; temporary workers or subcontractors and other employment scenarios which blur employer responsibility);

c) failure to match appropriately between data systems - restricted datasets did not allow additional information that may have facilitated matching such as place of injury, or within multiestablishment employers; and

d) Specific types of injury and illness may be underreported more commonly on SOII e.g. musculoskeletal disorders like carpal tunnel syndrome, rotator cuff syndrome.

The purpose of this research proposal is to match the WA BLS SOII data to the Washington State workers compensation data and further explore the reasons for the discrepancy between the two data systems. This will require extensive use of the Washington State workers compensation data since it is the more detailed dataset from which to characterize the actual claims. Occupational injury and illness

APPENDIX D (continued)

surveillance and prevention programs rely on data to guide and evaluate their efforts. Historically, BLS SOII trends have pointed to an overall decline in occupational injury and illness rates and thus systematic or variation in underreporting of OII to SOII may lead to an erroneous impression of the effectiveness of safety and health efforts. Data that is both accurate and complete is essential in designing quality programs.

It is important to note that there is significant national interest in the results of this work, specifically from the US Congress, the AFL-CIO, the US Chamber of Commerce, the AFL-CIO, and other occupational safety and health stakeholders. This intense interest likely will results in significant scrutiny of the results and subsequent demands related to additional analyses and research. While we expect to complete the described portions of the study by 6/30/2012 with likely continued publications until 6/30/2014, there may be additional requests for analyses of these data and susbsequent survey years.

Pilot Multisource Surveillance System: State based surveillance experts have proposed a possible alternative model for estimating state and federal non-fatal numbers and incidence rates of occupational injury and illness through creation of a multi-datasource surveillance system. This type of surveillance system currently operates for fatalities and is organized through BLS as the Census of Fatal Occupational Injury (CFOI). Optimally, like BLS CFOI, the system would incorporate many state and national data sources to provide both state and national estimates of occupational injury and illness. The Bureau of Labor Statistics (BLS) Survey of Occupational Injuries and Illnesses (SOII) is a principle source for surveillance data on national and state workplace injuries and illnesses; however, recent studies have called into question the completeness of the annual SOII estimates, suggesting that SOII underestimates the actual number of specific cases of occupational injury and illness. (Nestoriak and Pierce, 2009).

Washington State workers' compensation insurance is administered as an exclusive state 'monopoly' through the Washington State Department of Labor and Industries. As the insurer, Washington has unparalleled access to the insurance record and medical billing. Many other states use data systems created by their Department of Health (like 'Hospital Discharge Data', 'Emergency Department Data') to identify work-related injury and illness cases when the record indicates that workers compensation insurance is the payer. Many of these data systems capture the information about an injury at one point in time and have datasets with limited information. In Washington, L&I systematically collects information on WC claims for medical bill payment from outpatient, emergency dept, hospital, and other provisions of medical services; L&I also independently codes injury and illness information presented on the report of accident form and from administrative decisions by claim adjudicators. Thus, we are able to identify cases of disease across time and with various data systems (outpatient medical bills, pharmacy bills) that are unavailable in other states. A limitation of using workers compensation data is if a claim is not filed, a case can not be identified in WA workers compensation data.

The purpose of the multisource surveillance system pilot study is to use multiple data sources to take a census of two specific conditions, work-related carpal tunnel syndrome (WR-CTS) and amputations. First, we will use two data sources, the WA workers compensation data and the BLS SOII data for WA, to enumerate and characterize cases of WR-CTS and amputations among Washington workers. Additional data sources will be added to the multisource system in a subsequent application. We also plan to assess the feasibility of using such an approach and the ability to generalize findings to other states. We plan to expand the use of additional datasystems for multisource surveillance of CTS and amputations with a separate IRB application to use DOH CHARS data and DOH trauma registry data.

APPENDIX D (continued)

References:

Boden LI, Ozonoff A. Capture-Recapture Estimates of Non-fatal Workplace Injuries and Illnesses. Annals of Epidemiology. 2008:500-506.

Nestoriak N, Pierce B. Comparing workers' compensation claims with establishment responses to the SOII. Monthly Labor Review. May 2009: 57-63.

Rosenman KD, Kalush A, Reilly MJ, Gardiner JC, Reeves M, Luo Z. How much work-related injury and illness is missed by the current national surveillance system? J Occup Environ Med. 2006 Apr;48(4):357-65.

Ruser JW. Examining evidence on whether BLS undercounts workplace injuries and illnesses. Monthly Labor Review. 2008:20-32.

APPENDIX D (continued)

5.2 **Describe the study design and analysis plan.** Describe the sampling plan, the size of the sample or study group(s), and the power of the planned statistical tests. If applicable, specify the major independent, dependent, and extraneous variables, and discuss possible threats to internal and/or external validity. Describe the statistical tests that will be used and explain how the expected outcomes are related to the research objectives.

Matching Study: We will attempt to match all cases that appear in the WA BLS SOII data to cases that appear in the WA workers compensation data for the years 2006 - 2009. Our initial approach is similar to that employed by Dr. Boden in his comparison study except that we will use additional data elements from the WA WC and SOII data systems as well as data from the Washington Employment Security Department to improve matching.

The research component of the matching study requires several steps - we intend to first match employer establishments across the two systems, match OII cases in matched establishments, and then attempt a match of all cases across systems (this assesses misassignment by employers of workers to an individual business establishment and serves a final attempt to match between systems). While the end result of the study may be a 'capture-recapture' analysis which requires cases meeting eligibility criteria for inclusion into both WC and the BLS SOII, this analysis seeks to match all cases initially then apply the exclusion criteria, and in this manner the cases excluded can be analyzed for the appropriateness of the exclusion (i.e. cases may not be assigned the appropriate number of time loss days). The matching portion of this study in terms of protecting human subject could be reduced to solely matching injured worker cases between the two systems (skipping the employer establishment match) but the research requires an establishment match which we wish to elaborate on especially since it uses ESD QCEW data.

Matching establishments--The adequacy of BLS SOII estimates depends on understanding the OII cases reported by employer establishment relative to workers compensation claims reported for that establishment. In order to match by employer establishment between workers compensation and BLS SOII we will use L&I employer account information, L&I's access to WA State Employment Security Department data and BLS SOII establishment data. The rationale for this method is based on BLS Survey methods.

The main source for the SOII establishment sampling frame is the BLS Quarterly Census of Employment and Wages (QCEW). The QCEW is a quarterly census of employers reporting employment and wages by ownership, county, and six digit NAICS. QCEW data is reported to federal BLS by the Washington State Employment Security Department (ESD). The data set contains establishment identifiers (Federal ID) and is linkable to the Uniform Business Identifier (UBI) assigned by WA State. Since WA L&I WC and ESD have well correlated but not perfectly matched definitions of establishments, using the ESD QCEW data allows us to start with the exact establishment sampled by BLS SOII and 'trace it back' to the L&I data. This is especially important in multiestablishment firms where employer establishment accounts assigned by ESD and L&I vary significantly.

BLS SOII establisments will be matched to ESD employer identifiers thus identifying the WA State UBI number. Subsequently, the UBI will be linked to the WA L&I account information. Establishments within L&I accounts will be identified. If there is not an exact match within L&I, we will have to depend on case matching verifying that the case occurred within the ESD account.

A second use of the QCEW data is the documentation of employment of individuals. ESD QCEW contains records of employed individuals by employer account (not establishment) with SSN and name of the worker and thus when it is unclear if a worker is injured at a sampled establishment in L&I data (especially in multiestablishment firms), the L&I SSN and name of the injured worker can be used confirm the match to the employers account at the UBI level. Dr. Boden, while not using this method, included these types of cases as matched individual workers.

APPENDIX D (continued)

Matching Injured Workers between BLS and WA WC System:

All State Fund and Self Insured workers compensation claims (including rejected, medical only, and disability claims) for the years 2006 - 2009, defined by date established in the WA WC system, will be extracted. In addition all transactional data will be extracted to examine the effect of data developing over time reflecting symptoms, procedures, or diagnoses subsequent to the initial injury and the change in claim status from medical only to disability (and thus requiring inclusion in the BLS SOII). WA WC claims will be linked to SOII cases reported for the same time frame using employer and employee data including employer identifier, employer name, employer address, worker name, sex, date of birth, and date of injury. Records will be first linked deterministically; matching software (LinkPro software) will be used to attempt to link the remaining records probabilistically. Two researchers will manually review the probabilistic match to determine if it is indeed a match. Optimally, cases will match at the establishment level, i.e. that in the both WA WC and SOII data, the case is ascribed to the site of employment rather than the company's centralized mailing address. Employer address mismatches will be noted.

Records will then be grouped into one of three categories: matched cases; cases only in SOII; and cases only in workers compensation. Descriptive statistics will be used to characterize the three categories in terms of industry, occupation, date of disability, nature of injury, and other employee and employer variables.

Employee independent variables include age, gender, income, occupation, business location, injury nature, injury type, body part, marital status, history of WC claims to determine reinjury, and duration of employment. Employer independent variables include industry classification, employer employment size, and establishment account history. In characterizing the matched and mismatched cases we will look at transactional data, which includes date of disability (when time loss occurred or restricted work activity), kept on salary, light duty assignments, billing data, differences between date of injury and date of claim establishment, contested claims (either through attorney involvement or involvement of other legal aspects of workers compensation such as appeals, Board of Industrial Insurance Appeals), vocational retraining, and place of injury. The selection of this information is based on possible employer decision making regarding whether of not to report an injury or illness on the BLS SOII: contested claims may be not included by the employer; reinjuries need not be reported; and claims accepted beyond the period sampled by BLS survey procedures may not be reported.

Logistic regression will be used to evaluate which variables are most predictive of the capture of a work-related injury or illness in one versus both data sources.

Currently, we do not know the number of unweighted injuries reported to BLS by WA employers in their sample of ~5,000 employer establishments. The average number of WA WC claims filed (2006-2009) through the Washington State Fund is ~130,000 and for Washington Self-Insured Employers is ~60,000. All claims will be used for the matching portion of the study but will be quickly narrowed to the dataset of matched employers and matched cases.

Piloting a Multisource Surveillance System for Amputations and CTS:

We will first use the Washington State workers' compensation data and the BLS SOII data to pilot an amputations and CTS multisource surveillance system. The pilot is an off-shoot of the above study as it relies on matching cases but mostly uses the Washington State workers compensation data to create a census of these injuries.

The BLS data uses the Occupational Injury and Illness Classification System (OIICS) to classify cases of occupational injury and illness. There are defined codes that are used to identify amputations (OIICS Nature Code = 0311, 0319) and Carpal Tunnel Syndrome (OIICS Nature Code = 1241). These codes will also be used to identify cases in the WA Self-Insured data for cases involving more than 3 days of time loss. To identify amputation and CTS cases in WA WC State Fund data, we will use a

APPENDIX D (continued)

combination of the following additional injury and illness classification systems:

1. International Classification of Diseases (ICD-9) Diagnosis Codes and Procedure Codes

2. Current Procedural Terminology (CPT)Codes

3. Healthcare Common Procedure Coding System (HCPCS)

4. Diagnosis Related Group (DRG)

The codes used to identify suspected amputation and WR-CTS cases are presented in Table 1 and Table 2 respectively. These injury and illness codes will be used to capture cases through their use in bills for payment received by the Washington State Department of Labor and Industries - these bills may originate from the medical provider, hospital/urgent care/ outpatient surgical center, or within the administrative records used by claims coders to authorize payment for the injured worker. The general location of the codes for use in identifying cases is provided in Table 3.

Since this is a pilot study designed to create a census of these injuries in WA State, our initial approach is to use a very sensitive approach to case identification (identify as many possible cases of CTS and amputations) trading off that we will have less specificity (identify false positive cases - not CTS or amputations). False positive cases will need to be eliminated from the data set as well as a description of the true cases needs to occur. Therfore, we will review the medical records available electronically to confirm that there was an amputation injury or CTS. Medical records are within the L&I data system and are linked to the workers compensation claim identification number. To finalize our surveillance system, a sensitivity analysis will be performed to optimize sensitivity and minimize the number of false positive cases.

5.3 **Describe study procedures.** Explain what subjects will be asked to do, specify where study procedures will be performed, and when or how often study procedures will be conducted (for research involving records, describe record linkage procedures here). Provide a timeline or schedule of events, if applicable. If study procedures will be conducted within facilities such as clinics, hospitals, welfare offices, jails, etc., provide a letter of cooperation from each facility.

Since this is a records linkage study, individual subjects will not be asked to do any study specific activity. All study activities will be conducted at the Washington State Department of Labor and Industries and following approval of a data sharing agreement with the US Dept. of Labor and Washington State IRB approval, at the Bureau of Labor Statistics.

Workers compensation claims will be linked to BLS SOII records for 2006 - 2009 using employer and employee data including employer identifier (federal employer identification number), employer name, employer address, employee name, sex, date of birth, and date of injury. In cases where there exists a workers compensation claim without a BLS match in a sampled BLS employer establishment, we will confirm employment of worker using the Employment Security Department QCEW data. Records will be linked deterministically at first; matching software will be used to attempt to link the remaining records probabilistically.

We anticipate that both the matching component and the multisource surveillance system pilot will occur over the three year project period.

5.4 **List all data collection instruments, including questionnaires, interview guides, assessments or tests, focus group guides, record review forms, etc.** Indicate whether instruments have known reliability and validity, and if not, describe how reliability and validity will be ascertained. Attach copies of all data collection instruments to the application.

None.

APPENDIX D (continued)

6. Study Subjects

6.1 **Does this research involve interactions or interventions with human subjects?**

☒ No - This project involves records research only. (Skip to **Section 8** and complete **Appendix G.**)
☐ Yes

6.2 **Total expected number of subjects over the course of the research:**

6.3 **Age range:**

6.4 **Describe the inclusion criteria for subjects.**

6.5 **Describe the exclusion criteria for subjects.**

6.6 **Will the study exclude subjects based on:**

Gender
☐ No
☐ Yes - Provide rationale for exclusion.

Age (minors, seniors over 65)
☐ No
☐ Yes. Provide rationale for exclusion.

6.7 **Will individuals who are not proficient in English be excluded from the research?**

☐ No. Describe plans for translating or interpreting recruitment materials, scripts, consent forms, and study instruments. (Translations of Board-approved materials must be submitted for review after study approval.)

☐ Yes. Provide rationale for exclusion.

APPENDIX D (continued)

6.8 **Vulnerable subject groups (check all that apply):**

- ☐ Pregnant women/human fetuses/neonates (complete **Appendix B**)
- ☐ Prisoners (complete **Appendix C**)
- ☐ Children (complete **Appendix D**)
- ☐ Developmentally disabled
- ☐ Dementia/cognitively impaired
- ☐ Mentally/behaviorally/emotionally impaired
- ☐ Socially/economically disadvantaged
- ☐ Low literacy/educationally disadvantaged
- ☐ Seniors, over 65
- ☐ Seriously/chronically ill
- ☐ Substance users/abusers
- ☐ Undocumented immigrants
- ☐ Other (describe):

7. Recruitment (Skip this section if you are conducting records research only.)

7.1 **Explain how potential subjects for the research will be identified.** Describe all sources (e.g., agency records, databases, referrals, advertisements, etc.).

7.2 **Does this research involve recruiting subjects who are minors or dependent adults?**

- ☐ No
- ☐ Yes – Explain how, when, and where the parents or legal guardian will be contacted and asked for their permission for the study participation of the minor or dependent adult. (If a waiver of parental/guardian permission will be requested, complete **Appendix I.**)

7.3 **Explain how, when, and where potential subjects will be recruited, including who will make initial research contact with potential subjects.** Explain how privacy will be respected during the recruitment process and describe what steps will be taken to minimize undue influence to participate. (If potential subjects are identified through DSHS, DOH, or L&I, the agency must make initial contact.)

7.4 **Will potential subjects be offered gifts, payments, compensation, reimbursement, services without charge, or other incentives to participate?**

- ☐ No
- ☐ Yes - Describe the type of incentive, the monetary value, and when the incentive(s) will be given.

7.5 **Complete Appendix F: Recruitment, Consent/Assent, and Authorization Documents and attach all recruitment materials.**

8. Risks and Benefits (Complete this section for all research proposals.)

8.1 This research is:

- ☒ Minimal risk
- ☐ More than minimal risk

Explain why in relation to the federal definitions of minimal risk (Page 2):

The proposed analysis uses existing confidential information collected for the administration of social insurance programs (Washington workers' compensation data, Washington Employment Security Department data (Unemployment Insurance data)) and data collected at the federal and state level to characterize the burden of occupational injury and illness (the BLS Survey of Occupational Injury and Illness). Therefore, this research presents no additional requirements of the human subjects where records are being reviewed.

As a proposed analysis of existing workers compensation and BLS data, we do not anticipate that the research presents any risk greater than that posed by the storage of personal records and research use

APPENDIX D (continued)

of data within the Washington State Department of Labor and Industries workers compensation claims database (which already includes Employment Security Department data) and storage and use of the BLS SOII data within the L&I data system.

It is unlikely that subjects whose records are reviewed will know of their inclusion in the research using BLS data, specifically because of the the strict confidentiality associated with the sample of employer establishments included in the BLS Survey. The L&I claim record is confidential under state law (RCW 51.28.070) and the BLS record under the Confidential Information Protection and Statistical Efficiency Act of 2002. Several safeguards are in place against unintintentional release as mentioned in Section 8.4.

8.2 **Does the research involve any of these possible harms and/or discomforts to subjects?** Check all that apply.

- ☒ Invasion of privacy or breach of confidentiality
- ☐ Psychological/emotional discomfort or distress
- ☐ Social stigmatization
- ☐ Legal repercussions
- ☐ Economic (e.g., employment, insurability)
- ☐ Physical harm or discomfort
- ☐ Withholding standard care or procedures
- ☐ Significant time or inconvenience
- ☐ Other (describe):

8.3 **Describe each possible harm and/or discomfort checked above, the probability of the harm occurring, and the magnitude of the harm if it does occur.**

If the systems in place to protect confidentiality were to fail, personal health and occupation information might be made available. If individuals who submitted claims for workers compensation and the reasons for the claims were made known to the public, the claimants may suffer social stimatization from others who view claimants as lazy or from employers who blacklist them. They may be deemed uninsurable if health information were disclosed. The probability of this occuring is very unlikely as there are multiple safeguards in place to protect confidentiality.

Because BLS reporting and workers compensation injury and illness records include employer access to the employees medical record related to the occupational injury, the potential economic threats related to possible disclosure of information to the injured worker's employer are much less than in other occupational studies. The researchers using this data are seperated from the workers compensation claim adjudication procedures and can not share information or impressions with workers compensation claim managers. Research databases are on computer servers isolated from the the Washington State L&I Insurance Services data servers.

8.4 **Describe what steps will be taken to minimize each of the possible harms and/or discomforts to subjects.**

The BLS data files and all workers compensation data extracted from the L&I databases will be stored in password protected encrypted files on L&I SHARP servers. L&I SHARP servers are seperated from L&I claims adjudicator servers. No data will be stored on laptop or desktop 'C' drives or on any equipment outside of L&I or BLS facilities. For purposes of this study, both BLS and L&I data will not be accessed from remote locations (i.e. VPN, Citrix). Electronic logs will be kept of who accesses the data, network, and applications used. Audit logs will be secured. Initially, BLS and L&I data will only be accessible to L&I researchers (until a signed data sharing agreement is in place with the BLS researchers). Internal e-mail distribution of datasets and tabulations will not occur. Data tabulations will be faxed to BLS. When data is transferred to BLS it will be by secure FTP and the data will encrypted. All paper documents will be stored in secured filing cabinets and will be disposed of in certified, marked or locked disposal bins until they can be shredded. Workstations in non-office settings will have security screens. We will evaluate for erasure of the data before 6/30/2014 but may defer such action with the consent of the IRB depending on the status of data analysis, additional

APPENDIX D (continued)

research requests, and publications. Once it has been determined that there is no more use for the data, it will be eliminated from L&I servers and BLS servers. Procedures for BLS handling of L&I data will be documented in the data sharing agreement between the two agencies.

All L&I personnel who have contact with the BLS data and the L&I data, sign confidentiality agreements from BLS and L&I. The confidentiality agreements cite the applicable laws describing the penalties associated with the disclosure of the data under use. Discussion of research data and any case reviews regarding this project will be done with recognition of confidentiality and efforts to prevent unauthorized individuals from obtaining any information regarding cases.

8.5 **If this research involves interactions or interventions with human subjects, describe what steps will be taken if subjects experience serious distress, discomfort, or decompensation during study participation.** (If this is records research only, type "NA.")
NA

8.6 **Describe any anticipated benefits for individual subjects who are participating in or whose records are being used in this research.** If none, type "None."
None

8.7 **Describe how this research will benefit the class of subjects or contribute to general knowledge.**

Federal policymakers use BLS data to assess the overall effectiveness of federal OSHA efforts. This research will address the question of whether the BLS undercounts workplace illnesses and injuries and, if so, identify the types of illnesses and injuries that may not be reported in the survey. The research will also assess whether multiple data sources can be used to produce accurate estimates of WR-CTS and amputations. Our findings may suggest improvements to surveillance methods that would result in more accurate estimates of occupational injuries and illnesses and provide an evidence based allocation of OSHA resources and more confident estimates of occupational injury and illness rates.

8.8 **Explain how the anticipated benefits of this research outweigh the harms and/or discomforts.**
The anticipated benefit of improved workplace health and safety among the population of U.S. workers, gained through well informed occupational safety and health programs outweighs the low probability of harm to injured workers through breach of confidentiality. Generally, the breadth of data available in the Washington workers compensation data can provide unparralled understanding for the reasons cases are not reported on the BLS SOII. By identifying the injuries or illnesses that may be underreported to BLS e.g. CTS or musculoskeletal disorders, improvements may be made in BLS SOII design and capture of these underreported injuries. Current assessments of the 'overall' improvement in occupational safety and health statistics by stakeholders needs to be qualified by additional information. This study provides data to qualify the effectiveness of federal and state OSHA efforts.

9. Confidentiality and Data Security (Complete this section for all research proposals.)

9.1 **Will direct identifiers of study subjects be recorded?** Direct identifiers include name, address, phone, email address, Social Security Number, client identifier, medical record numbers, account numbers, PICCODE, license numbers, etc.

☐ No
☒ Yes - List the direct identifiers to be collected and explain why they are needed to conduct the research.
We intend to proceed in a stepwise approach to first match establishments, then match cases within matched establishments and then conduct an overall match of cases regardless of establishment in anticipation of difficulties in assigning workers to specific establishments within the L&I data base. The process provides important information related to the matching methods between the BLS SOII and WA WC.

APPENDIX D (continued)

However, while our protocol will involve the above, the match really reduces to matching individual worker cases between WA WC and WA BLS data based on the following data elements - worker name, worker date of birth and worker date of injury, employer name, employer address, employer federal identification number. In essence this is the data provided by BLS to identify injured workers and employers on the BLS SOII. Employer information alone is typically not information that is a direct identifier. However in this study, since it is linked to worker name and other personnel identifiers and to where the individual works, it facilitates the identification of the worker in L&I databases. Dr. Boden used four employee data elements - worker name, gender, age, and date of injury to match cases between the two systems; we are following his model for matching. We employ the use of the ESD data to add measures to verify matching of specific injured workers to specific establishments where the BLS Survey was conducted. The SSN provides a means to directly match an L&I claimant to a specific establishment identifier that is sampled by BLS or an establishment within a multiestablishment firm.

9.2 **Explain how confidentiality will be protected during each stage of data collection.**
Data is not being collected in this study but data is transferred between entities. Initial data transfer from BLS to SHARP will be made on electronic media storage devices (encrypted CD-ROMs, thumb drives). SHARP personnel were required to sign BLS confidentiality agreements.

9.3 **Explain how the physical security of source data and research records will be protected.**
The BLS data and L&I data extracts will reside on SHARP program network servers, which are isolated from L&I servers and will not be stored on computer "C" drives. Electronic files will be password protected and encrypted. Only SHARP BLS project staff will have the encryption software. Electronic data will not be stored on laptops, on L&I equipment outside of L&I facilities, not be transmitted by e-mail, and not be accessed remotely through Citrix. Computer monitors will have security screens, be password protected with hard passwords, and be locked when not in use.

Printed materials will be stored in secured area, locked file cabinets when not in use and disposed in accordance with confidential information - locked, disposal bins with subsequent shredding.

9.4 **Will a link between study code numbers and direct identifiers be retained after all contacts with subjects are completed or all record linkages performed?**

☐ No
☒ Yes - Explain why it is necessary to retain the link and between study codes and direct identifiers.
The primary purpose of the research study is to determine the overlap and discrepancies between the BLS SOII data and the Washington workers compensation data so retention of data elements that identify linked cases is important. Descriptive analyses of the linked and unlinked cases between the two datasets is important to determine the types of cases common and discrepant between the two systems. The final dataset likely will have a merge of the two datasets to also assess how cases are classified (nature of injury, source of injury) between the two systems.

9.5 **Specify the date when all direct identifiers will be permanently destroyed.**
We will evaluate destroying the identifiers associated with this research before 6/30/2014 but may defer, with IRB approval, depending on the status of data analysis, additional research requests, and publications.

9.6 **Will identifiable research data be disclosed to other parties?** (See Application Definitions.)

☐ No
☒ Yes - Describe the data to be disclosed, to whom, and the purpose of each disclosure.
We have co-investigators at the US Department of Labor Bureau of Labor Statistics who likely will be interested in analyses of the datasets. We intend to share data with our co-investigators over time following the institution of a data sharing agreement for the purpose of better understanding the

APPENDIX D (continued)

reasons for the mismatch.

9.7 **Do study plans involve using these research data for a future study?**

☐ No
☒ Yes – Explain.
We plan to use the results of the dataset matching effort to identify employers whose cases consistently match and employers whose cases are consistently missing from one database. In a future portion of this study, we would like to interview these employers to gather information on how they complete and submit their occupational injury and illness records. We anticipate submitting a separate IRB application for this work.

9.8 **Will a public use (i.e., de-identified) dataset be produced at the completion of the research?** (See Application Definitions.)

☒ No
☐ Yes - A file layout of all data elements must be submitted for WSIRB review prior to release.

9.9 **Will any identifiable research data or the study consent form be placed in a subject's medical records or case file?**

☒ No
☐ Yes - Explain.

9.10 **Will a federal Certificate of Confidentiality be requested?**

☒ No
☐ Yes, from (agency).

10. Mandatory Reporting (Skip this section if you are conducting records research only.)

WSIRB Policy requires reporting of all suspected abuse/neglect of children and vulnerable adults, and reporting of threats of harm to self (suicidal ideation) or others. Some research involves diagnostic testing or clinical care, such that reporting of health conditions is required. All instances of mandatory reporting must be described in study consent/assent forms as exceptions to confidentiality.

10.1 **Could interventions or interactions with subjects produce information that may lead to suspicion of abuse/neglect of a child?** (RCW 26.44)

☐ No
☐ Yes - Explain plans for reporting such incidents to Child Protective Services.

10.2 **Could interventions or interactions with subjects produce information that may lead to suspicion of abuse/neglect of a vulnerable adult?** (RCW 70.124, RCW 70.34)

☐ No
☐ Yes - Explain plans for reporting such incidents to Adult Protective Services or, in the case of state hospital patients, to hospital staff.

10.3 **Could interventions or interactions with subjects produce information that may lead to concern about threats of suicide or harm to other persons?**

☐ No
☐ Yes - Explain plans for reporting such incidents and plans to be implemented in the event of imminent threat of harm.

10.4 **Will study procedures involve testing or diagnosis of any disease or condition that is reportable under WAC 246-101?** (Such as HIV or other STDs, blood lead levels, etc.)

☐ No
☐ Yes. Include a statement in the study consent form that the subject's condition will be reported to the state or local health department, as applicable.

APPENDIX D (continued)

11. Use and/or Disclosure of Identifiable Records or PHI (Complete this section for all research proposals.)

11.1 **Does this research involve use or disclosure of identifiable records or PHI?**

- ☐ No – Skip to Section 12.
- ☒ Yes

11.2 **Will signed authorization be obtained from study subjects and/or their parents/guardians for the use or disclosure of their identifiable records or PHI?**

- ☒ No
- ☐ Yes – Explain how, when, and where signed authorization will be obtained and complete **Appendix F**.

11.3 **Are you requesting a waiver of authorization for the use or disclosure of identifiable records or PHI?**

- ☐ No
- ☒ Yes – Complete **Appendix I, Section 4**.

12. Informed Consent/Assent Process (Skip this section if you are conducting records research only.)

Signed informed consent/assent for study participation, and signed parent/guardian permission for the participation of a child, is required for studies that involve interventions or interactions with human subjects unless specific requirements are met and the WSIRB approves a waiver of consent/assent, or a waiver of parent/guardian permission.

12.1 **Are you requesting a waiver of:**

• Documentation of consent/assent for study participation	☐ Yes	☐ No
• Some or all required elements of consent/assent	☐ Yes	☐ No
• Parent/guardian permission for study participation of a child	☐ Yes	☐ No

If "yes" to any item, complete **Appendix I, Section 1, 2, and/or 3**.

12.2 **Identify who will obtain consent, assent, or parent/guardian permission.** Provide job titles/credentials, and a description of consent training for all individuals responsible for obtaining consent.

12.3 **Describe when, where, and how consent, assent, and/or parent/guardian permission will be obtained.** Attach a script to introduce and explain the research to potential subjects or parents/guardians of potential subjects.

12.4 **Explain how subjects' understanding of the research procedures and the risks and benefits of study participation will be assessed.**

12.5 **Will a witness to the consent/assent process be used?**

- ☐ No
- ☐ Yes. Identify the individual who will serve as a witness and describe his/her qualifications.

12.6 **Complete Appendix F: Recruitment, Consent/Assent, and Authorization Documents, and attach all consent/assent materials.**

Application Checklist

The following documents must be submitted with the application, when applicable.

- ☒ CVs/resumes for all investigators and research staff (limit to five pages each)
- ☒ Complete grant application (if project is funded by an external agency and DSHS, DOH, or L&I is the grantee) (one copy double-sided)
- ☐ All data collection instruments including questionnaires, interview guides, assessments or tests, focus group guides, etc.
- ☒ Appendix A: Additional Research Staff
- ☐ Appendix B: Research Involving Pregnant Women, Human Fetuses, and Neonates as Subjects
- ☐ Appendix C: Research Involving Prisoners as Subjects
- ☐ Appendix D: Research Involving Children as Subjects
- ☐ Appendix E: Unaffiliated Investigator Agreement (Send with signed original only.)
- ☐ Appendix F: Recruitment, Consent/Assent, and Authorization Documents
- ☐ Appendix G: Requests for Use or Disclosure of Records

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☐ Appendix H: Resource Requests
☒ Appendix I: Consent/Authorization Waivers

Submission of an incomplete application is a common cause for delay in the review of proposals.

If you have questions about the information required for review, please contact the Human Research Review Section at 360-902-8075 or at wsirb@dshs.wa.gov.

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Washington State Institutional Review Board (IRB)
Research Application: Human Subjects Protection Review

Appendix I: Consent/Authorization Waivers

Indicate any waivers you are requesting and complete the appropriate sections.

1. ☐ **Waiver of Signed Consent/Assent for Study Participation**

   WSIRB may waive the requirement for written documentation (but still require that consent be obtained) if either of the following conditions exist. Indicate which conditions apply and provide protocol-specific language to explain.

   1.1 The only record linking the subject and the research would be the consent form and the principle risk of the research would be the potential harm from a breach of confidentiality.
   Explain:

   OR

   1.2 The research involves minimal risk to subjects and includes no procedure for which written consent is normally required outside the research context.
   Explain:

   Note: In either case, the WSIRB may require the researcher to provide the participant with a written statement about the research.

2. ☐ **Waiver of Some or All Required Elements of Informed Consent/Assent for Study Participation**
   Explain:

   WSIRB may waive the requirements for informed consent/assent in accordance with 45 CFR 46.116(d) if all of the following conditions are met. Use protocol-specific language to explain how the proposed research meets the following conditions.

   2.1 This research involves no more than minimal risk to subjects.
   Explain:

   2.2 The waiver won't adversely affect the rights and welfare of the subjects participating in the research.
   Explain:

   2.3 This research could not practicably be carried out without a waiver or alteration.
   Explain:

   2.4 When appropriate, subjects will be provided with pertinent information after participation.
   Explain:

3. ☐ **Waiver of Parent/Guardian Permission for Study Participation of a Child**

   WSIRB may grant a waiver of parent/guardian permission for participation of a child in research if all of the following conditions are met. Use protocol-specific language to explain.

   3.1 This research involves no more than minimal risk to the child.
   Explain:

   3.2 The waiver won't adversely affect the rights and welfare of the child participating in the research.
   Explain:

APPENDIX D (continued)

3.3 This research could not practicably be carried out without a waiver of parent/guardian permission.
Explain:

3.4 Parent/guardian permission is not a reasonable requirement to protect children in this research and an appropriate mechanism for protecting the children who will participate in this research will be substituted for parent/guardian permission.
Explain:

3.5 When appropriate, parents/guardians will be provided with pertinent information after their child's participation.
Explain:

4. ☒ **Waiver of Authorization for Use or Disclosure of Identifiable Records or Protected Health Information (PHI).**

WSIRB may grant a waiver(s) of authorization for use or disclosure of identifiable records or PHI if the following conditions are met. Complete the following for each proposed use or disclosure of identifiable records or protected health information. Use protocol-specific language to explain, then sign the assurance below. **The research must meet <u>all</u> the criteria below for a waiver of authorization. Please read the next page before completing this section.**

4.1 The research involves no more than minimal risk to subjects.
Explain:
This is a records research study using three datasets: Washington workers compensation (WC) data, BLS Survey of Occupational Injury and Illness (SOII) data, and Employment Security Department (ESD) data. The primary risk for this project is the disclosure of identifiable personal health information and financial information by researchers or from the researchers databases. Risks of disclosure do not exceed those of the current data use by L&I and have been reduced by increased security protections for data including use of encrypted BLS files and encrypted matched L&I and BLS records, an isolated file on the L&I server (access restricted to SHARP BLS project researchers), and prohibited remote access of data. Disclosure to the employer is less of a risk in this study since the datasets used in this study are either generated by the employer (OSHA log and reporting to BLS SOII, and the ESD datasets), or are currently available to the employer (WA workers compensation claim record) for review. Of note, the BLS SOII data is protected from purposeful disclosure by the Confidential Information Protection and Statistical Efficiency Act of 2002, Public Law 107-347, with willful and knowing disclosure of confidential information classified as a Class E felony with the potential for imprisonment and or monetary penalty.

4.2 The waiver of authorization won't adversely affect the rights and welfare of the subjects participating in the research.
Explain:
No restriction to benefit entitlements from L&I will occur as the data is restricted to use by authorized L&I SHARP research staff and BLS research staff. Data will not be disclosed outside of L&I or BLS. It is likely that the research subject will be unaware of the use of their data within the research and therefore would be unlikely to suffer any recognized harms.

4.3 It is not practical to obtain signed authorization for this disclosure.
Explain:
The BLS SOII and ESD data does not contain address, telephone or other contact information from which to obtain a signed authorization. The records review will likely exceed ~10,000 records for the amputations and carpal tunnel syndrome multisource surveillance systems within L&I data. Current state law allows use of the WA WC records for research and while obtaining authorization would be optimal, the potential conflict from denying by a claimant sets up an impossible burden regarding this existing state law.

4.4 It is not possible to conduct this research without use or disclosure of identifiable records or PHI.
Explain:
PHI is required for matching between BLS and WA WC. Medical record use is required to obtain an accurate description of the injury and understanding potential misclassification of the injury by the employer.

4.5 Identifiable information used or disclosed for this research will be protected from improper uses or disclosure.
Explain:
Security protections in place include use of password protected access to the L&I network, specific project folder on the L&I network where access is granted only to L&I BLS project staff, encryption of BLS data and L&I - BLS linked datasets and tabulations, no remote access of datasets, no e-mailing of datasets or tabulations and additional civil and criminal penalties associated with use of BLS data. Following linking of datasets, matched BLS records will be assigned the corresponding L&I claim ID number. This will be the linking variable between

APPENDIX D (continued)

the two datasets

4.6 This research is of sufficient importance to outweigh the intrusion into the privacy of subjects that will result from the use or disclosure of his/her identifiable records and/or protected health information.
Explain:
This project will identify possible mismeasurement of the state and national statistics which have long been used by advocates as a means to evaluate state and national progress towards providing safer workplaces. Detractors from BLS have discussed the undercount as a cause for concern, and with some minimal limitations this research should provide a meaningful answer to these concerns. Further, Washington State has long been criticized for elevated BLS injury rates compared to other states and this will provide some important information related to data quality from workers compensation and BLS to identify the reasons for a possible elevated rate. Workers and employers will benefit from the social good associated with this research and evaluation project.

4.7 When appropriate, the subjects will be provided with additional pertinent information after participation.
Explain:
There will be publications in the public health literature, reports to the federal government, and likely presentation of information to elected state and federal elected officials regarding possible improvements the BLS SOII.

4.8 Explain when and how identifiable information used or disclosed for this research will be destroyed.
We anticipate evaluation for erasure of study datasets by 6/30/2014. Depending on publication status, additional requests for analyses, and possible expanded study objective from BLS, Congress and others, we may request an extension of this date. Please note that record level BLS data are not disclosable under federal law and identifiers in the L&I database which link to BLS survey establishments or cases are considered non-disclosable. These provisions, in essence preclude creation of a deidentified L&I dataset for release outside of the research context.

If you are requesting a waiver of authorization, provide your signed assurance:

As Principal Investigator, I assure that identifiable personal records and/or protected health information used or disclosed for this research without written authorization will not be reused for other purposes, or disclosed to any other person or entity, except as specifically required or permitted by law and approved by the WSIRB. I further assure that no individual whose records or protection health information is used in this research will be identified in any written report resulting from this research. I understand that, as the principal investigator of this research, I am also responsible for ensuring that all members of this research team will abide by these restrictions.

PRINICIPAL INVESTIGATOR'S SIGNATURE	DATE
	12/11/09

APPENDIX D (continued)

Waiver of Authorization

Signed authorization for disclosure of personally identifiable records is required, unless the WSIRB approves a waiver. This is the case even if direct identifiers (name, SSN, case numbers, medical record numbers, etc.) are not requested. A research protocol involves human subjects when personally identifiable information about individuals is used and disclosed for research purposes.

Researchers should consider the following points when preparing the justification for a waiver of authorization.

Criterion: The research involves no more than minimal risk to subjects.

- Every research project could potentially incur some risk to subjects. Explain the potential risk(s) to subjects specific to the proposed research. Explain why research risks are minimal. Explain procedures to lessen the possibility that the risk(s) would occur.

Criterion: The waiver of authorization won't adversely affect the rights and welfare of the subjects participating in the research.

- Individuals have an inherent right to privacy of personally identifiable information. Research involving disclosure of records without authorization is, by its nature, intruding on subject privacy. Explain protections to ensure that the research, although an invasion of privacy, will minimize potential harms to subjects (physical, social, emotional, etc.).

Criterion: It is not practical to obtain written authorization for this disclosure.

- Explain why it is not feasible, or could be detrimental to the research, to request a signed authorization from study subjects. Cost by itself is not sufficient justification.

Criterion: It is not possible to conduct this research without use or disclosure of identifiable records or PHI.

- Explain why the specific identifiable records are necessary in order to conduct the research. Why couldn't the study be carried out with de-identified records? Are identifiers--even indirect identifiers--really necessary?

Criterion: Identifiable information used or disclosed for this research will be protected from improper uses or disclosure.

- Explain confidentiality protections for records disclosed for the research: who will have access, where records will be housed, when identifiers will be removed, security procedures for research offices, computers, LANs or networks, etc.

Criterion: This research is of sufficient importance to outweigh the intrusion into the privacy of subjects that will result from the disclosure of his/her identifiable records and/or protected health information.

- Provide a strong scientific rationale for conducting the research. What would this research contribute to scientific knowledge or alleviation of a social/public health problem? In what ways would the importance of research findings justify intrusion into subject privacy?

Criterion: When appropriate, the subjects will be provided with additional pertinent information after participation.

- Explain whether subjects will be given information about research findings and told that their records were disclosed for the research without their authorization. If subjects will not be contacted for this purpose, simply state this and explain why.

Criterion: Explain when and how identifiable information used or disclosed for this research will be destroyed.

- If a waiver of authorization is approved by the WSIRB, state law requires that the records disclosed be de-identified when the research is completed. We generally expect that the de-identification standards in the HIPAA Privacy Rule be followed for this purpose. If an alternate method is proposed, explain it. State when identifiers--including indirect identifiers--will be permanently destroyed, and explain the mechanism for destruction. This includes destruction of paper printouts, disks, cleaning computer drives, etc.

APPENDIX E

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APPENDIX E (continued)

APPENDIX E (continued)

VITA

Sara E. Wuellner

Education

PhD candidate	University of Illinois, Chicago School of Public Health, Environmental and Occupational Health Sciences Expected graduation date: August 2015
MPH	University of Illinois, Chicago School of Public Health, Epidemiology and Biostatistics, July 2004
BA	University of Chicago Sociology, June 1998

Employment

Washington State Department of Labor & Industries, 2009–present

Epidemiologist

- Coordinate BLS-funded Washington State research into underreporting in the Survey of Occupational Injuries and Illnesses.
- Design study, develop survey tool, conduct interviews, and analyze data to assess establishment-based occupational injury record-keeping practices through interviews with SOII respondents.
- Execute record linkage of injury data across multiple data sources including SOII, workers' compensation claims data, and hospital discharge data.
- Analyze employer reporting in SOII compared to WC data using statistical methods.
- Publish findings in technical reports and peer-reviewed journal articles

University of Illinois, Chicago, School Of Public Health, 2005–2009

Study Coordinator

- Coordinated and conducted data collection including environmental sampling and recruitment of human subjects.
- Designed database for environmental data.
- Supervised field teams of research assistants.
- Maintained communication with study participants, community stakeholders, media, and scientific advisory board.
- Maintained Institutional Review Board approval for study protocol.

University of Chicago Medical Center, Obstetrics & Gynecology, 2004–2005

Epidemiologist

- Developed research protocol and questionnaire for online survey of college women's contraceptive practices and attitudes.
- Conducted qualitative interviews with women regarding contraceptive practices and reproductive history.

- Conducted statistical analyses (summary statistics, multivariable regression) using SAS.
- Prepared three manuscripts for publication in peer-reviewed journals.

Oregon Department of Human Services, Office of Family Health, Summer 2003
Research Analyst

- Analyzed statewide Medicaid, Pregnancy Risk Assessment Monitoring Survey (PRAMS), and vital statistics databases for state Maternal and Child Health Epidemiologist using SAS and SPSS.
- Presented findings at interagency meetings, national Maternal and Child Health conference.
- Participated in development of new state questions for Oregon PRAMS.

University of Illinois, Chicago, School Of Public Health, 2002–2004
Research Assistant

- Implemented pilot study of home environmental health-hazards education program, analyzed pilot data, and modified program survey tools accordingly.
- Executed gravimetric analysis with quality control procedures for projects on lung function of welders and swine confinement workers.
- Performed literature reviews to inform survey development.

Teaching experience

University of Illinois, Chicago, School Of Public Health, 2005–2009
Teaching Assistant

- Atmospheric Sampling for Environmental Health Professionals
- Air Quality Management

Publications

Wuellner, S. E., and D. K. Bonauto. "Exploring the Relationship between Employer Recordkeeping and Underreporting in the BLS Survey of Occupational Injuries and Illnesses." *Am J Ind Med* 57, no. 10 (2014): 1133–43. doi: 10.1002/ajim.22350.

Wuellner, S. E., and D. K. Bonauto. "Injury Classification Agreement in Linked Bureau of Labor Statistics and Workers' Compensation Data." *Am J Ind Med* 57, no. 10 (2014): 1100–9. doi: 10.1002/ajim.22289.

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Zite, N., S. Wuellner, and M. Gilliam. “Barriers to Obtaining a Desired Postpartum Tubal Sterilization.” *Contraception.* 73, no. 4 (2006): 404–7.

Zite, N., S. Wuellner, and M. Gilliam. “Failure to Obtain Desired Postpartum Sterilization: Risk and Predictors.” *Obstet Gynecol* 105, no. 4 (2005): 794–799.

Conference Presentations

Wuellner S. E., C. Rappin, W. Lu, and D. Bonauto. “Temp Worker Injuries in the BLS Survey of Occupational Injuries and Illnesses.” Poster presented at the Annual Meeting of the American Public Health Association, New Orleans, LA, November 2014.

Wuellner S.E., and D.K. Bonauto. “Occupational injury record-keeping among BLS sampled establishments: Implications for national surveillance.” Paper presented at the Annual Meeting of the American Public Health Association, Boston, MA, November 2013.

Wuellner S. E., D. Adams, and D. K. Bonauto. “Musculoskeletal Disorders, Injuries with Lengthy Work Absences often not Eligible for the BLS Survey of Occupational Injuries and Illnesses.” Paper presented at the Annual Meeting of the Council of State and Territorial Epidemiologists, Pasadena, CA, June 2013.

Wuellner S. E., and D. K. Bonauto. “How Employer Record-keeping Practices Threaten State-to-State Comparisons of BLS estimates.” Poster presented at the Annual Meeting of the American Public Health Association, San Francisco, CA, October 2012.

Wuellner S. E., D. Adams, and D.K. Bonauto. “Enumerating Work Injuries Using Multiple Data Sources: Feasibility in Washington State.” Paper presented at the Bureau of Labor Statistics meeting on SOII Undercount Research, Washington, DC, July 2012.

Wuellner S. E., and D. K. Bonauto. “Occupational Injury Record-keeping Knowledge and Practices: Lessons from Interviews with Washington State Employers.” Paper presented at the Annual Meeting of the Council of State and Territorial Epidemiologists, Omaha, NE, June 2012.

Wuellner S. E., and D. K. Bonauto. “Evaluation of Two Outcomes in a Case-Matched Dataset: Amputations and Carpal Tunnel Syndrome.” Paper presented at the National Occupational Injury Research Symposium, Morgantown, WV, October 2011.

Wuellner S. E., and D. K. Bonauto. “Surveillance of Work-Related Amputations Through Pooled Data Sources.” Paper presented at the Annual Meeting of the Council of State and Territorial Epidemiologists, Pittsburgh, PA, June 2011.

Wuellner S. E., and D. K. Bonauto. “Work-Related Injury and Illness Surveillance Through Multiple Data Sources: A Pilot Project.” Paper presented at the Annual Joint Statistical Meetings, Vancouver, BC, August 2010.

Wuellner S. E., and D. K. Bonauto. “From Time of Injury to Loss of Limb: Work-Related Amputations In Washington State 2006–2007.” Paper presented at the Annual Meeting of the Council of State and Territorial Epidemiologists, Portland, OR, June 2010.